Bellingen Shire COUNCIL

Standard Conditions for Engineering Works Associated with Developments

AUS-SPEC Cover Document

Revision: 1
Adopted: 26/06/2013 (Minute 08.016/13)
Council Reference: DWN 407037
(Transition period between previous document and this document until 31 December 2013)
Adopted standard conditions to apply to all development applications from 2014 (ie after 31/12/13)

Introduction

Council's Standard Conditions for Engineering Works Associated with Developments set out the minimum standards required for engineering works associated with development in Bellingen Shire.

These Standard Conditions are intended to ensure that works proposed to be built as part of a development are carried out in accordance with sound, contemporary engineering practice. In particular, they are intended to ensure that:

- any infrastructure that becomes a Council asset is safe, serviceable and durable.
- developments have satisfactory access in relation to the public road network.
- development is suitably provided for and compatible with other Council services, such as water and sewerage.
- development is carried out in accordance with relevant legislative requirements.

This document nominates those specifications from the AUS-SPEC suite of specifications that have been adopted by Council as standard conditions for engineering works associated with developments.

It also outlines other Council documents which are relevant to the development process and clarifies the hierarchy of documents to be used in the case of any discrepancy.

Specification currency

Specifications and standard drawings will change from time to time to ensure that they meet standards. The most current version of Councils standards will be available on Councils website (www.bellingen.nsw.gov.au) and it is the responsibility of developers/applicants to ensure that they are working to the most current standards.

Unless otherwise noted below, the most current Council adopted standards are dated **January 2014** (See footer of individual specification).

Adopted AUS-SPEC specifications

00 PLANNING AND DESIGN

001 General
0010 Quality requirements for design
0011 Development and subdivision of land
0012 Waterfront development
0013 Bushfire protection

002 Open space
0021 Site Regrading

004 Road reserve
0041 Geometric road Layout
0042 Pavement design
0043 Subsurface drainage (Design)
0044 Pathways and cycleways (Design)

006 Bridges
0061 Bridges and related structures

007 Public utilities
0071 Water supply – reticulation (Design)
0072 Water supply – pump stations (Design)
0074 Stormwater drainage (Design)
0075 Control of erosion and sedimentation (Design)
0076 Sewerage systems – reticulation (Design)
0077 Sewerage Systems – pump stations (Design)

02 SITE, URBAN AND OPEN SPACES

022 Preparation and ground work
0221 Site management
0222 Earthwork
0223 Service trenching
0224 Stormwater – site

025 Landscape cultivation
0257 Landscape – roadways and street trees

027 Pavements
0271 Pavement base and subbase
0272 Asphaltic concrete
0273 Sprayed bituminous surfacing
0274 Concrete pavement
0275 Segmental pavers – mortar bed
0276 Segmental pavers – sand bed
0277 Pavement ancillaries
0278 Granular surfaces.

028 Pathways
0281 Bushfire perimeter Tracks
0282 Pathways and cycleways (Construction)

029 Retaining walls
0292 Masonry walls
0293 Crib retaining walls

11 CONSTRUCTION – ROAD RESERVE

110 General
1101 Control of traffic
1102 Control of erosion and sedimentation (Construction)

111 Formation preparation
1111 Clearing and grubbing

1112 Earthworks (Roadworks)
1113 Stabilisation

112 Rainwater collection
1121 Open drains, including kerb and channel (gutter)
1122 Kerb and channel (gutter) replacement

114 Flexible pavements
1141 Flexible pavement base and sub base
1142 Bituminous cold mix
1143 Sprayed bituminous surfacing
1144 Asphaltic concrete (Roadways)
1145 Segmental paving
1146 Bituminous slurry surfacing

115 Road openings and restorations
1151 Road openings and restoration
1152 Road openings and restoration (Utilities)

116 Rigid traffic barriers
1163 Rigid road safety barrier systems

117 Pavement moisture control
1171 Subsurface drainage
1172 Subsoil and foundation drains
1173 Pavement drains
1174 Drainage mats

119 Traffic facilities
1191 Pavement Markings
1192 Signposting
1193 Guideposts
1194 Non-rigid road safety barrier systems
1195 Boundary fences for road reserves
1196 Street lighting

13 CONSTRUCTION – PUBLIC UTILITIES

134 Water supply
1341 Water supply – reticulation (Construction)
1342 Water supply – pump stations (Construction)

135 Water cycle management
1351 Stormwater drainage (Construction)
1352 Pipe drainage
1353 Precast box culverts
1354 Drainage structures

136 Sewerage systems
1361 Sewerage systems – reticulation (Construction)
1362 Sewerage systems – pump stations (Construction)

139 Others
1391 Service conduits
1392 Trenchless conduit installation

Standard Drawings

The following standard drawings have been adopted by Council and should be used to inform design. The standard drawings are available from Council's website (www.bellingen.gov.au).

	Drawing title	Year/Reference nominated on drawings	Council Reference (Dataworks #)
1	Standard Residential Dish Crossing and Pram Ramp	1992/587	359954
2	Standard Design for concrete footpath	2011	359955
3	Standard access culvert for rural roads	2009/RD1	359956
4	Standard access for rural roads – No culvert required	2009/RD2	359957
5	Driveway footpath crossing	2008/UD1	359958
6	Standard pipe culvert access	1987/512	359959

Handbook of Drainage Design

Where the AUS-SPEC specification references a 'Handbook of Drainage Design', required parameters and standards should be obtained from Councils Development Control Plan.

Where a particular parameter or standard cannot be obtained from existing Council documentation it shall be selected in line with industry best practice and nominated on documentation submitted to Council as part of the development application.

Drainage calculations are to be in accordance with Australian Rainfall and Run-off (1987). Stormwater modelling and calculations must be completed by a practicing civil or environmental engineer with experience and qualifications eligible for admission as a member of Engineers Australia.

Discrepancies and plan hierarchy

There are a number of documents and plans which inform development in Bellingen Shire. In particular specific development requirements are contained in Councils Local Environment Plan (2010) (LEP) and Development Control Plan (DCP).

In the event of a discrepancy in direction between Council specific documents, the directives shall take precedence in the following document order:

1. Bellingen Shire currently adopted Local Environment Plan (2010) (LEP)
2. Bellingen Shire Development Control Plan (DCP)
3. Bellingen Handbook of Drainage Criteria
4. Bellingen Water Sensitive Urban Design Guidelines
5. Bellingen Standard conditions for Engineering Works Associated with Development (AUS-SPEC specifications)
6. Bellingen Shire Council adopted Standard Drawings

That is, a directive given in the LEP shall take precedence over a directive given in the DCP, and so on.

If any further discrepancy or ambiguity exists, the matter shall be directed to the Deputy General Manager of Operations for resolution.

Other Industry Standards

If an engineering specification, design or drawing is not adequately covered by the available Council development documentation a developer may submit an alternative standard for consideration.

Any alternative standard must be approved in writing by Council's Deputy General Manager Operations prior to being utilised.

AUS- SPEC standards "Witness" and "Hold" points

Various standards require pausing of works or submission of documentation to ensure the maintenance of quality throughout the development. These points are referred to as "Witness Points" or "Hold Points"

Where the AUS-SPEC standards refer to a "**Witness point**", the appropriate documentation or works are to be witnessed by a supervising engineer.

Where the AUS-SPEC standards refer to a "**Hold point**", the appropriate documentation or works are to be witnessed by Councils Development Engineer or other Council officer as directed by Council Deputy General Manager of Operations. Release of the Hold Point will be authorised in writing by the appropriate Council Officer.

0010 QUALITY REQUIREMENTS FOR DESIGN

1 GENERAL

1.1 RESPONSIBILITIES

Objective
General: Provide a Quality Management System (QMS) for the execution and recording of design processes.

Performance
Requirements:

- Demonstrate the QMS by providing records of the design process.
- Provide documentation relevant to asset management.

Design qualifications
Designer: Qualification suitable for membership with Engineers Australia as a Professional Engineer

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

Standards

AS/NZS 1170-Various	Structural design actions
AS 1684-Various	Residential timber-framed construction
AS 1742-Various	Manual of uniform traffic control devices
AS 1742.2-2009	Traffic control devices for general use
AS 3600-2009	Concrete structures
AS 4100-1998	Steel structures
AS 5100-Various	Bridge design
AS/NZS ISO-9000:2006	Quality management systems - Fundamentals and vocabulary
AS/NZS ISO-9001:2008	Quality management systems - Requirements
AS ISO-10013:2003	Guidelines for quality management system documentation
AS/NZS ISO-19011:2003	Guidelines for quality and/or environments management systems auditing
SAA HB 90.3-2000	The Construction Industry - Guide to ISO 9001:2000

Other publications

Engineers Australia

Australian Rainfall and Runoff (AR&R) – 1997

WSAA

WSA 02: 2002	Sewerage Code of Australia WSA 02
WSA 03: 2011	Water Reticulation Code of Australia Version 3.1

1.4 STANDARDS

General
Standard: To AS/NZS ISO 9001.

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:

- BCA: Building Code of Australia.
- QMP: Quality Management Plan.
- QMS: Quality Management System.

Definitions

General: For the purposes of this worksection the definitions given in AS/NZS ISO 9000 and the following apply:

- Accreditation: Certification by a statutory or approved authority of the facilities, capabilities, objectivity, competence and integrity of an organisation or individual to provide a specified service and/or required operation.
- Certification: Assertion, in writing, of facts.
- Hold point: A defined position in the different stages of the Contract beyond which work can not proceed without mandatory verification and acceptance by the Superintendent.
- Non-conformance: Non fulfilment of a requirement, need or expectation that is stated, generally implied or obligatory.
- Professional engineer: A person who is listed or eligible for listing on the National Professional Engineers Register (NPER) and has appropriate experience and competence in the relevant discipline at the relevant time.
- Quality design check lists: Forms completed during the design process verifying key steps, and records.
- Records: Documents and data which are no longer subject to alteration and provide evidence of activities performed.
- Validation: Confirmation, through the provision of objective evidence, that requirements for a specific intended use or application have been fulfilled.
- 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.

2 QUALITY MANAGEMENT SYSTEM FOR DESIGN

2.1 GENERAL REQUIREMENTS

Design organisation's quality plan

Requirements: Provide a Quality Plan in conformance with AS/NZS ISO 9001, to include the following:

- Quality manual including the organisation's Quality Policy.
- Responsibilities for the implementation of the Quality Policy for the project.
- A commitment from top management to the development and implementation of the QMS.
- Evidence of the resources, infrastructure and work environment for the project.
- Policy for evaluating and selecting Subconsultants.

2.2 DESIGN PLANNING

General

Collaboration: Coordinate the different groups involved in the development of the design to ensure effective communication and clear assignment of responsibility.

Integrated planning with Subconsultants: Verify and incorporate inputs into the design process.

Design quality plan

Requirement: Provide a design Quality Plan, to include the following:

- Design stages.
- Review, verification and validation for each stage (Design program and procedures).
- Responsibilities and authorities for design.
- Define the design team, including Subconsultants, names of team members, roles and technical interfaces.
- Details of the resources assigned to the project.
- Organisation chart including communication paths with the Superintendent, the Principal, other Consultants and Contractors.

- For the construction phase, reference the Contractor's program for review and verification such as site inspections.
- Design inputs such as requirements and acceptable criteria.
- Any Witness Points or Hold Points for the design.
- Programmed approvals/consultations with regulatory authorities.
- Any third party review/verification/validation required by the Principal or regulating authority.
- Proposed design documentation.
- Procedure for managing design changes of project audits.
- Sign off of activities and record using the checklists in the **Annexures**.

2.3 DESIGN INPUT AND OUTPUT

Design input

Input to AS/NZS ISO 9001 clause 7.3.2: Identify, document and review for adequacy the following:

Requirement: Give notice if the design inputs do not provide sufficient information for verification.

Review: Submit design proposals for approval by the Principal at appropriate stages.

Design output

Output to AS/NZS ISO 9001 clause 7.3.3: To include the following, produced at various stages:

- Advice.
- Calculations.
- Drawings.
- Models.
- Other contract documents.
- Reports.
- Schedules of quantities.
- Sketches for shop drawings.
- Specifications.

Design checklist: Provide a quality record of the design processes and integrate additional criteria, as required, in the design checklists in **Annexure A**.

Acceptance criteria: Define on drawings or in the specification the acceptance criteria for standards of workmanship and other design requirements.

Define: Key characteristics e.g. safety signs.

2.4 REVIEW, VERIFICATION AND VALIDATION

Design review

Design meetings: Minute design meetings with all relevant parties in attendance and make sure the following considerations are included in the agenda:

- Principal's requirements.
- Sequence of design activities.
- Conformance with the design brief.
- Identification and control of design interfaces.
- Construction processes.
- Safety methods.
- Methods of verification.
- Consultation including Council or authority approvals, public input and existing utilities.

Method of quality recording: Provide and maintain quality records by notation on documents, minutes and checklists signed off by the review leader.

Design verification

Verification: At the end of each design stage examine the result of a given activity for conformance with the specified input requirements for that activity, include the following:

- Document the process.
- Identify responsibilities.

- Maintain adequate records of the verification.
- Site investigation and reporting.

Design validation

Validation: Following completion of design, validation shall be performed to make sure the design has met the specified requirements, include the following:

- Document the process.
- Identify responsibilities.
- Maintain adequate records of the validation.

Audit

Notice: Provide all reasonable assistance for the inspection of records of designs submitted to Council for acceptance. Provide access to the designer's premises on a 24 hour notice basis.

2.5 CONTROL OF DESIGN CHANGES

Design changes

Requirement: Review and amend the design quality plan as necessary during the course of the design, include the following:

- Manage, identify, record any design changes.
- Identify who can make and approve changes.
- Procedure for review of wider implications of design changes.

Process for changing documents after issue for construction: Once documents are issued for construction, any changes must go through the review, verification and approval process prior to re-release for construction.

Record: Maintain a register of design changes.

2.6 CONTROL OF DOCUMENTATION

Documentation

Distribution control: Maintain a master list of controlled documents, to include the following information:

- The source of data used in calculations and on drawings.
- Record of the personnel authorised to review, approve and change documents.

Design documentation and data: Provide calculations, sketches, drawings (including those retained for reference or circulated outside the design team), data sheets and specifications.

Requirement: Control and retain documents and data relating to the project e.g. from the Principal, other Consultants or Subconsultants and suppliers.

Design change register: Record changes made to any documents after they have been issued for construction.

Certification

Certification Report: Submit for approval a Certification Report signed by the designer accompanied by drawings and specifications. Conform with the design certificate and checklists included in **Annexure A**.

Certification of preliminary drawings: Submit a Certification Report with all preliminary drawings. Submit an updated Certification Report with the submission of final drawings. A Certification Report is not required when submitting sketch plans or concept plans.

Drawing requirements

Drawings: Define and set out the design concepts on design drawings in conformance with the following:

- Prepare all design drawings on a Council approved standard sheet and clearly number with each sheet numbered as part of a set. **Annexure B** provides guidelines for grouping information in design drawings.
- Refer to design worksections for documentation requirements.
- Provide a space in the bottom right hand corner of each drawing for an assigned number provided by Council.
- Do not overcrowd the drawings with information.

- Do not use colour to distinguish information.
- Use A1 or A2 size sheets, suitable for black and white copying and reduction to A3 paper size without loss of clarity.

2.7 CONTROL OF RECORDS

Records

Requirement: Retain appropriate design records in a format which can be understood readily with no prior knowledge of the particular design.

Copies of records: Make copies of records available to Council upon request without charge.

Design file: Maintain a design file containing records of calculations, approvals and decisions, geotechnical data and other design data that could be relevant in reviewing aspects of the design or planning future maintenance responsibilities.

Calculation record retention: Keep all calculations for the duration of the construction maintenance period.

Hydrologic and hydraulic design records: To *0074 Stormwater drainage (Design)*.

2.8 CONTROL OF NON-CONFORMANCE

Design variations

Record: Identify on the Certification Report checklists any aspects of the design which do not meet the requirements or tolerances set out in this worksection and other applicable Council design and construction specifications.

3 ANNEXURE A

3.1 CERTIFICATION REPORT

Design Certificate

Project Title: _____

Documentation No: _____

Designer: _____

I certify that the documentation noted above represents a design in conformance with the following checklist:

- Design checklist: AUS-SPEC design standards

I certify that this design conforms to current Australian or International standards, industry guidelines, Council's design specifications and specific instructions received with the exception of departures cited in the attached design checklists.

I certify that all structural/civil/hydraulic elements have been designed by an engineer suitably experienced in the relevant field and who has or is eligible for NPER registration with Engineers Australia.

Contact Phone: _____ _____ _____

Design Engineer/Surveyor Date

Contact Postal Address:

_____ _____

Qualifications

_____

_____

A.B.N.

_____

_____

3.2 DESIGN CHECKLIST 1 - DOCUMENTATION OF EXISTING SITE FEATURES

Checkpoints
Initial and date the following checkpoints or tick box if not applicable.

		By	Date	NA
1.1	Check detail survey by site inspection for existing drainage.	……	...../...../.....	☐
1.2	Check detail survey by site inspection for existing property descriptions, boundaries and accesses.	……	...../...../.....	☐
1.3	Check detail survey of contours as representative of site terrain.	……	...../...../.....	☐
1.4	Document trees and significant environmental features affected by the works.	……	...../...../.....	☐
1.5	Document significant features to heritage within the Works boundaries.	……	...../...../.....	☐
1.6	Document existing public and private property likely to be affected by the design.	……	...../...../.....	☐
1.7	Document survey and bench-marks.	……	...../...../.....	☐

Certified documents
Include the following certified documents:

List additional certified documents provided.

Non-conformance
Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.3 DESIGN CHECKLIST 2 - HORIZONTAL ROAD ALIGNMENT

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

		By	Date	NA
2.1	Check that alignment is compatible with design speeds.	……	...../...../.....	☐
2.2	Check that alignment is adequate in relation to clearance of roadside hazards.	……	...../...../.....	☐
2.3	Check that there is adequate horizontal sight distance for drivers and pedestrians.	……	...../...../.....	☐
2.4	Check that there is minimum conflict with existing services.	……	...../...../.....	☐
2.5	Check that road widths and lanes conform to Council and traffic design requirements.	……	...../...../.....	☐
2.6	Check that bridge alignment is compatible with the road alignment.	……	...../...../.....	☐
2.7	Check for adequate pedestrian, pram, bicycle and parking provisions.	……	...../...../.....	☐
2.8	Check for adequate provision for large vehicles such as buses, garbage trucks and emergency vehicles.	……	...../...../.....	☐
2.9	Check that intersections conform to the turning requirements of design traffic, including emergency vehicles.	……	...../...../.....	☐
2.10	Check adequate pavement width tapers and merges.	……	...../...../.....	☐
2.11	Identify and resolve any conflict with existing public utility services.	……	...../...../.....	☐
2.12	Document horizontal road alignment set out data.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.4 DESIGN CHECKLIST 3 - VERTICAL ROAD ALIGNMENT

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

		By	Date	NA
3.1	Check that grades conform to maximum and minimum requirements.	……	...../...../.....	☐
3.2	Check that vertical clearances to bridges and services conform to standards.	……	...../...../.....	☐
3.3	Check that there is adequate vertical sight distance for drivers and pedestrians.	……	...../...../.....	☐
3.4	Check that there is adequate cover to drainage structures or services.	……	...../...../.....	☐
3.5	Check that there is adequate vertical alignment for disposal of surface drainage from properties and road.	……	...../...../.....	☐
3.6	Check that grades conform to 1:100 year flood levels.	……	...../...../.....	☐
3.7	Check that vertical alignment is compatible with property access.	……	...../...../.....	☐
3.8	Check that gradients on intersecting roads do not exceed the cross slope of the through pavement and no greater than 3% at give way and stop signs.	……	...../...../.....	☐
3.9	Check that there is acceptable sight distance for all accesses to roundabouts.	……	...../...../.....	☐
3.10	Check that alignment coordination with horizontal alignment is in conformance with the Austroads design guides referenced in the AUS-SPEC specifications.	……	...../...../.....	☐
3.11	Identify and resolve conflict with existing public utility services.	……	...../...../.....	☐
3.12	Document vertical road alignment set out data on the longitudinal sections.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.5 DESIGN CHECKLIST 4 - ROAD CROSS-SECTIONS

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

		By	Date	NA
4.1	Document complete dimensions on typical cross-sections have.	……	...../...../.....	☐
4.2	Document kerb & gutter, road safety barrier and surface drainage on typical cross-sections.	……	...../...../.....	☐
4.3	Document batter slopes and batter treatment where appropriate.	……	...../...../.....	☐
4.4	Document pavement description and surface treatment.	……	...../...../.....	☐
4.5	Document property boundaries, service allocations and location of known existing underground services and pathway treatments.	……	...../...../.....	☐
4.6	Document cross-sections to define all variations and width transitions.	……	...../...../.....	☐
4.7	Document cross-sections allowing for assessment of impact of road level on adjoining property.	……	...../...../.....	☐
4.8	Verify the stability of embankment slopes, batters and retaining walls as satisfactory.	……	...../...../.....	☐
4.9	Check that cross section reference level conforms with vertical road alignment.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.6 DESIGN CHECKLIST 5 - ROAD AND INTERALLOTMENT DRAINAGE

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

		By	Date	NA
5.1	Document existing surface drainage.	……	...../...../.....	☐
5.2	Check that hydrological data is current.	……	...../...../.....	☐
5.3	Make hydrologic and hydraulic design calculations available for audit.	……	...../...../.....	☐
5.4	Check that underground drainage and structures do not conflict with public utility services.	……	...../...../.....	☐
5.5	Check that the designed drainage lines are compatible with existing incoming lines and outgoing lines.	……	...../...../.....	☐
5.6	Document pipeline length, type, size, class and bedding requirements for each drainage line.	……	...../...../.....	☐
5.7	Check that height of fill over drainage lines is within allowable limits.	……	...../...../.....	☐
5.8	Document drainage provisions for local depressions, e.g. median areas or areas adjacent to fills.	……	...../...../.....	☐
5.9	Check that the effect of headwater and back-up water on private property is satisfactory.	……	...../...../.....	☐
5.10	Document subsurface drainage by line and level if required.	……	...../...../.....	☐
5.11	Document batter drains for fills and cuttings if required.	……	...../...../.....	☐
5.12	Consider the height and energy level of downstream drainage.	……	...../...../.....	☐
5.13	Locate drainage structures and flowpaths to ensure safe vehicular and pedestrian transit.	……	...../...../.....	☐
5.14	Document drainage structure number, set out, type and pipe on the drainage plans and schedule of drainage elements.	……	...../...../.....	☐
5.15	Locate emergency flowpaths to minimise impact on private property.	……	...../...../.....	☐
5.16	Check that road drainage conforms with Council's drainage design criteria.	……	...../...../.....	☐
5.17	Check that interallotment drains conform with Council's Specification and Australian Rainfall and Runoff (AR&R) rainfall data.	……	...../...../.....	☐
5.18	Document appropriate land stabilisation and velocity controls to pipe systems, open channels and embankments.	……	...../...../.....	☐
5.19	For flood controlled allotments ensure, the floor height controls are compatible with road and drainage levels.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.7 DESIGN CHECKLIST 6 - SIGNS AND MARKINGS

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

		By	Date	NA
6.1	Conform to the documented Traffic Management Plan.	……	...../...../.....	☐
6.2	Document sign types, sizes, locations and support structure details to conform with AS 1742 (All parts).	……	...../...../.....	☐
6.3	Document pavement linemarking, pavement marking type and set out to conform to AS 1742.2.	……	...../...../.....	☐
6.4	Document signs and linemarking to conform to Council's policies.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.8 DESIGN CHECKLIST 7 - PAVEMENT DESIGN

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

		By	Date	NA
7.1	Document pavement design and surface treatment on the typical road and/or pathways and cycleways cross-sections. Document any variations on the specific cross-sections.	……	...../...../.....	☐
7.2	Check that the pavement design conforms to *0042 Pavement design* and/or *0044 Pathways and cycleways* for adequacy.	……	...../...../.....	☐
7.3	Assess geotechnical data and keep records of design calculations.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.9 DESIGN CHECKLIST 8 - BRIDGE/MAJOR CULVERT DESIGN

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

		By	Date	NA
8.1	Check that the design engineer is suitably experienced in the relevant field and who has or is eligible for NPER registration with Engineers Australia.	……	...../...../.....	☐
8.2	Assess geotechnical data for adequacy and keep records.	……	...../...../.....	☐
8.3	Check that the type and functional dimensions of the bridges conform to AS 5100, AS 4100, AS 3600, AS 1684, AS/NZS 1170.	……	...../...../.....	☐
8.4	Document the type and class of all materials.	……	...../...../.....	☐
8.5	Keep records of all significant design calculations and make available for audit.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.10 DESIGN CHECKLIST 9 - EROSION AND SEDIMENTATION CONTROL PLANS

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
9.1 Check that the concept erosion control plan conforms to *0075 Control of erosion and sedimentation (Design).*	…….	…../…../…..	☐
9.2 Check that the erosion and sedimentation control conforms to development consent conditions and environmental legislations.	…….	…../…../…..	☐
9.3 Check that the erosion and sedimentation control plan conforms to *0075 Control of erosion and sedimentation (Design).*			
9.3 Check that the soil and water management plan conforms to *1102 Control of erosion and sedimentation (Construction).*	…….	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.11 DESIGN CHECKLIST 10 - WATER SUPPLY

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

		By	Date	NA
10.1	Check that the design engineer is suitably experienced in the relevant field and who has or is eligible for NPER registration with Engineers Australia.	……	...../...../.....	☐
10.2	Check that a practicing registered Surveyor performed the survey.	……	...../...../.....	☐
10.3	Assess geotechnical data for adequacy and keep records.	……	...../...../.....	☐
10.4	Check that the type and functional dimensions of the reticulation and any pump station meet the State Department of Public Works and Services guidelines and the appropriate Australian Standards, and are compatible with the Water Reticulation Code of Australia WSA 03.	……	...../...../.....	☐
10.5	Document the type and class of all materials, fittings, joints, and plant, pumps special requirements for crossings and protection.	……	...../...../.....	☐
10.6	Keep records of all significant design calculations and make available for audit.	……	...../...../.....	☐
10.7	Check that the design conforms to requirements of all Statutory Authorities.	……	...../...../.....	☐
10.8	Check the design conforms to any development consent conditions.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.12 DESIGN CHECKLIST 11 - SEWERAGE SYSTEM

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

		By	Date	NA
11.1	Check that the design engineer is suitably experienced in the relevant field and who has or is eligible for NPER registration with Engineers Australia.	……	...../...../.....	☐
11.2	Check that a practicing registered Surveyor performed the survey.	……	...../...../.....	☐
11.3	Assess geotechnical data for adequacy and keep records.	……	...../...../.....	☐
11.4	Check that the type and functional dimensions of the reticulation and any pump station meet state Department of Public Works and Services guidelines and the appropriate Australian Standards, and are compatible with the Sewerage Code of Australia WSA 02.	……	...../...../.....	☐
11.5	Document the type and class of all materials, fittings, joints, plant, pumps and special requirements for crossings and protection.	……	...../...../.....	☐
11.6	Keep records of all significant design calculations and make available for audit.	……	...../...../.....	☐
11.7	Check that the design conforms to requirements of all Statutory Authorities.	……	...../...../.....	☐
11.8	Check that the design conforms to development consent conditions.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

4 ANNEXURE B

4.1 EXAMPLE COMPILATION OF DRAWINGS

Sequence of drawing sheets: The following sequence is acceptable to Council in the compilation of a full set of roadworks drawings.

Sheet No	Topic
1.	Development consent number (if applicable), project title, locality drawing and index of sheets.
2.	General layout plan with contour details and extent of work.
3.	Typical road cross-sections showing road widths, pavement (design) configuration, batter slopes, kerb and gutter types.
4.	Plan and longitudinal section of each road showing set out data, road safety barrier locations, guide posts and services.
5.	Drainage plan and schedule of drainage elements (pipe lines and structures).
6.	Drainage profiles.
7.	Drainage structure details.
8.	Road cross-sections.
9.	Intersection layout details.
10.	Pavement marking and signposting.
11.	Erosion and sedimentation control concept plans (short term and long term treatment).
12.	Structure details - bridges, retaining walls, etc.

Multiple sheets: A set of roadworks plans may require more than 1 sheet for each of the topics listed and may also require supplementary sheets for site specific details.

Scale: Nominate scales on all drawings.

North point: Show on all plan views.

0011 DEVELOPMENT AND SUBDIVISION OF LAND

1 GENERAL

1.1 INTRODUCTION

Worksection

General: This worksection provides guidance on the design requirements and planning permission process for development and subdivision of land within the Bellingen Shire. More detailed information on the application process can be found in the Bellingen Shire Council Application Guide available at www.bellingen.nsw.gov.au.

Structure: This worksection is divided into six sub-sections:

- General.
- Pre-submission planning.
- Application process.
- Application requirements.
- Post-determination requirements.
- Completion.

Other documentation: This worksection also provides an introduction to other documentation affecting development and subdivision including:

- State planning legislation.
- Council planning instruments.
  - . Bellingen Shire Development Control Plan 2010
  - . Bellingen Shire Council Local Environment Plan 2010
  - . Development Application Form
  - . Bellingen Shire Council – Application Guide
  - . Bellingen Shire Council's currently adopted Driveway policy.
- Council standard drawings.
- AUS-SPEC *Design* worksections (Workgroup 00 *Planning and Design*).
- AUS-SPEC *Construction* worksections (Workgroup *02 Site, Urban and open spaces, 03 Structure* and 11 *Construction – Roadways* and 13 *Construction – Public Utilities*).

1.2 COUNCIL'S OBJECTIVES

Planning

Objectives: Council's objectives for land development and subdivision are as follows:

- To provide a functional, attractive and safe environment for residents that is consistent with community standards and needs.
- To minimise adverse effects on the natural environment.
- To provide for the needs of future users of the land with respect to building requirements, vehicular and pedestrian access, provision of services and an amenity appropriate to the zoning of the land.
- To economically utilise the land resource of the area.
- To achieve a balance between the development/subdivision of residential, commercial and industrial land and the amenity of existing occupants/residents.
- To provide for an equitable and efficient distribution of public amenities and services.
- To minimise Council's future maintenance costs for roads, services and open spaces.

1.3 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *0010 Quality requirements for design.*

1.4 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian standards

AS/NZS ISO 9001-2008 Quality management systems – Requirements

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- ARI: Average recurrence interval.
- DA: Development assessment.
- WAE: Work-as-executed.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Development assessment: The process for ensuring that a proposed development on land is consistent with the plans, zones and other instruments determining how the land is to be used.
- Hold point: A defined position in the different stages of the Contract beyond which work can not proceed without mandatory verification and acceptance by the Superintendent.
- Planning: The process of making decisions to guide future allocation and development of land.
- Qualified surveyor: A surveyor who is eligible for membership of the Spatial Sciences Institute as a certified engineering surveyor.
- Registered Surveyor: A surveyor accredited by the Institution of Surveyors for civil design in the appropriate area.
- Rural land: Land, other than urban and rural residential, comprising larger holdings.
- Rural residential land: Rural home site and hobby farm land.
- Urban residential land: Land within areas zoned residential, village or township.
- 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.
- Zones: A smaller area within the larger Council area which is identified in a development plan. A zone groups together areas with similar characteristics to integrate mutually beneficial uses and separate incompatible uses. Zones are typically based on land uses.

1.6 PREPARING AN APPLICATION

Requirements

Consent: Refer to the planning and development instrument(s) applying to the land to determine if the proposed development is permitted and, if so, whether an application for consent is required. Minor development and subdivisions may not require consent. Refer to exempt or complying development standards.

Application form: Submit an application on Council's standard application form and provide supporting information compiled following consultation with Council and to **APPLICATION REQUIREMENTS**.

Site Information

Compilation: Before submitting an application, compile the following site information and include on the plans for submission:

- Land title.
- Existing easements.
- Items of heritage significance.
- Topography, slope and aspect.
- Stormwater and overland flows.
- Surrounding development.
- Existing trees and vegetation.
- Existing and proposed local road and traffic situations.
- Other physical characteristics pertinent to the design.

Fees/contributions
Schedule: Fees for applications are prescribed by state legislation and regulations and Council. Obtain a fee schedule from Council which includes non-prescribed fees/contributions that may be required as a condition of consent.

1.7 CONSULTATION AND GETTING HELP

All development related planning controls including the Local Environment Plan, Development Control Plan, zoning and constraint maps and relevant application forms are available under the Development heading of Council's website www.bellingen.nsw.gov.au.

If you have any enquiries or require further general advice, you can discuss with Council staff by phoning (02) 6655 7300.

2 APPLICATION PROCESS

2.1 CONSENT AND EXEMPTIONS

Development Requiring Consent
Development requiring consent will require you to submit an application for the proposed development and/or subdivision in conformance with state planning legislation and regulations and Council's requirements. Consent will then either be approved rejected.

Exempt and Complying Development
Not all development will require development consent, certain development can be classified as Exempt or Complying Development.

Exempt Development is development that may be carried out without the need for development consent. Such development is however not exempt from any approval, licence, permit or authority that is required under any other Act and adjoining owners' property rights and the common law still apply. Development may be classified as exempt under the following legislation:

- *Schedule 2 of Bellingen Local Environmental Plan 2010.*
- *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008: This SEPP generally relates to minor works or activities such as single carports, farm sheds and home occupations. To be exempt the work must meet the predetermined standards outlining the size, type and location of the building work for it to be exempt of any planning or construction approval.*
- *State Environmental Planning Policy (Temporary Structures) 2007: Exempt development under the SEPP includes the erection and use of some temporary structures for certain private functions and community events such as marquees, stages and the like subject to prescriptive standards.*

Complying Development is development which must meet prescriptive requirements. It is a combined planning and construction approval and involves the lodgement of an application for a Complying Development Certificate. This can be issued by Council or by a private accredited certifier. As with exempt development the circumstances where it is applicable are specified in the following legislation:

- *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 : This relates to a variety of development types ranging from dwelling houses and swimming pools to minor commercial activities.*
- *State Environmental Planning Policy (Affordable Rental Housing) 2009: amongst other things this SEPP specifies the complying development standards applicable to secondary dwellings (commonly known as Granny Flats).*
- *State Environmental Planning Policy (Temporary Structures) 2007: In addition to the provisions for exempt development this SEPP provides for another tier of development (via complying development provisions) for certain activities often related to private functions or community events (eg larger marquees or stages).*

If you consider your proposed development may be exempt or complying development it is recommended that you seek initial advice from Council's Building Surveyors.

Exempt Development and Complying Development must meet various prescriptive requirements including zoning, land based restrictions and in some instances minimum lot and floor areas. If what you proposes does not meet this requirements then you will need to lodge a development application.

Please Note:
- *There are other State and Federal controls that regulate development and you should familiarise yourself with these to see if they are applicable to what you propose. Further information is available from www.planning.nsw.gov.au*
- *All relevant state legislation including State Environmental Planning Policies can be found at www.legislation.nsw.gov.au*

2.2 DEVELOPMENT APPLICATION PROCESS.

The development application process is primarily established by legislation and whilst it can vary according to the type of works proposed and the approvals required there is a fundamental process.

Once you have established that you need development consent then the next step is to determine the type of approval ie; local, integrated, designated etc….

Other approvals may also be required, for example; if stormwater and sewer connection works or installation of a water meter are involved then an approval under Section 68 of the Local Government Act would be required. If works are necessary on Council's road reserve an approval under the Roads Act 1993 will be required. Other acts that may be triggered and which will necessitate concurrence of approval from an authority other than Council include:

- Rural Fires Act 1997
- Water Manangment Act 2000
- Environmental Protection and Biodiversity conservation Act 1999
- Threatened Species Conservation Act 1995

If the proposal involves any engineering or building construction works you will also need to apply for and be issued with a Construction Certificate before any work can commence.

In the case of building work you can choose to seek either the services of Council's Building Surveyor or a private accredited certifier to issue the Construction Certificate.

2.3 SUBMITTING AN APPLICATION

Preparation

General: Prepare the application in conformance with **APPLICATION REQUIREMENTS** and submit to Council.

Development application form: Available from www.bellingen.nsw.gov.au

Fees schedule: Available www.bellingen.nsw.gov.au

State where schedule can be obtained, e.g. website address or department name. Consider including a copy as an annexure to this worksection.

Contributions schedule: Available from www.bellingen.nsw.gov.au

Submission: Submit application

Owner's approval: If the applicant is not the owner of the land to be developed, written authority from the owner must be submitted with the application form.

2.4 ASSESSMENT BY COUNCIL

Assessment Criteria

General: Council will assess each application based on its merits in conformance with the state Planning Acts and Regulations and the following assessment criteria:

- Natural and built environmental impacts.
- Social and economic impacts.
- Suitability of the site.
- Public interest.
- Conformance with the provisions of any planning instruments, development control plans and regulations applying to the land.

Design standards: Minimum design standards do not relieve the applicant of the responsibility to properly address all assessment criteria. Council will consider alternative approaches to development and subdivision design if the applicant satisfies the Council that objectives of Council have been achieved.

Staged development: If staged development is proposed, prepare a plan showing the complete concept with the various stages and conformance with the standard requirements.

2.5 DETERMINATION AND APPEAL

Determination

Notification: Council will notify the applicant in writing stating that consent has been granted subject to conditions, or that consent has been refused (with reasons).

Appeal

Reconsideration: Submit a request for reconsideration within the required time frame from determination. Include the reconsideration fee and list the reasons for reconsideration.

Appeal to court: Submit an appeal with the appropriate court within the required time frame from determination.

Appeal by third party: Any third party may submit an appeal to the court if they believe a breach of the Act has occurred.

2.6 APPLICATION APPROVAL

General

Revocation of consent: Council may revoke or modify consent in circumstances of fraud, failure to conform with legislation or non conformance with conditions of consent.

Commencement: The consent will lapse if the works have not been commenced within the consent period from determination or such other shorter period stipulated by the consent.

Private certification: Obtain confirmation from Council that a private certifying authority (PCA) can issue subdivision certificates.

3 POST-DETERMINATION REQUIREMENTS

3.1 CERTIFICATES

Building approval

General: Obtain building approval before any works commence on site.

Compliance certificates

General: Obtain a compliance certificate at the completion of each stage identified by the certifying authority.

Occupation certificates

General: Before occupation of a building, obtain an occupation certificate.

Subdivision certificates

General: Obtain a subdivision certificate authorising the registration of the plan of subdivision.

3.2 ENGINEERING DOCUMENTATION

Certification

General: Provide certification of all drawings for the following works by a Professional Engineer or Registered Surveyor:

- Earthworks (site regrading).
- Roadworks.
- Drainage works.
- Water supply.
- Sewerage works.
- Foreshore works.

General: Provide certification of all drawings for the following works by a Professional Engineer:

- Bridgeworks.
- Retaining walls.
- Other major structures.
- Pumping stations.

Documentation

Council documents: Obtain standard drawings, design specifications and construction specifications prepared by Council for use in developments and subdivisions.

Specifications: Provide specifications conforming to Council's requirements for all works not covered by Council specifications.

3.3 COMMENCEMENT OF WORKS

Necessary conditions

Approval: Do not commence works on site before building approval is issued.

Quality control
Minimum requirement: Nominate the developer's Superintendent or representative and obtain approval from Council of their qualifications and experience.

Quality assurance
Standard: To AS/NZS ISO 9001.

Quality plan: Submit a quality plan before commencement of works if a quality assured design or construction is a condition of consent.

Water, sewerage and drainage
Certifying authority: Bellingen Shire Council

3.4 INSPECTIONS AND TESTING

General
Requirement: Submit test results to verify the materials supplied and the work carried out conform to the approved documentation.

Inspections
Key stages: Arrange inspections with Council's nominated person at the following key stages of construction nominated as a condition of consent:

- Site regrading and clearing.
- Installation of erosion control measures.
- Protection of existing services.
- Preservation measures for trees, vegetation or heritage sites.
- Site sampling and testing.
- Provisions for new services.
- Formwork and reinforcement before placing of concrete.
- Drainage installation before backfilling.
- Water supply installation before backfilling.
- Subgrade preparation.
- Establishment of line and level for kerb and channel (gutter) placement.
- Road pavement construction.
- Road pavement surfacing.
- Final inspection.
- End of maintenance period.

Records
Procedures: Submit records of all test results to the certifying authority promptly. Testing to conform to documented test procedures by testing organisations approved by Council before commencement of works.

Access: Allow uninterrupted access at all times for audit inspections or testing.

Hold points: Certain stages of construction will be subject to Hold points, pending acceptable test results. Each construction worksection provides a summary of Hold points and Witness points required during the construction activity. See appropriate construction worksections for further details.

3.5 INSURANCES

Policies
Professional indemnity: Provide evidence of professional indemnity insurance for the Developer's lead consultant.

Minimum insured value required ($): 20,000,000

Third party and public risk: Provide evidence that all Contractors have obtained appropriate third party and public risk insurance.

Submission of insurance documentation must be made before the commencement of the works.

4 COMPLETION

4.1 COMPLETION OF WORKS AND TITLE ISSUE

Documentation

Final survey (original) plan: Provide the final survey plan prepared by a Qualified Surveyor upon completion of all conditions of development consent, and any other certificate approvals.

Subdivision certificate: Submit the following for endorsement of the subdivision certificate:

- The final survey plan.

Number of copies: 2

Size of final survey plan: A1

Street name approval from: Bellingen Shire Council

Title issue: Submit plans with the land title registration authority to effect plan registration and the issue of new titles for the subdivision lots.

Maintenance period

Commencement maintenance period: At the date of issue of the subdivision certificate

Period of maintenance: For any development involving subdivision and at the discretion of Council, The developer shall undertake all repair and maintenance of the development works for a period of up to 12months.

Sewerage and water system commissioning

Commencement of maintenance period for pumping stations and associated facilities: At the completion of pump performance tests and commissioning.

4.2 WORK-AS-EXECUTED

Requirement

Certification: At completion, submit as an accurate record, two full sets of WAE drawings marked up in red showing any variations from the design certified by the lead consultant.

4.3 BONDS

Guarantee bonds

Consideration: If the following conditions apply, the Council will consider the acceptance of a bond for the performance of engineering works to enable the early release of plans of subdivision:

- Engineering works minimum of 25% complete.
- All water supply and sewerage works complete and tested.
- WAE drawings for the water supply and sewerage works submitted.
- No major engineering problems exist, to the satisfaction of the consent authority.
- All works involving potential risk to public safety (e.g. road junctions, flood control structures) complete.
- Geotechnical reports required as a condition of consent regarding the suitability of land for development submitted.
- Full payment of all fees and contributions required as a condition of consent.
- The applicant enters a legal agreement with Council setting out the terms of the performance bond.

Maintenance bonds

The developer shall enter in to a bond to maintain all Engineering works (Roads, Drainage, Water and Sewer, etc) formed of constructed as part of the development for the full term of the maintenance. A bond equal to 15% of the value of the engineering works secured by either cash deposit or Bank

Guarantee shall be provided . The bank guarantee shall remain current until written release is provided by Councils Deputy General Manager Operations.

Period of bonds

Maximum period (months): 12

Bank guarantees/deposits: Bank guarantees and interest bearing deposits in the name of Council will only be accepted for works above the minimum accepted value.

Minimum accepted value for guarantees/deposits: $5,000

Outstanding bonds

Progressive reduction of performance bonds: Submit a schedule of quantities of outstanding works for calculation of bond value.

Minimum performance bonds: 10% of contract sum or estimated cost of the works.

Incomplete works: Bonds may be accepted for incomplete works.

Incomplete works bond rate (%): 130% of quoted cost.

Tree protection bond

Requirement: Protect trees identified by Council at all times during excavation and/or construction. If required by Council, submit a bond that will be forfeited if the trees are damaged or removed.

Bond period: 6 months after the issue of the compliance certificate for a component of the work, occupation certificate or subdivision certificate, as applicable.

0012 WATERFRONT DEVELOPMENT

1 GENERAL

1.1 RESPONSIBILITIES

Objective

General: Provide design and documentation for the structures/waterways covered by this worksection.

Council's objectives: Design structures/waterways to support the following objectives:

- Retain and enhance the biological diversity of the local flora and fauna.
- Preserve or improve the local ecosystem.
- Maintain or improve the flood levels in the area.
- Improve public access to the intertidal area of the waterfront.
- Maintain or improve the quality of water air and land.
- Minimise the disruption of the natural shoreline.
- Minimise future maintenance.
- Integrate the waterfront developments into the natural landscape.
- Conserve the waterfront or offshore items of heritage significance.

Legislative requirements: The design must satisfy the requirements of local state and federal government Planning Instruments, Regulations and Acts.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksections:

- *0010 Quality requirements for design.*
- *0011 Development and subdivision of land*
- *0074 Stormwater drainage (Design).*
- *0075 Control of erosion and sedimentation.*
- *0061 Bridges and related structures*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian Standards

AS 1100	Technical drawing
AS 1100.101-1992	General principals
AS 1428	Design for access and mobility
AS 1428.1-2009	General requirements for access - New building work
AS 1428.4.1-2009	Means to assist the orientation of people with vision impairment - Tactile ground surface indicators
AS 1657-1992	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS/NZ 3661	Slip resistance of pedestrian surfaces
AS/NZS 3661.2:1994	Guide to reduction of slip hazards
AS 3962-2001	Guidelines for design of marinas
AS/NZS 4586:2004	Slip resistance classification of new pedestrian surface materials
AS 4678-2002	Earth-retaining structures
AS 4997-2005	Guidelines for design of maritime structures

Austroads

AGRD06A-2009 Guide to road design - Pedestrian and cyclist paths

Other documents

Australian and New Zealand Environment Conservation Council

ANZECC guidelines Australian and New Zealand guidelines for fresh and marine water quality 2000

Federal legislation

Environment Protection and Biodiversity Conservation Act 1999.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- ANZECC: Australian and New Zealand Environment Conservation Council.

2 PRE-DESIGN PLANNING

2.1 CONSULTATION

Council and other Authorities

Responsibility: Consult with Council and other relevant Authorities during the preparation of design. In addition to the requirements of this worksection, identify the specific design requirements of these Authorities.

Public consultation

Requirement: Undertake public consultation on designs in conformance with Council policy.

Utilities services plans

Existing services: Obtain service plans from all relevant public utility authorities and other organisations whose services exist within the area of the proposed structures/waterways.

Heritage considerations

Requirement: Provide a plan for management of heritage assets.

Protection of existing infrastructure

Existing plans: Obtain drawings of existing adjoining structures.

Dilapidation reports: Carry out inspections of all existing structures adjoining the proposed construction works. Prepare a report on their existing structural condition including photographic records of any defects.

2.2 SITE INVESTIGATIONS

Survey

Requirement: Carry out a detailed survey including survey grid, survey datum, hydrographic survey and terrestrial surveys and prepare a survey report.

Standard: To AS 3962 and AS 4997.

Qualifications: Registered surveyor.

Geotechnical report

Requirement: Carry out a detailed geotechnical investigation and prepare a geotechnical report.

Standard: To AS 3962 and AS 4997.

Qualifications: Professional geotechnical engineer.

Wind, hydrodynamic and sediment movement assessment

Requirement: Carry out detailed site investigations and prepare a report.

Standard: To AS 3962.

Qualifications: Professional hydraulic engineer.

3 STRUCTURES

3.1 DESIGN

General

Critical design feature: Provide water circulation and tidal flushing.

Sea level rise: Design for sea level rise due to global warming. Minimum allowance for future sea level rise to AS 4997 Table 4.1.

Aesthetics: Consider visual impact and design structures to complement the natural coastline.

Marinas

Standard: To AS 3962.

Residential developments: Avoid locating public marina facilities near residential areas to minimise the noise and privacy impacts.

Wharfs, jetties and boardwalks

General: To AS 4997.

Disabled access: To AS 1428.

Slip resistance: To AS 3661.2 and AS/NZS 4586.

Ramp width: To AGRD06A-2009.

Boat ramps

Standard: To AS 4997.

Scour protection: Design the footings to bear on rock or make allowance in the design for loss of material in conformance with the geotechnical report and wind/hydrodynamic/sediment report.

Floating structures and fenders

Standard: AS 4997.

Construction materials selection: Consider marine growth.

Access and safety structures

Standard: AS 4997and AS 1657.

Revetment structures

Erosion: Make allowance in the design for loss of material in front of the revetment, in conformance with wind, hydrodynamic and sediment control reports.

Runoff: Provide a kerb and gutter arrangement to the top of revetment.

Seawalls

General: To AS 4997 and AS 4678.

Drainage: Design appropriate drainage to relieve the water pressure behind the wall.

Erosion: Make allowance in the design for loss of material from the seaward face in conformance with the wind/hydrodynamic/sediment movement report. Alternatively, design foundations to bear on rock in conformance with geotechnical report.

Bridges and related structures

General: Conform to *0061 Bridges and related structures.*

Vertical clearance: To the requirements of the relevant waterway and maritime Authorities.

Public access: Maintain continuity of public access along the public foreshore.

Services

Electrical connections: Consider the most adverse water levels when establishing the locations for the electrical services.

3.2 MATERIALS

General

Standards: To AS 4997 clause 6 and AS 3962 clause 5.2.

Durability

Maintenance: Document low maintenance materials for construction, finishes and fitments. Consider exposure conditions and appropriate durability requirements.

Protection of materials: Document protection methods for materials to satisfy durability requirements.

3.3 ENVIRONMENTAL CONSIDERATIONS

Construction
Demolition: Explore possibilities for re-using any demolished material from the site.

Imported fill: Analyse the impact on water quality, sedimentation and erosion.

Noise and light pollution: Analyse the impact onto local wild life patterns.

Construction materials
General: Demonstrate that the proposed construction materials will not have an adverse impact on the local ecosystem. Analyse the impact of construction materials on water quality, sedimentation and erosion. Prepare a report.

4 DOCUMENTATION

4.1 GENERAL

Design reports
Requirement: Provide a design report including the following:

- Design criteria.
- Site investigation reports supporting the design.
- Detailed design calculations (civil, structural and hydraulic).
- Hydraulic design models (drainage, flood control, tidal movements, sedimentaion).
- Flood study report, including flood control measures.
- Water quality study.

Environmental management report for construction
Requirement: Provide environmental management plan as part of overall construction management plan. Include the following:

- Water quality management and monitoring program.
- Air quality management and monitoring program.
- Noise control program.
- Light pollution control program.
- Acid sulphate soils management plan.
- Erosion and sedimentation management plan.
- Plan for management and protection of marine flora and fauna.

Specifications
Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11,13 and 14-18.

Design certification
Requirement: Provide a signed and dated design certificate.

4.2 WORK-AS-EXECUTED

General
Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

0021 SITE REGRADING

1 GENERAL

1.1 RESPONSIBILITIES

Objective
General: Provide design and documentation of site regrading works to meet the following requirements:

- Provide an efficient and economical design.
- Enhance the environment of the site whilst maintaining the site's natural features.
- Provide safe conditions for construction.
- Provide equal building conditions for all residential development allotments.
- Minimise impact on adjoining properties and other works.
- Maintain or improve drainage and overland flow paths.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):

- *0010 Quality requirements for design.*
- *0012 Waterfront development.*
- *0041 Geometric road layout.*
- *0074 Stormwater drainage (Design).*
- *0075 Control of erosion and sedimentation (Design).*
- *0257 Landscape – Roadways and street trees.*
- *1102 Control of erosion and sedimentation (Construction).*
- *1111 Clearing and grubbing.*
- *1112 Earthworks (Roadways).*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

Australian Standards

AS 3798:2007	Guidelines on earthworks for commercial and residential developments
AS 4970:2009	Protection of trees on development sites

Austroads

AGPT08-2009	Guide to Pavement Technology - Pavement construction
AGRD07-2008	Guide to Road Design - Geotechnical investigation and design

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection, the following abbreviations apply:

- ARI: Average recurrence interval.
- EPA: Environmental protection agency.
- WAE: Work-as-executed.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Site suitability

Improvement: The natural state of a site may not be suitable for the intended function. Site regrading may be required to:

- Alleviate flooding.
- Fill gullies or create emergency flowpaths after installation of underground stormwater systems.
- Improve stormwater runoff.
- Reduce excessively steep slopes, to allow construction of economical foundation solutions.
- Allow effective recreational use or provide improved access.
- Fill local unwanted depressions.
- Improve ground conditions in areas where existing soils have plastic/reactive properties.

Contours: Review the natural surface contours and design finished surface levels to confirm land will be suitably prepared for use.

Land use restrictions

Constraints: Identify all constraints, natural or otherwise, which may apply to the site.

2.2 CONSULTATION

Council and other Authorities

Responsibility: Consult with Council prior to commencement of design to identify any design requirements in addition to the requirements of this worksection.

Haul routes: Consult with Council to define acceptable routes for haulage with applicable load limits.

Bond: Council will confirm if payment of a bond is required. This may be necessary where concerns exist regarding the ability of a haul road to sustain the loads without undue damage or maintenance requirements.

Tree preservation officer: Consult with Council's tree preservation officer to identify requirements relating to tree protection and clearing of the site.

Salinity: Consult the relevant land and water resource Authority and advise Council/Developer of areas requiring action to prevent salinity development.

Utilities services plans

Existing services: Obtain service plans from all relevant public utilities Authorities and other organisations whose services exist within the site area. Plot these services on the relevant drawings, including the plan and cross-sectional views.

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

3 DESIGN

3.1 GENERAL

Considerations

Natural environment: Consider the implications of site regrading for the existing natural environment. Minimise site regrading in heavily treed areas.

Watercourses and riparian zones: Design site regrading Works that preserve and do not degrade existing watercourses and riparian zones. Refer to worksection *0012 Waterfront development* if new waterways are proposed.

Haulage: Design areas for site regrading in conjunction with the roadworks design, with the objective of balancing cut to fill, achieving an economical works and minimising the haulage of imported fill or spoil. Bulk haulage has an adverse effect on adjacent development, and infrastructure. Refer to *0041 Geometric road layout* worksection and AGRD07 clause 4.3.2.

Salinity prevention

Existing conditions: Evaluate existing soil salinity conditions in known salt affected areas, or areas found to be salt affected by the geotechnical investigations.

Groundwater table: Implement appropriate strategies aimed at lowering the groundwater table where necessary, together with primary measures to prevent extension of salinity problems.

Approval

Measures: Make enquiries with EPA and subsequently obtain Council approval for any proposed sediment, siltation, erosion or salinity control devices/measures.

Agreement: Obtain written agreement from adjoining property owners prior to carrying out any construction work on their property. Submit all agreements to Council.

3.2 DRAINAGE AND RUNOFF

General

Underground drainage: Regrade areas to minimise the need for surface inlet pits and, where practical, allow surface water to flow naturally to roads or drainage reserves without excessive concentration.

Overland flow: Provide depressions at low points and over major drainage lines, to direct stormwater for storms of up to a 100 year ARI.

Inundation areas: In areas known to be affected by stormwater flows, investigate the existing conditions as they relate to the proposed Works. Submit all data obtained to Council and recommend appropriate contour adjustments.

Level requirements

Areas abutting 100 year ARI flood levels: Regrade to a minimum level of 0.5 m above the 100 year ARI flood levels. Do not cause flooding of other areas as a consequence of such regrading.

Building areas: Regrade in the direction of the catchment area drainage system as follows:

- Desirable surface grading: 1.5%.
- Minimum surface grading: 1.0%.

Steep building areas: For building areas with natural ground slopes greater than 15% obtain confirmation of the compatibility of the proposed Works from a geotechnical engineer. Document any specific requirements on the Drawings.

Piped gullies or depressions: Design finished surface levels of piped gullies or depressions to provide adequate cover depth over pipelines (if piped) and direct surface stormwater flow to inlet pits.

Temporary diversion drains

Drawings: Identify the location of any temporary drains required to divert surface flows away from the regrading area, including any erosion or sedimentation control treatment. Size temporary drains to accommodate the volume of water to be diverted.

Erosion and sedimentation control

Objective: Minimise soil disturbance and material loss off site.

Control measures: Provide measures including, but not limited to the following:

- Trench stops at 30 m spacing along a trench. Direct overtopping to the kerb.
- Blue metal bags placed along kerb and gutter at maximum 30 m spacing.
- Blue metal bags placed around downstream drainage pits.

Additional requirements: Conform to *0075 Control of erosion and sedimentation (Design)* and *1102 Control of erosion and sedimentation (Construction)*.

Adjoining properties

Easement: Create drainage easement rights in conformance with *0074 Stormwater drainage (Design)* if it is proposed to divert or direct piped stormwater into adjoining properties.

3.3 SITE

Clearing

Worksection: Conform to *1111 Clearing and grubbing*.

Requirement: Clear the site of the following:

- Low scrub.
- Fallen timber.

- Debris.
- Stumps.
- Large rocks.
- All roots and loose timber which may contribute to drain blockage.
- Any trees which Council has deemed approaching the end of their functional life or dangerous/hazardous to normal use of site.

Document: Indicate special requirements of Council on the Drawings.

Disposal

Requirement: Document the removal and legal disposal of all materials cleared from the site.

Spoil: Submit for approval all proposed locations for disposal of excavated material.

Trees

Overfilling: Do not fill over butts of trees in areas that require filling. Document clearing of all trees in such areas and relocating/replanting with advanced species. Submit the number and type of which for approval by Council.

Relocating: Relocate clear of probable future building locations. Document future positions on Drawings and note that replanting cannot commence until filling has been completed and graded.
Preservation: Document approved preservation measures for selected trees, to prevent destruction caused by placement of fill or any other action within the tree drip zone. Refer to AS 4970 for further guidance.

Fill

Type: Sound clean material and free from large rock, stumps, organic matter and other debris.

Commencement: Obtain approval from council prior to commencement of fill placement over prepared areas. Document this requirement on relevant Drawings.

Quality and compaction: Conform to AS 3798, the requirements of *1112 Earthworks (Roadways)* worksection and AGPT08 section 4.

Restricted fill: Submit for approval by Council a proposal for the use of restricted fill material comprising natural sands or industrial wastes/by-products. Include details of the material type and its intended location for use.

Top dressing

Landscaping: Document dressing of all areas where fill will be placed, with clean arable topsoil, fertilised and sown with suitable grasses. Conform to *0257 Landscape – roadways and street trees.*

Re-use: If possible, retain existing topsoil from the site and document its re-use in the same location.

Retaining walls

Worksections: Refer to *0292 Masonry walls* and *0293 Crib retaining walls*.

Boundary: Design retaining walls to sit fully inside the site, when filling to site boundary. Submit design for approval by Council.

Design: Use an appropriately qualified and experienced structural engineer to design and certify all retaining walls.

Adjacent services: Design wall so that no imposed loads are applied directly to adjacent service infrastructure and that services are located outside the zone of influence of the wall.

4 DOCUMENTATION

4.1 GENERAL

Approvals

Requirements

Standard: Refer to AS 3798 Section 3 for guidelines on the documentation requirements for earthworks design.

Design reports

Requirement: Provide a report documenting all geotechnical requirements, including the following:

- Site preparation and compaction requirements.
- Recommendation for the minimum acceptable quality of fill to be used.

Report guidelines: Refer to AGRD07 section 2.5 for further guidelines on report content.

Other documentation

Watercourses: Provide documentation necessary from relevant Authorities to support the filling of dams and watercourses.

4.2 DRAWINGS

Site regrading plan

Features: Define the location of features by distance to corner boundaries, monuments, etc for the purpose of relocation at the geotechnical testing stage and for WAE Drawings.

Annotation: Annotate with the following text unless otherwise approved by Council:

- Retain all topsoil on site and utilise effectively to encourage appropriate revegetation.

Geotechnical requirements: Incorporate all geotechnical requirements and recommendations.

EPA requirements: Document specific requirements of the EPA. Incorporate any sediment, siltation, erosion or salinity control devices/measures with specific reference to the stage at which these are to be provided.

Haulage routes: Document details of all haulage routes including the load limits applicable to each route.

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

Geotechnical report

Certification: Provide a geotechnical report certifying the works to be suitable for the intended purpose. Include any other geotechnical certification, test results and survey data required to conform to the specification.

0041 GEOMETRIC ROAD LAYOUT

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Design and document a road system to provide the following:

- Improved urban structure and revitalisation.
- Convenient and safe access for pedestrians, vehicles and cyclists.
- Appropriate access for buses, emergency and service vehicles.
- A quality road network that minimises maintenance costs.
- A convenient zone for public utilities.
- An opportunity for street landscaping.
- Convenient parking.
- Conformance to the Disability Discrimination Act.
- An appropriate response to climate, geology and topography, existing built fabric, heritage and cultural context of the area.
- Phasing of construction to suit access and funding.
- Drainage of elements within the roadway reserve.
- Street lighting.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *0010 Quality requirements for design.*
- *0011 Development and subdivision of land*

Related worksections: The following worksections are related to this worksection:

- *0021 Site regrading.*
- *0042 Pavement design.*
- *0043 Subsurface drainage (Design).*
- *0044 Pathways and cycleways.*
- *0061 Bridges and other structures.*
- *0074 Stormwater drainage (Design).*
- *0075 Control of erosion and sedimentation (Design).*

Workgroup

11 Construction - Roadways

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian standards

AS 1348-2002	Glossary of terms - Roads and traffic engineering
AS/NZS 2890	Parking facilities
AS/NZS 2890.1:2004	Off-street car parking
AS 2890.5-1993	On-street car parking
AS/NZS 2890.6:2009	Off-street parking for people with disabilities
AS/NZS 3845: 1999	Road safety barrier systems

Austroads

AGRD01-2010	Guide to road design - Introduction to road design
AGRD02-2006	Guide to road design - Design Considerations
AGRD03-2010	Guide to road design – Geometric design
AGRD04-2009	Guide to road design – Intersections and crossings
AGRD04A-2010	Guide to road design – Unsignalised and Signalised Intersections
AGRD04B-2011	Guide to road design - Roundabouts
AGRD06-2009	Guide to road design – Roadside design, safety and barriers
AGRD06A-2009	Guide to road design – Pedestrian and cycle paths
AGRD07-2008	Guide to road design - Geotechnical investigation and design
AGRD08-2009	Guide to road design - Part 8 Process and documentation
AGTM03-2009	Guide to traffic management Part 3 - Traffic studies and analysis
AGTM05-2008	Guide to traffic management Part 5: Road management
AGTM06-2007	Guide to traffic management Part 6: Intersections, interchanges and crossings
AGTM07-2009	Guide to traffic management Part 7: Traffic management in activity centres
AGTM08-2008	Guide to traffic management Part 8: Local area traffic management
AGTM11-2008	Guide to traffic management Part 11: Parking
AGTM12-2009	Guide to traffic management Part 12: Traffic impacts of development
AP-G34-2006	Design vehicles and turning path templates

1.4 STANDARDS

General

Road design: To AGRD01 and AGRD02.

Geometric design: To AGRD03.

Intersection design: To AGRD04, AGRD04A.

Geotechnical investigation and design: To AGRD07.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AADT: Average Annual Daily Traffic.
- ASD: Approach Sight Distance.
- AU: Auxiliary.
- BA: Basic.
- CH: Channelised.
- DDA: Disability Discrimination Act
- EDD: Extended Design Domain.
- HOV: High occupancy vehicle.
- LATM: Local Area Traffic Management.
- MGSD: Minimum gap sight distance.
- NDD: Normal Design Domain.
- SISD: Safe Intersection Sight Distance.

Definitions

General: For the purpose of this worksection, the definitions of terms used to define the components of the road reserve are in conformance with AS 1348, Glossary of Austroads Terms and AGRD03.

The words ‘street’ and ‘road’ are interchangeable throughout all parts of this worksection.

- Activity centre: Urban planning term for those places that are vibrant hubs where people shop work, meet, relax and often live.
- Approach sight distance: Relates to the ability of drivers to observe the roadway layout at an anticipated approach speed.
- Batter: Surfaces which connect carriageways or other elements of cross-sections to the natural surface. Batter provides a recovery area for errant vehicles and is used for landscaping and access for maintenance vehicles.

- Carriageway: That portion of the road or bridge devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes.
- Crossfall: The slope of the surface of a carriageway measured normal to the design or road centreline.
- Cycleway: Portion of a road or footpath for the exclusive use of cyclists.
- Extended Design Domain (EDD): The design domain for the assessment of existing roads. EDD is a range of values below the lower bound of the NDD.
- Footpath: A public way reserved for the movement of pedestrians and of manually propelled vehicles. The paved section of a pathway.
- Horizontal alignment: The bringing together of the straights and curves in the plan view of a carriageway. It is a series of tangents and curves that may or may not be connected by transition curves.
- Landform: The type and shape of terrain, usually including topography, geological characteristics, coastlines, rivers and water bodies.
- Legibility distance: The maximum distance that the various types of traffic control signs or devices can clearly be seen under normal operating conditions and where there is no restriction to the line of sight.
- Minimum gap sight distance: Relates to the critical acceptance gap that drivers are prepared to accept when undertaking a crossing or turning manoeuvre at intersections.
- Minor road: All roads which become part of the public road system and are supplementary to arterial and sub-arterial roads. Minor roads may include local sub-arterial roads, collector roads, local roads, and access streets. The terminology of road hierarchy may be different in different states. Refer to the relevant State Road Authorities for more information www.australia.gov.au.
- Normal Design Domain (NDD): The design domain for a new road is referred to as the Normal Design Domain. The extent of NDD defines the normal limits for the values of parameters that have traditionally been selected for new roads.
- Outer separator: It is the portion of the road reserve separating a through carriageway from a service road.
- Pathway: See footpath.
- Pavement: The portion of a carriageway placed above the subgrade for the support of, and to form a running surface for, vehicular traffic.
- Plan transition: The length over which widening and shift is developed from the ‘tangent-spiral’ point to the ‘spiral-curve’ point; i.e. the length between the tangent and the curve.
- Reaction time: The time taken for a driver to perceive and react to a particular stimulus and take appropriate action. It is measured in seconds.
- Road network: A framework for movement by other modes, including pedestrian, bicycle and bus and plays a vital role in supporting neighbourhoods and town centres.
- Road reserve: The strip of public land between abutting property boundaries, specifically gazetted for the provision of public right of way. It includes the road carriageway, as well as footpaths, verges and landscape.
- Roundabout: A form of intersection channelization in which traffic circulates clockwise around a central island and all entering traffic is required to give way to traffic on the circulating roadway.
- Service road: A roadway parallel to and separated from an arterial road to service adjacent property. They are usually continuous.
- Shoulder: The portion of formed carriageway that is adjacent to the traffic lanes and flush with the surface of the pavement.
- Shoulder width: The measurement taken from the outer edge of the traffic lane to the edge of usable carriageway and excludes any berm, verge, rounding or extra width provided to accommodate guideposts and guard fencing.
- Side friction factor (f): A measure of the frictional force between the pavement and the vehicle tyre.
- Safe intersection sight distance (SISD): Relates to an overall check that vehicles utilising the intersection have sufficient visibility to allow reaction and deceleration so as to provide adequate stopping distance in potential collision situations.
- Speed (85^{th} percentile): The speed at or below which 85% of the vehicles travel:

  - Design speed: A speed fixed for the design and correlation of those geometric features of a carriageway that influence vehicle operation.
  - Desired speed/Operating speed: The speed over a section of a road adopted by a driver as influenced by the road geometry and other environmental factors.
- Sight distance: The distance, measured along the carriageway, over which the visibility occurs between the driver and an object or between two drivers at specific heights above the carriageway in their lane of travel.
- Stopping Sight Distance: The sum of the braking distance and the distance the vehicle travels at a design speed during a reaction time of 2.5 seconds.
- Superelevation: A slope on a curved pavement selected so as to enhance forces assisting a vehicle to maintain a circular path.
- Traffic lane: That part of the roadway set aside for one-way movement of a single stream of vehicles.
- Traffic lane width: Traffic lanes are measured to the face of the kerb or to the lane line for multi-lane roads or roads with shoulders.
- Verge: The section of the road formation that joins the shoulder with the batter. It may accommodate public utilities, stormwater flows, street lighting poles, guide posts, road safety barriers and plantings.
- Vertical alignment: The longitudinal profile along the centreline of a road consisting of series of grades and vertical curves.

1.6 HIERARCHICAL ROAD NETWORK

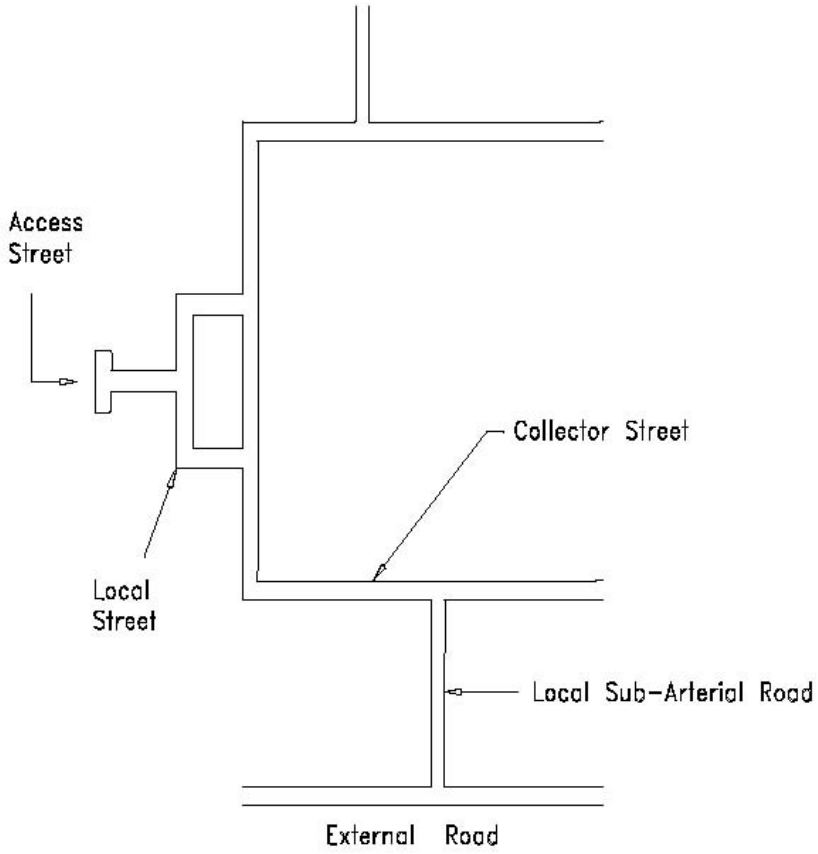
Road functions

Requirement: Design the network such that the predominant function of the road is conveyed to the motorists. Note that each class of road in the network serves a distinct set of functions and a hierarchical road network is essential to maximise road safety, residential amenity and legibility. Refer to the **Typical road hierarchy diagram**.

Access management categories: Conform to AGTM05.

Traffic management objectives: Conform to AGTM06.

Road function and traffic hierarchy: Conform to AGTM08.



Typical road hierarchy diagram

Classification

Terminology: The terminology used to describe each class of road varies from state to state. This worksection uses the functional categories common to the majority of states.

Functional classification of urban roads: To AGRD02 Table 2.2.

Functional classification of rural roads: To AGRD02 Table 2.3.

Levels of roads: The four generic distinct levels of roads are Access Street, Local Street, Collector Street and Local Sub-Arterial Road.

Emergency access

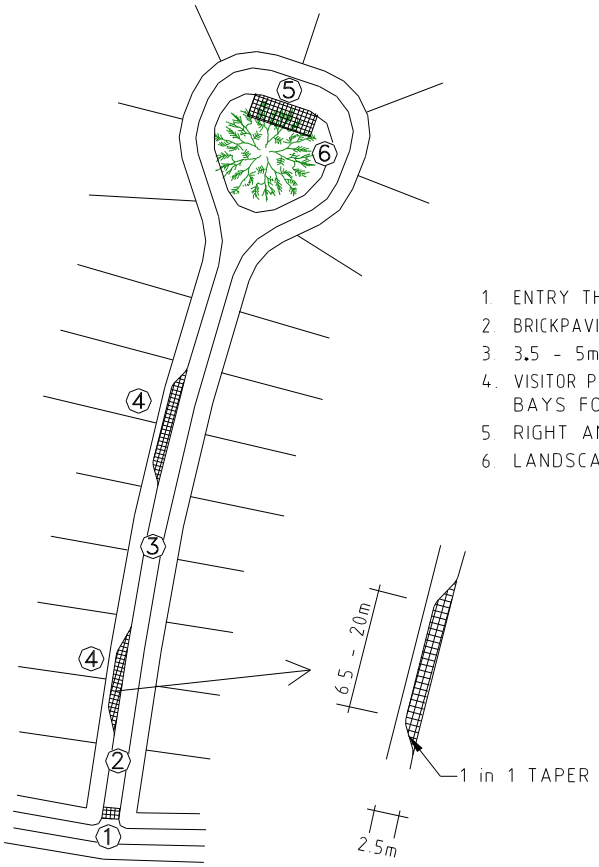
Requirement: Provide at least two access routes for emergency access for each street type in all subdivisions.

Traffic calming: Provide calming geometry to conform with AGTM08.

Access street

Identification: Access street is the lowest order road.

Description: The primary function is residential with amenity features which facilitate pedestrian and cycle movements. Vehicular traffic is compliant, in terms of speed and volume, to amenities, pedestrians and cyclists. The features of an example of an access street are shown in the **Typical access street layout.**



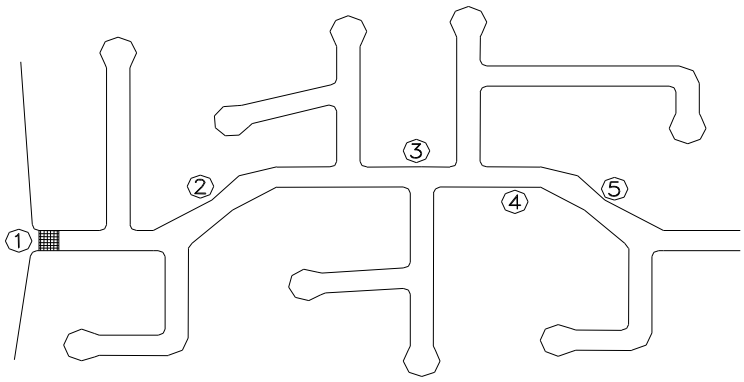
1. ENTRY THRESHOLD TO INDICATE LOWER SPEED ENVIRONMENT
2. BRICKPAVING OR COLOURED SURFACE TO INDICATE SHARED WAY
3. 3.5 - 5m CARRIAGEWAY WIDTH
4. VISITOR PARKING AREAS WHICH CAN ALSO BE USED AS PASSING BAYS FOR STREETS LONGER THAN 100m
5. RIGHT ANGLED VISITOR PARKING
6. LANDSCAPED OPEN SPACE

Typical Access street layout

Local street

Identification: Local street is the second lowest order road.

Description: A local residential street, balancing the status of the street in terms of access with residential amenity functions. Resident safety and amenity are dominant but to a lesser degree than access streets. Typically, local streets link access streets with collector streets. Refer to the **Typical local street layout.**



1. BRICK-PAVED ENTRY THRESHOLD SIGNIFIES ENTRY TO LOWER SPEED ENVIRONMENT
2. BENDS IN CARRIAGEWAY CONTROL SPEED
3. SHORT SECTIONS OF STRAIGHT CARRIAGEWAY CONTROL SPEED
4. CARRIAGEWAY WIDTH 7m
5. 1.2m FOOTPATH ON ONE SIDE

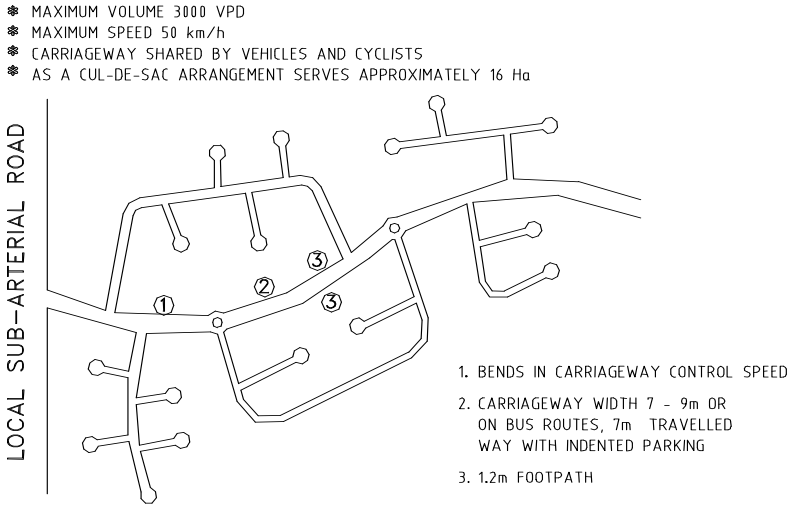
Typical Local street layout

Collector street

Identification: Collector street is the third lowest order road.

Description: It has a residential function but also carries higher volumes of traffic collected from local streets and connects to local sub-arterial roads and provides for community transport and business

access. There is a reasonable level of residential amenity and safety through restrictions of traffic volumes and speeds. However, amenity and resident safety do not have the same priority as in access streets or local streets. Refer to a **Typical collector street layout.**

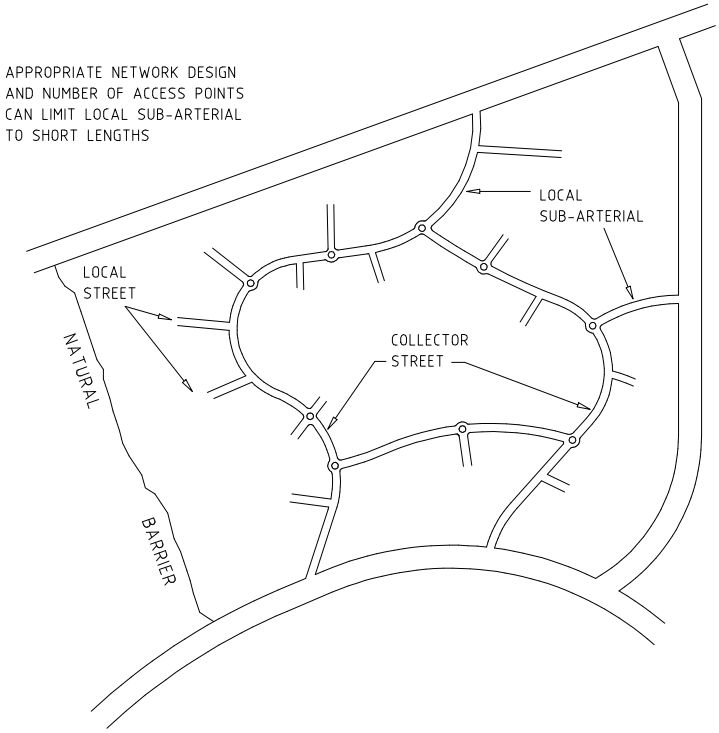


Typical Collector street layout

Local sub-arterial road

Identification: Local sub-arterial road is the highest order road within a residential development.

Description: Its main function is to provide convenient and safe distribution of traffic generated by the development. It provides direct access for single dwelling allotments and access for multi-unit developments and non-residential land uses as appropriate. The local sub-arterial road serves only the development and does not attract through traffic. Refer to typical Sub-arterial road layout showing also connection to external roads and minor streets.



Local sub-arterial road layout

2 PRE-DESIGN PLANNING

2.1 PLANNING

Road hierarchy
Requirement: In new areas, as distinct from established areas with a pre-existing road pattern, ensure each class of route reflects its role in the road hierarchy by its visual appearance and physical design. Routes differ in alignment and design according to the volume of traffic they are intended to carry, the desirable traffic speed, and other relevant factors.

Integrated design principles
Requirement: Integrate all design principles in the development of the road network to provide a balance between maximising amenity, safety and convenience considerations and those related to the drivers' perception of appropriate driving practices.

Preparation for design: Design development inputs to conform to AGRD08.

Acceptable vehicle speed
Requirement: Determine the acceptable vehicle speed for the particular section of road to AGRD03 clause 2.2.4.

Intersection turning movements
Requirement: Minimise the number of turning movements at intersections or junctions that a driver is required to undertake to reach a particular property within the development.

Conformance with Development Control Plan
Pattern and width: Conform to any relevant Development Control Plan (DCP). In areas not covered by such a plan, pattern and width(s) are determined by Council.

Legibility
General: Design for clear legibility in conformance with the following:

- Differentiation: Reinforce legibility by providing sufficient differentiation between the road functions. (see **Classifications**)
- Landmark features: Emphasise distinct landmark features such as watercourses, mature vegetation or ridge lines within the structural layout so as to enhance the legibility.
- Introduced features: Provide the necessary legibility, by the inherent design and functional distinction of the road network in addition to introduced physical features such as pavement and lighting details

Environmental considerations
Requirement: Evaluate the environmental considerations including topography, existing public utility services, visual intrusion, noise, vibration and pollution in the road design to AGRD03 clause 2.2.6.
Noise reduction: Consider vertical alignment adjacent to intersections and/or sensitive areas (e.g. schools, hospitals) to minimize braking noise.

Salinity prevention
Design constraints: For the design of roads through or adjacent to land known to be salt affected, take the following actions:

- Consultation: Consult with the relevant land and water resource authority.
- Early planning: Consider adjustments in horizontal and vertical line to avoid detrimental interference to and recharge of subsurface water within or adjacent to the road reserve.
- Landscaping: Select appropriate native deep-rooted species for plantings in association with road reserve works. Provide for plantations of sufficient size and density, multiple row belts and relatively close spacings, to lower the groundwater table.

Heritage considerations
Requirement: Heritage sites are recorded in the State heritage asset register. Some sites may contain archaeological sites relating to Aboriginal or non-Aboriginal occupation. Plan for the management of heritage assets.

2.2 CONSULTATION

Council and other Authorities

Requirements: Consult with the Council and other relevant authorities during the preparation of design. In addition to the requirements of this worksection, identify the specific design requirements of these authorities.

Public consultation

Public consultation of design proposals is required as part of the Council DA process.

Utilities service plans

Existing services: Obtain service plans from all relevant utilities and other organisations whose services exist within the area of the proposed development. Plot these services on the relevant drawings including the plan and cross-sectional views.

Requirements for utility services: To Streets Opening Conference *Guides to codes and practices for street openings.*

3 DESIGN

3.1 ROAD NETWORK DESIGN CRITERIA

General

Routing: Provide routing as follows:

- Avoid through routes in the internal road system that are more convenient than the external road network in conformance with AGTM08.
- Design and locate the external road network to provide routes that are more convenient for potential through traffic within the network.
- Provide access to major roads at intervals of no more than 1.5 km, of adequate capacity to accommodate through network movements.

Road links: Provide for road links as follows:

- Hierarchy: Except in exceptional circumstances, do not link one road with another that is more than two levels higher or lower in the hierarchy.
- Restriction: Avoid access from Access streets or Local streets to an access-controlled arterial road.

Traffic volumes and speeds: Ensure that the traffic volumes and speeds on any road are compatible with the residential functions of that road.

Road layout: Conform to the requirements of the external road network and satisfy the transport provisions of an outline development plan.

Travel time: Minimise the time required for drivers to travel on all streets within the development.

Internal road connections: Provide for intersections of internal roads as T-junctions or controlled by roundabouts.

Access street: Restrict the maximum length of an Access street to ensure that its status within a residential place is retained. Adopt design speed and volume to enable the integration of pedestrian, bicycle and vehicular movements without impairing residential convenience.

Local sub-arterial road: Minimise the length of local sub-arterial road within a development.

Pedestrian or bicycle network: Where Access streets form part of a pedestrian or bicycle network, provide for access links with adjoining access streets or open space systems to ensure functional efficiency of the pedestrian and bicycle network.

Traffic management in Activity Centres: Conform to AGTM07.

Traffic impacts of developments: Conform to AGTM12.

3.2 DESIGN SPEED

General

State Road Authority guidelines: Use design speed as the basic parameter in road design. It is dependent on the functional classification of the road, topography, land use and abutting development and desired speed of drivers.

Design speed values for urban roads

Requirement: Conform to the following operating speeds:

- Access street: 25 km/h.
- Local street: 50 km/h.
- Collector street: 60 km/h.
- Local sub-arterial road: 60/80 km/h.
- Speed limits: To AGTM05 Table 5.4.
- Typical urban operating speeds: To AGRD03 Table 3.1.

Operating speed model

Model: Determine the operating speed using the operating speed model to AGRD03 clause 3.5 to predict the operating speed of cars along the length of the road where the operating speed varies with the horizontal curvature and is also dependent on the driver behaviour, road and the vehicle characteristics.

Hazard reduction

Low speeds: Adopt a low design speed to discourage speeding. Avoid vertical or horizontal curves of low design speed located in otherwise high-speed sections to minimise the risk of creating a potentially dangerous section of road. Recognise that in low design speed roads, operating speeds may be in excess of posted speed limits.

Hazardous features: Make hazardous features visible to the driver. Adopt traffic engineering measures that help a driver avoid errors of judgement.

Road safety barriers: Assess and design road safety barriers to AS/NZS 3845.

Design speed values for rural roads

Criteria: Determine the minimum design speed value for other elements for Council Works on the concept of a 'speed environment' as outlined in AGRD03 clause 3.4 and Table 3.2.

Requirement: Conform to the following operating speeds:

- High speed rural roads: > 90 km/h.
- Intermediate speed rural roads: 70-90 km/h.
- Low speed rural roads: 50-70 km/h.

Restricted access to major roads: Design all rural subdivisions to control access to major roads. Limit access to one point on to local, collector, local sub-arterial or arterial road networks.

3.3 CROSS-SECTION

Road reserve characteristics

Cross section: Provide for all road functions including the following:

- Safe and efficient movement of all users.
- Provision for parked vehicles. Give particular attention to access for disabled persons in conformance with the Disability Discrimination Act.
- Access to public transport.
- Buffer from traffic acoustic nuisance for residents.
- Provision of public utilities
- Streetscaping.
- Requirements of Disability Discrimination Act.

Operational aspects: Conform to the following:

- Allow vehicles to proceed safely at the operating speed intended for that level of road in the network with only minor delays in the peak period.
- Take into consideration the restrictions caused by parked vehicles where it is intended or likely that this will occur on the carriageway.
- Vehicles include trucks, emergency vehicles and, on some roads, buses. (Refer to **Bus route criteria table**).

Type of cross-section

General: Determine the type of cross-section considering the following factors:

Design life: To AGRD03 Table 4.1.

Pedestrians and cyclists: Provide for the safety of pedestrians and cyclists where it is intended they use the carriageway by providing sufficient width and control of landscaping to provide sight distances.

Access to allotments: Adopt a carriageway width to provide for unobstructed access to individual allotments. Provide for drivers to comfortably enter or reverse from an allotment in a single movement, taking into consideration the possibility of a vehicle being parked on the carriageway opposite the driveway.

Traffic lanes

General: Determine the number and width of the traffic lanes required depending upon the traffic volume, presence of cyclists, available road reserve width and the side friction constrained by abutting access.

Standard traffic lane width for urban and rural roads: 3.5 m.

Reduced lane width: If there are site constraints the traffic lane width may be reduced to 3.2 m subject to the approval of the relevant road authority.

Urban arterial road widths: To AGRD03 Table 4.3.

Single carriageway rural road widths: To AGRD03 Table 4.5.

Dual carriageway rural road widths: To AGRD03 Table 4.6.

Plan transitions

Restrictions: In urban road design it is often impracticable to use plan transitions as kerb lines are fixed in plan and any shift requires carriageway widening. Widening on horizontal curves compensates for differential tracking of front and rear wheels of vehicles, overhang of vehicles, and transition paths. If proposed roads are curved, consider the adequacy of carriageway width.

Crossfall changes: To avoid abrupt changes in crossfall, which can cause discomfort in travel and create a visible kink in the kerb line, conform to the following:

- The wider the pavement the longer the transition.
- Use superelevation transitions at all changes in crossfall, not just for curves. Drainage problems can arise with superelevation transitions which may require extra gully pits and steeper gutter crossfalls.
- Where crossfalls change at intersections, draw profiles of the kerb line. Calculated points can be adjusted to present a smooth curve.

Crossfall

General: Desirably, crown the roads on centerline. Provide crossfall to drain the carriageway on straights and curves and to provide superelevation on horizontal curves. Provide pavement crossfalls on straight roads for various pavement types to the **Pavement crossfall on straights table**.

Pavement crossfall on straights table

Type of pavement	**Crossfall (%)**
Earth, loam	5
Gravel, water bound Macadam	4
Bituminous sprayed seal	3
Asphalt	2.5 – 3
Concrete	2 - 3

Recommended minimum crossfall: 2%.

Rate of change: Do not exceed the rate of change of crossfall in the following conditions:

- Through traffic: 6% per 30 m.
- Free flowing turning movements: 8% per 30 m.
- Turning movements for which all vehicles are required to stop: 12% per 30 m.

Precedence of crossfall over grade: Conform to the following:

- The crossfall on a Collector street or Local sub-arterial road will take precedence over the grade in Local or Access streets. Maintain the crossfall on the major road and adjust the local street levels to suit.
- A rate of change of grade of 2 % in the kerb line of the side street relative to the centre line grading is a reasonable level.

Shoulders

Function: Design road shoulders to carry out the following functions:

- Structural: Provide lateral support to the road pavement layers.

- Traffic: Provide an initial recovery for an errant vehicle, emergency use, a refuge for stopped vehicles and space for cyclists.

Shoulder width: Provide the following:

- Generally: 1.5 – 2 m.
- For higher volume roads: 2.5 – 3 m.

Shoulder sealing: Seal the shoulders partially or wholly to reduce maintenance costs and to improve moisture conditions under pavements. Conform to the following sealed widths:

- Minimum width of shoulder seal for AADT < 1000: 0.5 m.
- For wet areas where moisture control is required:
  - Desirable shoulder seal width: 0.5 m.
  - Preferred shoulder seal width: 1 m.
- For discretionary stopping of cars: 2.5 m.
- For bicycles, minimum sealed width: 2 – 3 m.

Shoulder crossfall: Provide the following shoulder crossfall:

- For earth and loam: 5 – 6%.
- For gravel or crushed rock: 4 – 5%.
- For concrete and for full depth pavement with bitumen seal or asphalt wearing course: Match with the traffic lane.

Verge

General: Design the verge to perform the following functions:

- A traversable transition between the shoulder and the batter slopes.
- A firm surface for stopped vehicles.
- Space for installation of guideposts and road safety barriers.
- Reduce scouring due to stormwater run-off.

Minimum width: To AGRD03 Table 4.9.

Verge rounding: Provide verge and batter toe rounding to minimise rollover accidents to AGRD03 Table 4.10.

Verge slope: Provide verge slopes for local roads or behind kerb and channel in cut:

- Without rounding: 5%.
- With rounding: Initial slope same as abutting shoulder.

Verges and property access

Criteria: Design the verge with consideration of utility services, the footpath width, access to adjoining properties, likely pedestrian usage and preservation of trees.

Restriction: If normal crossfalls are impracticable adopt low level footpaths.

Crossfalls in footpath paving: < 2.5% to AGRD06A.

Longitudinal grade: Conform to the following:

- Parallel to the longitudinal grade of the road.
- Limit: May be steeper than 5%.

Driveway profile: Conform to the following:

- Provide a vehicular driveway centreline profile for the property access.
- Check the design using critical car templates, available from the Council.
- Design driveway profiles so that vehicles can use the driveway satisfactorily.

Batters

Requirement: Accommodate differences in level across the road between road reserve boundaries by the following measures used individually or combined:

- Cutting at the boundary on the high side and providing the verge at normal level and crossfall.
- Battering at the boundary over half the verge width with the half against the kerb constructed at standard crossfall.

Batter slopes: Design the batter slopes considering the following factors:

- Recommendations of geotechnical investigations.

- Batter stability and safety.
- Available width of road reserve.
- Landscape requirements.
- Maintenance costs and accessibility requirements. Preferred maximum batter slope for a slasher is 4:1.

Design batter slopes: To AGRD03 Table 4.12.

Benches: Provide benches for high batters > 10 m vertical height or batters on unstable ground. Provide benches as shown in AGRD03 Figure 4.7.

- Minimum width of bench: 3 m.
- Maximum crossfall: 10%.
- Preferred bench width for road safety, maintenance and drainage: 5 m.

Roadside drainage

General: Provide drains to remove water from the road and its surroundings and to maintain road safety and pavement strength. Provide table drains, catch drains, median drains or kerbs and channels.

Table drain: Provide a dish drain, or similar structure along the invert of table drains, seal the outer edges of the pavement, the shoulder verges and the drain lining where scour is likely to occur to AGRD03 Figure 4.8. Provide the following slopes:

- Side slopes: < 4H:1V.
- Desirable slope: 6H:1V.

Catch drains: Provide catch drains to prevent overloading of the table drain and scour of the batter face at least 2 m from the edge of cuttings to minimise possible undercutting of the top of the batter.

Median drains: Provide median drains with side slopes 10H:1V to reduce the chance of vehicle overturning. Provide a depressed median of minimum 10 m width. Place the invert of the median drain below subgrade level to facilitate drainage of pavement layers.

Kerb and channel: Provide kerb and channel to perform the following:

- Collect and convey surface drainage to a discharge point.
- Delineate the edges of the carriageway.
- Separate carriageways from areas dedicated to footpath users.
- Support the edge of the base course of the pavement.
- Reduce the width of cut by substituting an underground drainage system in place of table drains.

Kerb type and placement: Determine the type of kerb and placement to AGRD03 clause 4.6 and the following:

- Provide barrier kerb for lightly trafficked Local roads, adjacent to parking lanes and parking areas and bus bays to reduce the risk to pedestrians.
- Provide layback kerb on minor roads to allow for off-road parking and for continuous access to property.

Location: Place kerb and channel with the clearance between the face of the kerb and edge of the traffic lane to AGRD03 Table 4.13.

Scour protection

Requirement: Provide scour protection of roadside drainage and table drains. The level of protection will depend on the nature of the soils, road gradients and volume of stormwater runoff.

Protection of the works: Provide concrete lined channels, turfing, rock pitching, grass seeding, individually or in combination. Carry out geotechnical investigations to determine the level and extent of any protection works before proceeding to final design stage.

Medians

General: Provide medians to improve the safety and operation of urban and rural roads with multiple lanes.

Median width: Minimum median width to AGRD03 Table 4.14.

Median slopes: Provide median slopes to AGRD03 Table 4.15.

Bicycle lanes

General: Consider provisions for cyclists in the road design and provide adequate space for cyclists to share the road safely and comfortably by providing on-road bicycle facilities in the form of the following:

- Separate bicycle lanes: Provide separation from other motor traffic with exclusive bicycle lane on the left side of the road by pavement markings and signs.
- Road shoulders.
- Widened lanes for joint use by bicycles and other vehicles.

Bicycle lane width: To Bicycle lane widths table.

Restriction: Provide a minimum bicycle width of 2 m in congested areas.

Bicycle lane widths table

Lane width (m)	**Speed limit (km/h)**		
	60	**80**	**100**
Desirable	1.5	2.0	2.5
Acceptable	1.2 - 2.5	1.8 – 2.7	2.0 – 3.0

Minimum clearance with adjacent traffic on local roads: 1 m.

High occupancy vehicle (HOV) lanes

General: If there are any public transport services proposed in the route, provide HOV priority lanes for public transport in conformance with the following:

- Shoulder width: 3.5 m.
- Intermittent bays: Provide bays with appropriate length tapers to provide safe movement of vehicles.
- Provide access to public transport in conformance with the Disability Discrimination Act.

Bus lane width: On new roads, conform to the following:

- To AGRD03 Table 4.21.
- Minimum width between the kerbs:
  - If bicycle lanes are provided: 15 m.
  - If bicycle lanes are not provided: 11.6 m.
- Kerbside width of bus lanes: To AGRD03 Table 4.22.

On-site parking

On-site: Design on-site parking by determining the demand for parking to AGTM11, including the following:

- Accommodate on-site parking requirements for normal levels of activity associated with any land use.
- Ensure that the through traffic is not impeded.
- Locate all on-site parking of dimensions that allow convenient and safe access and usage.
- Number of on-site parking spaces for non-residential land uses: Conform to parking standards as determined by the relevant authority.
- The layout and access arrangements for parking areas for non-residential land uses: To AS/NZS 2890.1.
- On-site parking for people with disabilities: To AS/NZS 2890.6 and to the Disability Discrimination Act.

Number of on-site residential spaces: Conform to the following:

- Provide two car parking spaces (which may be in tandem) on-site for each single dwelling allotment.
- Provide three spaces on-site for each two dwelling units for multi-unit residential developments.

Minimum dimension: Include one space for each residential unit within the allowable building area and with a minimum dimension of 5.0 m by 3.0 m.

On-street parking

Standards: To AS 2890.5, AGRD03 clause 4.10 and AGTM11.

Road reserve parking: Provide adequate parking within the road reserve for visitors, service vehicles and any excess resident parking since a particular dwelling may generate a high demand for parking.

Future spaces: On single lane carriageways, provide one space for each two allotments on the verge within 25 m of each allotment, with scope to provide one additional space for single dwelling allotments or for each two units in a multi-unit development if required at a future time.

Short term truck parking: On single lane carriageways, combine a number of verge spaces to provide for short term truck parking within 40 m of any allotment.

Verge and carriageway parking: On single lane access streets, provide parking spaces within the verge. Provide verge and carriageway parking in conformance with the following:

- Adequate dimensions.
- Convenient and safe to access.
- Well defined with traffic control devices.
- All-weather surface.
- No restriction to the safe passage of vehicular, disabled and pedestrian traffic.

Joint use: For non-residential land uses, provide the opportunity for maximum joint use of shared parking by a number of complementary uses.

On-street parking dimensions: Conform to the following:

- Single (car) space: 6.5 m x 2.5 m
- Combined spaces for two cars:13.0 m x 2.5 m
- Truck parking: 20 m x 2.8 m with adequate tapers at both ends to allow parking manoeuvres determined to AP-G34.

Material: Construct all verge spaces and indented parking areas of concrete, interlocking pavers, lawn pavers, bitumen with crushed rock or other suitable base material designed to withstand the loads and manoeuvring stresses of vehicles expected to use those spaces.

Right-angled parking: Provide right-angled parking only on Access streets and Local streets where speeds do not exceed 40 km/h.

Angled parking space widths: To AS 2890.5 Table 2.2.

Service roads and footpath

General: Service roads provide access to the abutting property or control access to the arterial road from the abutting property.

Minimum service road lane width: To AGRD03 Table 4.25.

Minimum service road carriageway width for roads with low traffic volumes: To AGRD03 Table 4.26.

Operating speed: 40-60 km/h.

Outer separator width: To AGRD03 Table 4.27

Urban border: Provide urban borders comprising of a pedestrian path and the nature strip to AGRD03 Table 4.28, to ensure the following:

- Separate pedestrians from vehicular traffic.
- Provide off-road bicycle facilities.
- Provide for indented bus bays.
- Take up level differences between the carriageway and the boundaries of the adjacent properties.
- Provide for public utility services and drainage.

Typical urban border slopes: Conform to the following:

- For footpaths
  - Desirable: 1%
  - Maximum: 2.5%
- Nature strip:
  - Grassed soil: 4-10%
- Determine minimum slope on urban borders by considering the drainage.
- Determine the maximum slope by considering the terrain and provision of access at driveways.

Footpaths: Provide footpaths either adjacent to the roadway or separated from it by a nature strip.

Standard: To AGRD06A.

Minimum desirable width: 1.2 m.

Crossfall: Varies from flat to 2.5%.

Bus stops

New bus stops: In conformance with the requirements of the Disability Discrimination Act (Australian government 1992) and other road authorities and transport agency disability standards which outline the requirements of the access paths, manoeuvring areas, ramps, waiting areas, surfaces and tactile ground surface indicators.

Urban bus stops: To AGRD03 Figure 4.39 provides a typical bus bay layout.

Rural bus stops: Locate bus stops in the road shoulder between the carriageway and table drain.

Minimum shoulder width for a bus stopping area: 3 m.

Minimum length of bus stopping area: 15 m.

For intermediate speed environments provide a longer sealed distance: 30-50 m.

3.4 SIGHT DISTANCE

General

Stopping and sight distance: Provide stopping and sight distance at all points on the road conforming to AGRD03 Section 5.

Sight distance parameters: To AGRD03 Table 5.1 and the following:

- Object cut-off height: 0.2 m.
- Driver eye height: Adopt the following:
  - . For cars: 1.1 m.
  - . For commercial vehicles: 2.4 m.
- Driver reaction time: Adopt reaction time of 2.5 seconds for all roads. If 1.5 seconds and 2 seconds reaction times are required, arrange approvals from the State Road Authority. AGRD03 Table 5.2 provides further details on reaction times.

Stopping sight distance: Conform to the following:

- General: To AGRD03 clause 5.3, measured from an eye height of 1.15 m to an object height of 0.20 m.
- On sealed roads: Car stopping sight distance to AGRD03 Table 5.4.
- On horizontal curves: To AGRD03 Figure 5.4.
- On horizontal curves with roadside barriers: Provide minimum shoulder widths and manoeuvre times for sight distances over roadside safety barriers on horizontal curves to AGRD03 Table 5.6.

Horizontal curve perception sight distance: Provide sufficient sight distance by adopting larger crests for a horizontal curve. Do not provide a horizontal curve starting over a crest. Check sufficient visibility is provided for the curve by providing:

- Clear driver eye height: 1.1 m.
- A zero object height such that the driver can see the road surface in order to perceive the curvature.
- Driver visibility of a minimum of:
  - . 5 degrees of arc.
  - . 80 m of arc.
  - . The whole curve.

3.5 COORDINATION OF HORIZONTAL AND VERTICAL ALIGNMENT

Horizontal and vertical alignment coordination

General: The 3 dimensional coordination of the horizontal and the vertical alignment on the road aims to increase efficiency, safety, encourage uniform speed, improve aesthetics, provide harmony with the landform and drainage.

Requirement: Conform to the following:

- Avoid the use of minimum radius horizontal curves with crest vertical curves.
- Contain the crest vertical curves within horizontal curves to enhance the appearance of the crest by reducing the three dimensional rate of change of direction and to improve safety.
- Provide the same design speed of the road in both horizontal and vertical planes.
- Avoid sharp horizontal curves at or near the top of a crest vertical curve.

- Consider three dimensional combined horizontal and vertical stopping sight distance and minimum sight distance.
- Provide a horizontal curve to indicate the change in direction before introduction of vertical curve in both directions of travel.
- Be aware that a short vertical curve on a long horizontal curve or a short tangent in the grade-line between sag curves may adversely affect the road's symmetry and appearance.

Aesthetic consideration: Conform to the following:

- Provide horizontal curves slightly longer than the vertical curve, such that the curves fits with the terrain and are coincident.
- Provide long horizontal curves to short curves such that:
  - The overtaking opportunities are not reduced.
  - Small deflection angles avoid the appearance of a kink.
  - Best appearance is provided for deviations around obstructions.
  - The far tangent point is beyond the driver's point of concentrated vision for curves located at the end of long straights.

Drainage consideration: To ensure pavement drainage and to reduce the risk of aquaplaning, avoid very long crest and sag curves, that result in long sections of flat grades at the top and the bottom of the curves.

3.6 HORIZONTAL ALIGNMENT

General

Requirement: Provide horizontal alignment for safe and continuous vehicle operation at a uniform travel speed. Include the following:

- For low and intermediate speed rural roads and minor urban roads, where physical restrictions curve radii cannot be overcome, introduce curvature of a lower standard than the design speed of the project to AGRD03 Table 7.1.
- Provide tangents of suitable length as frequently as the terrain permits to facilitate overtaking manoeuvres.
- Determine the horizontal alignment from the design speeds for a particular street within the road hierarchy (see **Design Speed**).

Horizontal curves

Types of horizontal curves: Conform to the following:

- Compound curves: Provide a smaller curve preceding a larger curve. Avoid diminishing radii at steep downgrades.
- Reverse curves: Do not use reverse curves unless there is sufficient distance between the curves to introduce full superelevation of the two curves without exceeding the standard rate of change of crossfall for a particular design speed.
- Transition curves: Join the straight and circular curves to smooth the travel of vehicles within the traffic lane. Transition the horizontal curves with the transition length based on the superelevation runoff length for the recommended combination of speed, radius and superelevation. Avoid transition curves for large radius horizontal curves and where operating speed is less than 60 km/h. Where lane width is ≤ 3.5 m, provide transition paths for trucks.

Horizontal curves and tangent lengths

Speed/radius relation: Conform to the following:

- For a given design speed, utilise the minimum radius of curvature that ensures that drivers can safely negotiate the curve.
- Avoid curves that progressively tighten (e.g. parabolic curves) and sudden reverse curves that drivers cannot anticipate as they have the potential to produce an uncomfortable sense of disorientation and alarm.

Speed restriction: Where speed restriction is provided by curves in a street, conform to the relationship between the radius of the curve and the desired vehicle speed.

Tangents: Determine appropriate lengths for tangents between speed restrictions, which may be curves, narrow sections or other obstructions.

Sight distance: Determine the sight distance on curves to AGRD03 clause 5.4.

Side friction and minimum curve size

Recommended side friction factors: To AGRD03 Table 7.4.

Minimum radii for horizontal curves based on superelevation and side friction: To AGRD03 Table 7.5.

Maximum allowable deflection angles without horizontal curves: To AGRD03 Table 7.6.

Superelevation

Requirement: Use of superelevation in association with horizontal curves for geometric design of roads with all design speeds.

Criteria: Determine the superelevation by including the following:

- Operating speed of the curve.
- Difference between the inner and outer formation levels in flat or urban areas
- Stability of high vehicles when adverse crossfall is considered.
- Length available to introduce the necessary superelevation.

Minimum radius of curves: Determine from the following:

- Design speed.
- Minimum superelevation (or maximum adverse crossfall) at any point on the circular portion of the curve.

Low design speed and crowned pavement: Conform to the following:

- Access and Local streets: For design speeds of 50 km/h or less, and curves of 60 m radius or less, generally have the pavement crowned on a curve instead of superelevation.

Superelevation in rural roads: Design superelevation, widening and centreline shift and transitions in conformance with the AGRD03 clause 7.7.

High design speed: Conform to the following:

- Maximum superelevation for urban roads of higher design speeds: 6%.
- Maximum values for different road types: To AGRD03 Table 7.7.
- Avoid any increase in the longitudinal grade leading to excessive crossfall at intersections.
- While it is desirable to superelevate all curves, limit adverse crossfall to 3%.

Length of superelevation: Design superelevation development lengths to satisfy both rate of rotation and relative grade criteria to AGRD03 Table 7.9.

Transitions: Conform to the following:

- Planning: Plan transitions on superelevated curves for appearance and to provide sufficient length in which to apply the superelevation.
- Urban roads: Superelevation may be conveniently applied to the road cross section by shifting the crown to 2 m from the outer kerb, as long as the road is not too wide.
- Access to adjacent properties: The axis of rotation of the cross section for urban roads is normally the kerb grading on either side which best enables access to adjacent properties and intersections.
- On the outside of superelevation, or where the longitudinal grade of the gutter is < 0.5%, adopt a crossfall of 63 mm in a 450 mm wide gutter.

Curves with adverse crossfall

General: Avoid adverse crossfall greater than 3% except for curves with an operating speed ≤ 70 km/h in constrained areas and for intersection turns and roundabouts.

Minimum radii with adverse crossfall: To AGRD03 Table 7.10.

Adverse superelevation: Provide adverse superelevation at the following:

- Property access controls.
- Channel drainage controls.
- Grading restrictions.
- Intersections to maintain visibility of the road surface.

Pavement widening on horizontal curves

Widening: Provide pavement widening on curves to AGRD03 Table 7.11 to maintain lateral clearance between vehicles taking into account the following factors:

- Radius of the curve.
- Width of lane on a straight road.

- Vehicle length and width.
- Vehicle clearance.

3.7 VERTICAL ALIGNMENT

General

Documentation: Show vertical alignment on a longitudinal section with a vertical scale of 10H:1V.

Vertical controls

Requirement: Consider the effect of the following features on the vertical geometric design:

- Existing topography.
- Geotechnical conditions.
- Existing intersections.
- Property entrances.
- Pedestrian access.
- Service utility assets.
- Median openings.

Minimum clearance above flood levels and water tables: As defined by the relevant road authority.

Vertical clearances

General: Provide minimum vertical clearances over roadways and pedestrian/cycle paths to AGRD03 Table 8.1.

Precedence: If there is a conflict the following order takes precedence:

- Policies of the road owning authority e.g. Council, State Road Authority.
- Requirements of the authority that owns the object e.g. rail authority.

Underground services

Clearance requirements: Consult the relevant authority to determine the minimum clearance requirements for:

- Gas mains.
- Water mains.
- Stormwater drains.
- Sewer outfall.
- Telecommunication cables.
- Underground electrical cables.
- Road authority assets e.g. traffic signals and street lighting.

Longitudinal gradient

General: Provide grades as flat as possible, consistent with longitudinal drainage requirements such that all vehicles operate at the same speed. Conform to the following minimum grades:

- Road with kerb and channel:
  - Minimum desirable grade: 1%
  - Absolute minimum grade: 0.3%.
- Roads in cut:
  - Unlined drains: 0.5%.
  - Lined drains: 0.3%.
- Roads without kerb and channel and not in cut: 0%.
- Minimum gradient of 0.5%.
- In very flat conditions: Reduce grade to 0.3%.
- If underground drainage with gully pits or other special works are used: Consider near level grades. Provide variable crossfall to achieve the required grade in the gutter.

Maximum grade: To AGRD03 Table 8.3.

Intersections: Conform to the following:

- Longitudinal grade of the minor street on the approach to an intersection: < 4%.
- Design actual gradient dependent on the type of terrain.

- Interrelate the design of the road alignments and the grades used.
- Avoid a steep grade on a minor side street if vehicles have to stand waiting for traffic in the major road.

Maximum grade in cul-de-sacs and turning circles: < 5 %.

Vertical curves

Criteria: Design vertical curves in conformance with the following:

- Provide vertical curves like simple parabolas on all changes of grade exceeding 1%.
- Desirable minimum design speed: 40 km/h.
- The length of the crest vertical curve for Stopping Sight Distance: To AGRD03 Table 8.7.
- Limit the length of crest curve with 0.3% to 0.5% grade: 30 to 50 m.

Sag curves: Provide the lengths of sag vertical curves to AGRD03 clause 8.6.4 and the following:

- For kerbed roads: Limit the maximum length of sag curves with less than 0.3% grade to 30 m.
- Maintain a minimum grade of 0.5% in the kerb and gutter. This may require some warping of road cross sections at sag points.

Sag vertical curves: As residential roads are usually lit at night, the criterion for designing sag vertical curves is a vertical acceleration of the following:

- For desirable riding comfort: 0.05 g.
- For minimum riding comfort: 0.10 g.

Side road intersections: Locate intersections of roads at a safe distance from a crest, determined by visibility from the side road. If it is proposed to locate intersections of a side road where a crest occurs, provide details with justifications.

3.8 AUXILIARY LANES

General

Requirement: Provide auxiliary lanes adjacent to the through traffic lanes to enhance traffic flow and maintain the required level of service where an Arterial road meets with the Sub-arterial, Collector or Local roads.

Types of auxiliary lanes

Speed change lanes: Provide speed change (acceleration or deceleration) lanes at intersections or interchanges to allow an entering vehicle to access the traffic stream at a speed approaching or equal to 85th percentile speed of the through traffic.

Overtaking lanes/climbing lanes: Provide overtaking lane lengths to AGRD03 Table 9.2 and merge sight distance at the end of overtaking to AGRD03 Table 9.3.

Slow vehicle turnouts: Provide a short section of paved shoulder to allow vehicles to pull aside and be overtaken. Provide turnout lengths of 60 – 160 m for average approach speed of 30 – 90 km/h and a width of 3.7 m.

Cross-section

Auxiliary lane width: Provide auxiliary lane width not less than the normal width for that section of the road.

Shoulder width: 1 m.

Crossfall: Provide same crossfall of the auxiliary lane as the adjacent lane.

3.9 INTERSECTIONS

Design criteria

Requirement: Consider the following factors in the location and design of intersections:

- Alignment and grade of approach road.
- Provision of drainage.
- Interference with public utilities.
- Property access.
- Topography.
- Natural and built environment.

Urban and rural intersections: To AGRD04 Table 4.1.

Road users considerations: To AGRD04 Table 3.2.

Design criteria: Design intersections to AGTM06.

Intersection types

Traffic management: Select the type of intersections for traffic management in conformance with AGTM06 Table 2.4.

The basic forms of an intersection may include the following:

- Signalised, unsignalised or a roundabout.
- Channelised (i.e. has traffic islands and/or medians) to develop specific types of intersections, or unchannelised.
- Flared, to provide additional through and/or turning lanes, or unflared.
- An urban or rural intersection to which different driver expectations and hence different design and traffic management guidelines may apply.

Location

Requirement: Locate intersections to AGRD04 Table 4.2 and the following:

- Streets intersection: Preferably at right-angles and not less than 70º.
- Landform: Allowing clear sight distance on each of the approach legs of the intersection.
- Minor street: Intersect the convex side of the major street.
- Vertical grade lines at the intersection: Conform to the following:
  - Provide a desirable grade of 3%with a maximum of 5%.
  - Allow for any direct surface drainage.
- For a left turn, where two minor side streets intersect a major street in a staggered pattern, provide to have a minimum centreline spacing of 40 m.

Traffic volumes: Design for all movements to occur safely without undue delay. Use projected traffic volumes in designing all intersections or junctions on Local sub-arterial roads.

State roads and national highways: Design intersections for the junction of Council's roads with existing state rural or urban roads and national highways to AGRD04.

Approval of State Road Authority: Design intersections with state roads or national highways in conformance with the requirements of the State Road Authority.

Sight distance: Provide adequate stopping and sight distances for horizontal and vertical curves at all intersections.

Parking: Where required, make appropriate provision for vehicles to park safely.

Drainage: Design the road reserve cross-section profile to satisfy the drainage function of the carriageway and/or road reserve.

Turning movements: Accommodate all vehicle turning movements in conformance with AP-G34 and the following:

- For intersection turning movements involving Local sub-arterial roads: Provide for the 'design semi-trailer' with turning path radius 19.0 m.
- For intersection turning movements involving Local streets or Collector streets, but not Local sub-arterial roads: Provide for the 'design single unit' bus with turning path radius 12.5 m.
- For intersection turning movements on access streets but not involving local sub-arterial roads, collector streets or local streets: Provide for the garbage collection vehicle used by the local authority.
- For turning movements at the head of cul-de-sac access streets: Provide for sufficient area for the 'design single unit' truck to make a three-point turn or, if the length of the cul-de-sac is less than 60 m, for the 'design car' to make a three-point turn. If driveway entrances are used for turning movements, design the required area to withstand the relevant loads.

Turning radii at intersections or driveways on Local sub-arterial road: Design for the intended movements within desired speeds to be exceeded to AGRD04 Table 5.1.

Bus facilities: Provide minimum length required for bus lane on an intersection to AGRD04 Table 6.1.

Minimum width of bicycle and bus lanes: To AGRD04 Table 6.2.

Sight distance

Sight distance: Provide adequate horizontal and vertical sight distance at intersections. Examine each intersection location for conformance with the criteria for Approach Sight Distance (ASD), Minimum gap sight distance (MGSD) and Safe Intersection Sight Distance (SISD). Ensure ASD and SISD are achieved for all intersections, and MGSD where appropriate. Reposition an intersection if required to obtain conformance with the following sight distance criteria:

- ASD: To AGRD04A Table 3.1 and grade corrections to AGTM06 Table 3.3 for sealed roads.
- MGSD: To AGRD04A Table 3.5 for various speeds.
- SISD: Provide SISD for sealed roads to AGRD04A Table 3.2.

Type of turn treatments

General: Provide the appropriate type of right-turn and left-turn treatments from the following:

- Basic turn treatment (Type BA)
  - Rural basic (BA) turn treatment: To AGRD04A Figure 4.1.
  - Rural basic left-turn treatment for minor roads: To AGRD04A Figure 8.2, width minimum length of widened parallel shoulder to AGRD04A Table 8.1.
  - Urban basic (BA) turn treatment: To AGRD04A Figure 4.2.
- Auxiliary lane turn treatment (Type AU): Provide short lengths of auxiliary lane to improve safety on high speed roads where an arterial road meets with sub-arterial, collector or local roads. Provide the following turn treatments as appropriate:
  - Rural auxiliary lane turn treatments: To AGRD04A Figure 4.5.
  - Urban auxiliary lane turn treatments: To AGRD04A Figure 4.6.
  - Urban auxiliary left-turn treatment – Short turn lane (AUL(S)) major road: To AGRD04A Figure 8.10 with setting out details of the left turn geometry to AGRD04A Table 8.4 and with minimum kerb radii for low speed environment to AGRD04A Table 8.3.
- AUR right turn treatments: Not as safe as a channelised treatment at unsignalised intersections. Prefer not to use and many state and territories do not approve.
- Channelized turn treatment (Type CH):
  - Rural channelised (CH) intersection turn treatment: Layout to AGRD04A Figure 4.7 and design details to AGRD04A Figure 8.5 and Figure 8.6.
  - Urban channelised (CH) intersection turn treatment: Layout to AGRD04A Figure 4.8 and design details with a high entry angle left-turn island to AGRD04A Figure 8.12 and Urban CHL with acceleration lane to AGRD04A Figure 8.13.

Staggered T-intersections: Rural staggered T intersections may be ‘right to left’ or ‘left to right’ type to AGRD04A Section 4.11. Each type has either safety or cost advantages. Consider traffic volumes and available width in design selection. Provide staggered T-intersections by:

- Setting out the alignment of the minor roads on new major roads to form a staggered T-intersection.
- Realigning one or both minor road legs of an existing intersection.

3.10 ROAD NETWORK ELEMENTS

Roundabouts

Design criteria: To AGRD04B and AGTM 06 Section 4. If alternative criteria is proposed , submit alternative criteria for consideration.

General: Provide the following:

- Functional design: To achieve safety of all users and traffic performance.
- Entry width: To provide adequate capacity.
- Adequate circulation width: Compatible with the entry widths and design vehicles (eg. buses, trucks, cars).
- Central islands: Of diameter sufficient only to give drivers guidance on the manoeuvres expected.
- Deflection of traffic to the left on entry: To promote gyratory movement.
- Adequate deflection of crossing movements to ensure low traffic speeds.
- A simple, clear and conspicuous layout.
- Design to ensure that the speed of all vehicles approaching the intersection will be less than 50 km/h.

Approval: Obtain approval of roundabouts from the Council and the relevant State Road Authority.

Traffic calming

Design criteria: Calming devices (e.g. thresholds, slowpoints, speed humps, chicanes and splitter islands) to AGTM08. Select the type of local area traffic management devices from AGTM08 Table 7.1.

Local area traffic management(LATM) devices: Conform to the following:

- Streetscape:
  - . Reduce the linearity of the street by segmentation.
  - . Avoid continuous long straight lines (e.g. kerb lines).
  - . Enhance existing landscape character.
  - . Maximise continuity between existing and new landscape areas.
- Location of devices/changes:
  - . Other than at intersections, maintain consistency with streetscape requirements.
  - . For compatibility with existing street lighting, drainage pits, driveways, and services.
  - . Slowing devices optimally at spacings of 100 m to 150 m.
- Design vehicles:
  - . Ensure emergency vehicles are able to reach all residences and properties.
  - . Local streets with a 'feeding' function between arterial roads and minor local streets may be designed to AP – G34 templates.
  - . Bus routes: Allow buses to pass without mounting kerbs and with minimal discomfort to passengers.
  - . Provide for building construction traffic in newly developing areas where street systems are being developed in line with LATM principles.
- Control of vehicle speeds:
  - . Reduce speed using devices which shift vehicle paths laterally (slow points, roundabouts, corners) or vertically (humps, platform intersections, platform pedestrian/school/bicycle crossings).
  - . Create a visual environment conducive to lower speeds. This can be achieved by 'segmenting' streets into relatively short lengths (less than 300 m), using appropriate devices, streetscapes, or street alignment to create short sight lines.
- Visibility requirements (sight distance):
  - . Provide critical sight distances so that evasive action may be taken by either party in a potential conflict situation. Relate sight distances to likely operating speeds.
  - . Consider sight distance to include those of and for drivers, pedestrians and cyclists.
  - . Ensure night time visibility of street features. Locate speed control devices near existing street lighting if practicable and delineate all street features/furniture for night time operation. Provide additional street lighting at proposed new speed control devices located away from existing street lighting.
- Safety: Provide roadside design that conforms with AGRD06 including:
  - . Safety barriers.
  - . Treatment options.
  - . Steep down grades.

Critical dimensions.

Dimensions: Conform to the following:

- Pavement narrowings:
  - . Single lane between kerbs: 3.50 m.
  - . Single lane between obstructions: 3.75 m.
  - . Two lane between kerbs: Minimum 5.50 m.
- Plateau or platform areas: 75 mm to 150 mm height maximum, with 1 in 15 ramp slope relative to road grade.

- Width of clear sight path through slowing devices: 1.0 m maximum (i.e. the width of the portion of carriageway which does not have its line of sight through the device blocked by streetscape materials, usually vegetation).
- Mountable areas required for the passage of large vehicles: To appropriate turning templates.

Approval: Obtain approval of traffic calming devices from the Council.

Bus routes

Criteria: Conform to the following:

- Design the road hierarchy to cater for buses on routes identified by the Council.
- Location of bus routes and bus stops: Arrange so that no more than 5% of residents have to walk in excess of 400 metres to catch a bus.
- Design roads above the Local street level in the network hierarchy as bus routes.

Dimensions: To the **Bus route criteria table**.

Bus route criteria table

Road	Carriageway Width (min)	Stops (Spacing)	Bays
Collector*	9 m	400 m**	Single
Local sub-arterial	11 m	400 m	Shelters
Arterial	13 m	400 m	Shelters and bays
* Collector roads not identified as bus routes may have 7 m carriageways. ** Loop roads with single entry/exit only require stops and bays on one side road. *** Shelters are subject to Council's requirements.			

4 DOCUMENTATION

4.1 GENERAL

Design process

System: Develop a flow chart to incorporate the brief, consultation, selection of design parameters, approvals and critical dates.

Design review, verification and validation: Provide design documentation that conforms with AGRD08.

Design calculations

Calculations: Provide results and reference software used for relevant distance or curvature calculations. If friction is a factor in layout/geometry, note the pavement type assumed for surface conditions and noise minimisation.

Approvals

Authorities: Drawings are signed by the Council Designer or Council's Consultant and where required by Council, certify as complying with the appropriate design worksections.

Certificate format: To *0010 Quality requirements for design.*

4.2 DRAWINGS

Drawing sheets

Requirement: Provide separate sheets for the following:

- Cover.
- Plan views.
- Longitudinal sections.
- Cross sections.
- Structural details.
- Standard drawings.

Drawing presentation

Plain English: Drawings form part of the permanent record and are legal documents. Keep terminology in plain English, enabling drawings to be easily read and understood by those involved in the construction of the Works.

Drawings: Present drawings on A1 sheets unless otherwise authorised. Prepare clear and legible drawings with consistent lettering and style, and clearly referenced with notations and tables as appropriate.

Compliance

Consistency: Provide drawing sheets consistent with the scope and sequence of the example provided in Annexure B of *0010 Quality requirements for design.*

Drawings content

Drawing scale: Conform to the following:

- All plans for Council works: 1:500. However, rural plans may be 1:1000.
- Longitudinal sections: 1:500 Horizontal and 1:100 Vertical.
- Cross Sections: 1:100 Natural.

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

0042 PAVEMENT DESIGN

1 GENERAL

1.1 RESPONSIBILITIES

Objective

General: Select appropriate pavement and surfacing materials, types, layer thicknesses and configurations to ensure that the pavement performs to its design functions and requires minimal maintenance under the anticipated traffic loading for the design life adopted.

Criteria: This worksection covers the design of road pavement to meet the required design life, based on the subgrade strength, traffic loading, climatic conditions, environmental factors, and includes the selection of appropriate materials for subgrade, subbase, base and wearing surface.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *0010 Quality requirements for design.*
- *0043 Subsurface drainage (Design).*
- *1131 Rolled concrete subbase.*
- *1132 Lean mix concrete subbase.*
- *1133 Plain or reinforced concrete base.*
- *1134 Steel fibre reinforced concrete base.*
- *1135 Continuously reinforced concrete base.*
- *1141 Flexible pavement base and subbase.*
- *1143 Sprayed bituminous surfacing.*
- *1144 Asphaltic concrete (Roadways).*
- *1145 Segmental paving.*
- *1146 Bituminous slurry surfacing.*

Related worksections: The following worksection is related to this worksection:

- *0041 Geometric road layout.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Austroads

AGPT01:2009 Guide to Pavement Technology – Part 1 Introduction to Pavement Technology.
AGPT02-2012 Guide to Pavement Technology – Part 2 Pavement structural design.
AGPT04C:2009 Guide to Pavement Technology – Part 4C Materials for Concrete Road Pavements.
AGPT05:2008 Guide to Pavement Technology – Part 5 Pavement Evaluation and Treatment Design.
AGPT06:2009 Guide to Pavement Technology – Part 6 Unsealed Pavements.
AGPT07:2009 Guide to Pavement Technology – Part 6 Pavement Maintenance.
AGPT08:2009 Guide to Pavement Technology – Part 08 Pavement Construction.
AGRD01: 2006 Guide to Road Design Part1: Introduction to Road Design.
AGRD02: 2006 Guide to Road Design Part 2: Design considerations.
AGRD08:2009 Guide to Road Design - Part 8 Process and Documentation
AP-T85:2007 Optimum use of granular bases: material selection for detailed performance evaluation.
AP-T68:2006 Update of the Austroads sprayed seal design method.

Other publications

Cement Concrete Aggregates Australia (CCAA)

T51: 2004 Guide to Residential Streets and Paths.

Concrete Masonry Association of Australia (CMAA)

T45: 1997 Concrete Segmental Pavements—Design guide for residential access ways and roads.
Clay Brick and Paver Institute (CBPI)

Manual 1Clay paving design and construction 2003.
Techniques 15-1995 – Design Considerations for Clay Paved Roadways.

1.4 STANDARDS

General

Standard: Road design to Austroads AGRD01 and AGRD02.

Design considerations: To AGRD02 Table 3.1.

Pavement structural design: To AGPT02.

2 DESIGN CRITERIA

2.1 PAVEMENT

General

Pavement types: To AGPT01.

Design variables

All proposed road pavements: Consider the following input variables for Urban and rural roads:

- Design traffic.
- Subgrade evaluation.
- Climatic conditions (For climatic zones see www.bom.gov.au).
- Environment – surface noise considerations (To AGPT02 Section 4).
- Pavement and surfacing materials – note any exclusions of local aggregates commonly available.
- Construction and maintenance considerations (To AGPT02 Section 3).

The design variables may be different in different states. Refer to the relevant design manuals of State Road Authorities for more information www.australia.gov.au.

2.2 TRAFFIC

Standards

General: To AGPT02 Section 7 and Section 12.

Minimum pavement design life

General: Select the design life to suit the design traffic conditions based on the following minimum design lives of pavement. Alternatively calculate the 'whole of life' costs and adopt an appropriate 'first cost' to select the pavement:

- Flexible, unbound granular: 25 years.
- Flexible, containing one or more bound layers: 25 years.
- Rigid (concrete): 40 years.
- Segmental block: 25 years.

Equivalent standard axles (ESA)

General: Calculate design traffic in equivalent standard axles (ESAs) for the applicable design life of the pavement, taking into account present and predicted commercial traffic volumes, axle loadings and configurations, commercial traffic growth and street capacity. AGPT02 Table 7.4 provides the values of cumulative growth factor for a range of annual growth rates and design period.

Interlocking concrete segmental pavements: The simplification of replacing ESA's with the number of commercial vehicles exceeding 3 tonne gross contained in CMAA—T45 is acceptable up to a design traffic of 10^6. Beyond this, calculate ESAs.

Traffic data

Pavement design: Include all traffic data and/or assumptions made in the calculation of the design traffic. Consider the width of structural pavement beyond the trafficked lanes to suit edge conditions and traffic movements.

Design traffic volumes

Calculation of design traffic volumes for lightly trafficked roads: To AGPT02 Section 12.

Calculation of design traffic volumes approaching or exceeding 10^6 ESAs: To AGPT02 Section 12.7.

Guide to design ESAs

Traffic values (in ESAs): To AGPT02 Table 12.2 for lightly trafficked urban streets and to **Design ESA's 25 year design life table** subject to variation depending on the circumstances for the particular project.

Design ESA's 25 year design life table

Street type	Design ESA's—25 year design life
Urban Residential - Access Street - Local Street - Collector Street Local Sub-Arterial	 6×10^4 3×10^5 1×10^6 2×10^6
Rural Residential	3×10^5
Commercial and Industrial	5×10^6

2.3 SUBGRADE EVALUATION

Design considerations

Design strength/stiffness of the subgrade: Consider the following factors:

- Sequence of earthworks construction.
- The compaction moisture content and field density specified for construction.
- Moisture changes during service life.
- Susceptibility to flooding.
- Subgrade variability.
- The presence or otherwise of weak layers below the design subgrade level.
- Stabilisation requirements.
- Dispersive soils.
- Plasticity parameters.
- Swell characteristics.
- Salinity.

California Bearing Ratio (CBR)

Except where a mechanistic design approach is employed using AGPT02 (or software designed for this purpose), as the measure of subgrade support, use the California Bearing Ratio (CBR).

Where a mechanistic design approach using linear elastic theory is employed for flexible pavements, the measure of subgrade support is in terms of the elastic parameters (modulus, Poisson's ratio).

Design CBR considerations

Adopted subgrade Design CBR: Consider the effect of moisture changes in the pavement and subgrade during the service life involving the following:

- Provision of subsurface drainage in the estimation of equilibrium in-situ CBRs.
- Design of the pavement structure.

Subsurface drainage: Refer to *0043 Subsurface drainage (Design)*. If subsurface drainage is not proposed, the Design CBR must allow for a greater variability in subgrade moisture content during the service life of the pavement with a design moisture content above the optimum moisture content.

Calculation of design CBR

Criteria: Conform to the following:

- Field determination of subgrade CBR (To AGPT02 Section 5.5)
  - . In situ CBR test.
  - . Cone penetrometers.
- Laboratory determination of CBR and elastic parameters (To AGPT02 Section 5.6)
- Presumptive values for lightly trafficked roads. (To AGPT02 Section 5.7, Table 5.4)

Field confirmation
Testing: Confirm the Design CBR obtained from laboratory testing by site testing performed on existing road pavements near to the job site under equivalent conditions and displaying similar subgrades. Consider the use of dynamic cone penetrometer (DCP) in test pits within the subgrade for use in conjunction with CBR testing.

Summary of results
Pavement design: Include a summary of all laboratory and field test results and assumptions and/or calculations made in the assessment of Design CBR.

2.4 ENVIRONMENT

Environmental factors
Pavement design: Include all considerations for environmental factors, and any assumptions made that would reduce or increase design subgrade strength, or affect the choice of pavement and surfacing materials.

Moisture and temperature
General: Consider moisture and temperature at the design stage of the pavement. Refer to AGPT02 Section 4.

Moisture considerations
Significant factors: Consider the following factors relating to moisture environment in determining the design subgrade strength/stiffness and in the choice of pavement and surfacing materials:

- Rainfall/evaporation pattern.
- Permeability of wearing surface.
- Depth of water table and salinity problems.
- Relative permeability of pavement layers.
- Whether shoulders are sealed or not.
- Pavement type (boxed or full width).

Design moisture content
Changes in moisture content: Evaluate the design subgrade strength parameters (i.e., CBR or modulus) at the highest moisture content likely to occur during the design life, i.e., the design moisture content.

Temperature changes
Asphalt wearing surfaces and bound or concrete layers: Consider the effect of maximum/minimum seasonal variations in temperature in the design of pavements, particularly if traffic loading occurs at night when temperatures are low and cause a potential reduction in the fatigue life of thin asphalt surfacing.

Specific location effects
In selection of pavement, consider the following:

- Freezing.
- Snow/ice removal (use of chemicals/salt).
- Mine subsidence.
- Bushfire heat.
- Extreme temperatures.
- Industrial traffic spills.

Pavement evaluation and treatment design:

- Conform with AGPT05 for investigation of existing sealed road pavements and design of pavement treatment.

2.5 PAVEMENT AND SURFACING MATERIALS

Pavement classification
Pavement materials: Adopted classification according to their fundamental behaviour under the effects of applied loadings:

- Unbound granular materials, including modified granular materials.
- Bound (cemented) granular materials.

- Asphaltic Concrete.
- Cement Concrete.

Conform to the following:

- To AGPT04C for concrete road pavements.
- To AGPT06 for unsealed pavements.

Surfacing classification

Surfacing materials: Adopted classification:

- Sprayed bituminous seals (flush seals).
- Asphaltic concrete and bituminous slurry surfacing (cold overlay).
- Cement concrete.
- Concrete segmental pavers.
- Clay segmental pavers.

Materials

Pavement materials: To AGPT02 Table 6.1 for pavement material categories and characteristics.

Unbound granular materials including modified granular materials: To *1141 Flexible pavements*.

Bound (cemented) granular materials: To *1141 Flexible pavements*.

Asphaltic concrete: To *1144 Asphaltic concrete (Roadways)*.

Cement concrete: To *1131 Rolled concrete subbase*, *1132 Mass concrete subbase*, *1133 Plain or reinforced concrete base*, *1134 Steel fibre reinforced concrete* or *1135 Continuously reinforced concrete base*, as appropriate.

Sprayed bituminous seals: To *1143 Sprayed bituminous surfacing*.

Concrete and clay segmental pavers: To *1145 Segmental paving*.

Bituminous slurry surfacing (cold overlay): To *1146 Bituminous slurry surfacing.*

2.6 CONSTRUCTION AND MAINTENANCE

Considerations

Construction and maintenance factors: Consider the following for the type of pavement, choice of base and subbase materials, and the type of surfacing adopted:

- Documentation of joints incorporated in the design.
- Extent and type of drainage.
- Use of boxed or full width construction.
- Available equipment of the Contractor.
- Use of stabilisation.
- Aesthetic, environmental and safety requirements.
- Social considerations.
- Construction under traffic.
- Use of staged construction.
- Ongoing and long-term maintenance costs.

3 PAVEMENT THICKNESS DESIGN

3.1 PAVEMENT STRUCTURE

Minimum pavement thickness

Pavement thickness, including the thickness of surfacings:

- Roads with kerb and channel (gutter): 250 mm.
- Unkerbed roads: 200 mm.
- Carparks: 150 mm.

Final thickness of subbase and base layers:

- Flexible pavement: Subbase 100 mm, base 100 mm

- Rigid pavement: Subbase 100 mm, base 150 mm

Subbase extent

Subbase layer: Minimum of 150 mm behind the rear face of any kerb and/or channel (gutter).

Base extent

Base and surfacing: To the face of any kerbing and/or channel (gutter).

Kerb conditions: If the top surface of the subbase layer is below the level of the underside of the kerb channel (gutter), extend the base layer a minimum of 150 mm behind the rear face of the kerb and/or channel (gutter).

Unkerbed roads: Extend the subbase and base layers at least to the nominated width of shoulder.

Carparks

Concentrations: Allow for traffic load concentrations within carpark areas (e.g. entrances/exits).

Drainage

Precautions: Make provision for pavement layer drainage on the assumption that during the service life of the pavement ingress of water will occur.

3.2 PAVEMENT DESIGN

Unbound granular flexible pavements – Bituminous surfaced

Criteria: Design unbound granular flexible pavements with thin bituminous surfacings, including those with cement or lime modified granular materials, with design traffic up to 10^6 ESAs to AGPT02 Figure 12.2.

For design traffic above 10^6 ESAs, use AGPT02 Figure 8.4 (or software designed for this purpose).

Flexible pavements containing bound layers—Bituminous surfaced

Criteria: Design flexible pavements containing one or more bound layers, including cement stabilised layers or asphaltic concrete layers other than thin asphalt surfacings, to AGPT02 Section 8 (or software designed for this purpose).

Alternatively for design traffic up to 10^6 ESAs: Assume bound layers to be equivalent to unbound layers of the same thickness, and design the pavement to AGPT02 Section 12.8.

Rigid pavements

Criteria: Design rigid (concrete) pavements, with design traffic up to 10^6 ESAs to either CCAA-T51 *Guide to residential streets and paths* or AGPT02 Section 12.9 (or software designed for this purpose).

Criteria: Design rigid (concrete) pavements for design traffic above 10^6 ESAs to AGPT02 Section 9 (or software designed for this purpose).

Concrete segmental pavements

Criteria: Design concrete segmental pavements with design traffic up to 10^6 estimated commercial vehicles exceeding 3 T gross to CMAA-T45.

Clay segmental pavements

Criteria: Design clay segmental pavements with design traffic up to 10^6 ESAs to *CBPI Manual 1 – Clay paving design and construction* and CBPI Techniques 15 - Design Considerations for Clay Paved Roadways.

4 SURFACING DESIGN

4.1 SURFACE TYPE

Streets

Wearing surface specifications: Bituminous wearing surface as follows except where the pavement is designed for concrete or segmental block surfacing:

- Urban/rural residential streets: Access street and local street, alternatives:
  - primer seal plus two coat flush seal, or
  - primer seal, plus one coat flush seal, plus bituminous slurry surfacing; or
  - primer seal, plus asphalt.
- Urban/rural residential streets: Collector and local sub-arterial, alternatives:
  - primer seal, plus one coat flush seal, plus bituminous slurry surfacing; or

. primer seal, plus asphalt.

- Commercial and industrial streets:
  . primer seal, plus asphalt.

Braking and turning zones

Alternatives: Provide either bituminous slurry surfacing or asphalt surfacing with suitable binders at intersection approaches and cul-de-sac turning circles on residential streets with flush seals, within the vehicle braking and turning zones. Consider surfacing materials in braking zones to provide additional wear and roughness properties.

4.2 SURFACE TYPE PROPERTIES

Sprayed bituminous seals (flush seals)

Criteria: Sprayed bituminous (flush) seals, including primer seals to *AP-T68 sprayed seal design method – 2006: Summary* or to the relevant State Road Authorities' Bituminous Surfacing Manual.

Primer seal: Indicate on the Drawings 7 mm primer seals below all flush seals, bituminous slurry surfacing, and asphalt surfacings. Conform to the following:

- Use size 5-7 mm aggregate < 200 v/l/d.
- Use 7-10 mm size aggregate > 200 v/l/d.
- If the conditions are either very hot and/or wet, and the traffic is in excess of 600 v/l/d, use size 10 mm aggregate.

Two-coat flush seals: Double-double seals, comprising a minimum of two coats binder and two coats of aggregate as follows:

- 1st coat—14 mm.
- 2nd coat—7 mm.

Single coat flush seal: If bituminous slurry surfacing (or asphaltic concrete) is to be applied as the finished surface, provide single coat flush seals either 14 mm or 10 mm thick.

Bituminous slurry surfacing (cold overlay)

Minimum thickness: 8 mm nominal compacted thickness.

Primer seal and single coat seal: Indicate on the Drawings a 7 mm primer seal and a single coat flush seal on the drawings below the bituminous slurry surfacing.

Asphaltic concrete

Light to medium traffic: In urban residential access and local streets, rural or light trafficked commercial streets (design traffic up to approximately 3×10^5 ESAs), design the asphalt mix as either a 'high-bitumen content' mix or a mix to AGPT02 Section 6.5 and *1144 Asphaltic concrete (Roadways).*

Medium to heavy traffic: In urban residential collector and sub-arterial roads, medium to heavily trafficked rural and commercial streets and in all industrial roads, design the asphalt mix as a dense graded mix to *1144 Asphaltic concrete (Roadways).*

Minimum thickness: Design asphaltic concrete surfacings to provide a nominal compacted layer thickness:

- On light to medium trafficked residential rural and commercial streets: > 25 mm
- On medium to heavily trafficked residential, rural or commercial roads: 40 mm.

Primer seal: Indicate a 7 mm or 10 mm primer seal on the drawings below the asphalt surfacing.

Segmental pavers

Size and shape: Conform to the following:

- Concrete segmental pavers: 80 mm thick, shape Type A, and designed to be paved in a herringbone pattern.
- Clay segmental pavers: 65 mm thick, Class 4, and designed to be paved in a herringbone pattern.

Edge restraint: Design the edges of all paving to be constrained by either kerbing and/or guttering, or by concrete edge strips.

5 DOCUMENTATION

5.1 GENERAL

Calculations

Requirements: Submit all considerations, assumptions, subgrade test results, and calculations with the pavement design for approval by Council.

Specifications

Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11, 13, 14-18.

Design certification

Requirement: Provide a signed and dated design certificate.

5.2 DRAWINGS

General

Requirements: Clearly indicate the structure, material types and layer thicknesses of the proposed pavement and surfacing.

5.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

0043 SUBSURFACE DRAINAGE (DESIGN)

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

Control moisture fluctuations: Design the subsurface drainage system to control moisture content fluctuations in the pavement and/or subgrade within the limits assumed in the pavement design.

Salinity prevention: In areas with a history of salinity problems, prescribe subsurface drainage to keep the groundwater table lower in the strata so as to avoid progressive deterioration of the health of topsoil and upper layers due to salinity levels increased by rising and/or fluctuating groundwater tables.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *0010 Quality requirements for design.*
- *0011 Development and Subdivision of land*
- *1172 Subsoil and foundation drains.*
- *1173 Pavement drains.*
- *1174 Drainage mats.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian standards

AS/NZS 1477: 2006	PVC pipes and fittings for pressure applications.
AS 2439	Perforated plastics drainage and effluent pipe and fittings.
AS 2439.1-2007	Perforated drainage pipe and associated fittings.

Austroads

AGPT10: 2009	Guide to Pavement Technology – Part 10: Subsurface drainage.
AGRD05:2010	Guide to Road Design – Part 5: Drainage design

Other publications

ARRB Australian Road Research Board.

ARR368: 2006	The collection and discharge of stormwater from road infrastructure.

1.4 STANDARDS

General

Standard: To AGPT10.

Drainage design: To AGRD05.

1.5 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definitions based on functions apply:

Drainage types:

- Subsoil drains: are intended for the drainage of ground water or seepage from the subgrade and/or the subbase in cuttings and fill areas.
- Foundation drains: Foundation drains are intended for the drainage of seepage, springs and wet areas within and adjacent to the foundations of the road formation. Can also be termed ‘formation drains’.

- Sub-pavement drains: are intended for the drainage of the base and subbase pavement layers in flexible pavements. They may also function to drain seepage or groundwater from the subgrade.

Drainage mats:

- Type A drainage mats: are intended to ensure continuity of a sheet flow of water under fills, to collect seepage from a wet seepage area, or for protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water. Can also be termed 'drainage blankets'.
- Type B drainage mats: are constructed to intercept water which would otherwise enter pavements by capillary action or by other means on fills and to intercept and control seepage water and springs in the floors of cuttings. Can also be termed 'drainage blankets'.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Geotechnical investigations

Investigations: Obtain an appropriate geotechnical investigation comprising sub-grade soil characteristics and ground water effects to enable selection of drainage units. Refer to AGPT10.

3 DESIGN

3.1 DESIGN CRITERIA

Subsoil and sub-pavement drains

Locations: Provide subsoil or sub-pavement drains on both sides of the formation in the following locations:

- Cut formations where the depth to finished subgrade level is equal to or greater than 400 mm below the natural surface level.
- Locations of known hillside seepage, high water table, isolated springs or salt affected areas.
- Irrigated, flood-prone or other poorly drained areas.
- Highly moisture susceptible subgrades, i.e., commonly displaying high plasticity or low soaked CBRs.
- Use of moisture susceptible pavement materials.
- Existing pavements with similar subgrade conditions displaying distress due to excess subsurface moisture.
- At cut to fill transitions.

Exceptions:

- Omit drains if the geotechnical report indicates the absence of subsurface moisture at the time of investigation and the likelihood that changes in the subsurface moisture environment will not occur within the design life of the pavement and/or the pavement has been specifically designed to allow for likely variations in subgrade and pavement moisture contents.
- If only one side of the formation is in cut, and the other side in fill, it may be sufficient to provide subsoil or sub-pavement drains only along the edge of the formation in cut.

Additional locations: The need for subsoil and sub-pavement drains may otherwise become apparent during the construction process, due to changes in site moisture conditions or to areas of poorer subgrade being uncovered that were not identified in the geotechnical investigation.

Drawings: Indicate the potential need for subsoil or sub-pavement drains in addition to those shown on the Drawings.

Layout, alignment and grade

Typical cross sections: Typical cross sections of subsoil and sub-pavement drains are shown in Figures 2.1 and 2.2.

Kerbed roads: In kerbed roads, the two acceptable alternative locations for the line of the trench are directly behind the kerbline. Pavement layers must extend to at least the line of the rear of the trench.

Unkerbed roads: In unkerbed roads, locate subsoil and sub-pavement drains within the shoulder, preferably at the edge of the pavement layers as shown in Figure 2.2.

Grade: The minimum longitudinal design grade is 1.0%. For non corrugated pipes, an absolute minimum grade of 0.5% is acceptable.

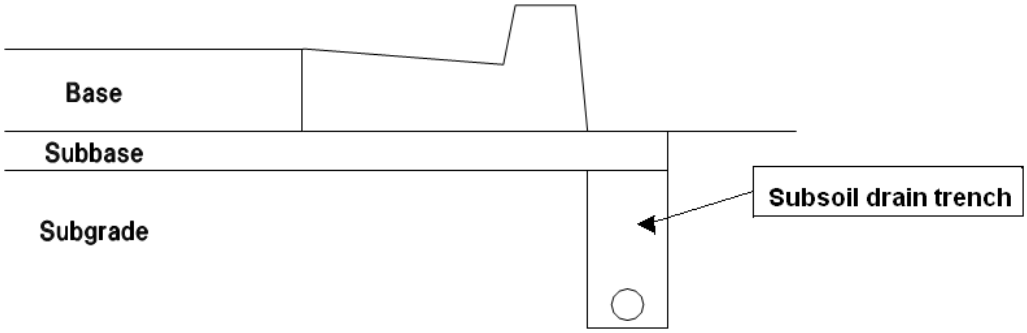


Figure 2.1 Typical subsoil drain

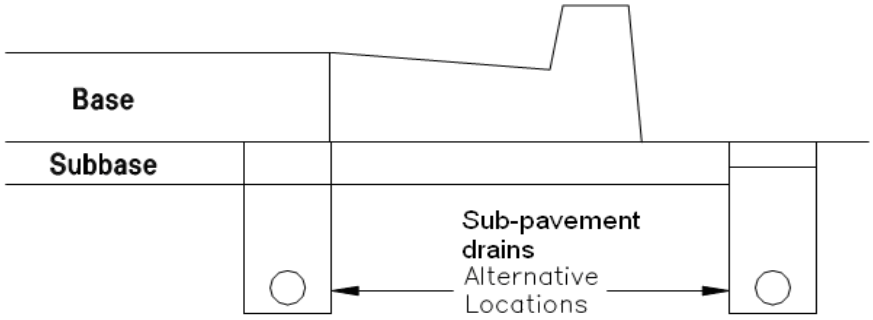


Figure 2.2 Typical sub-pavement drain

Trench dimensions and location:

- Trench widths - 300 mm minimum.
- Minimum depth below finished subgrade level:
  - In earth 600 mm.
  - In rock 450 mm.
- Locate below the invert level of any service crossings.

Outlets and salinity prevention: Space outlets at maximum intervals of 100 metres. Join into gully pits or outlet headwalls. As a salinity prevention measure and where practical, provide discharge on the downhill side of the embankment or in the cut-fill area so as to reduce the risk of recharge to the subsurface water table.

Unslotted plastic pipe: Unless otherwise authorised, if subsurface drains outlet through fill batters, specify unslotted plastic pipe of the same diameter as the main run.

Drain outlet: Install a small precast concrete headwall at the drain outlet with a marker post to assist maintenance and protect the end of the pipe.

Cleanouts: Provide cleanouts at the commencement of each run of drain, and at intervals not exceeding 80 metres. Locate cleanouts directly at the rear of kerb or at the edge of shoulder, as applicable.

Salinity prevention: In salinity affected areas, consider providing a separate drainage system for subsurface drains to discharge to a basin where controlled release or desiccation treatment and removal can be facilitated as a maintenance operation.

Saline subsurface drainage: Do not discharge directly into natural watercourses.

Reference to water quality targets: Refer to downstream watercourses quality targets - provide advice on discharge operations and maintenance compatible with water quality targets and the requirements of the relevant land and water resource authority.

Foundation drains (Formation drains)

Location: Foundation drains are designed to drain excessive ground water areas within the foundation of an embankment or the base of cutting, or to intercept water from entering these areas.

Drawings: The need to provide foundation drains may be apparent from the results of the geotechnical survey along the proposed road formation alignment, and in this case show the location on the Drawings. In addition, indicate on the Drawings the potential need for foundation drains at various locations typified as follows:

- Where the road formation traverses known swampy, flood-prone, salt affected areas or watercharged strata.
- Commonly, the need to provide foundation drains is determined during construction, and hence in this situation requirements and locations cannot be ascertained at the design stage.

Layout, alignment and grade

Typical cross section: Typical cross-sections of foundation drains are shown in Figure 2.3.

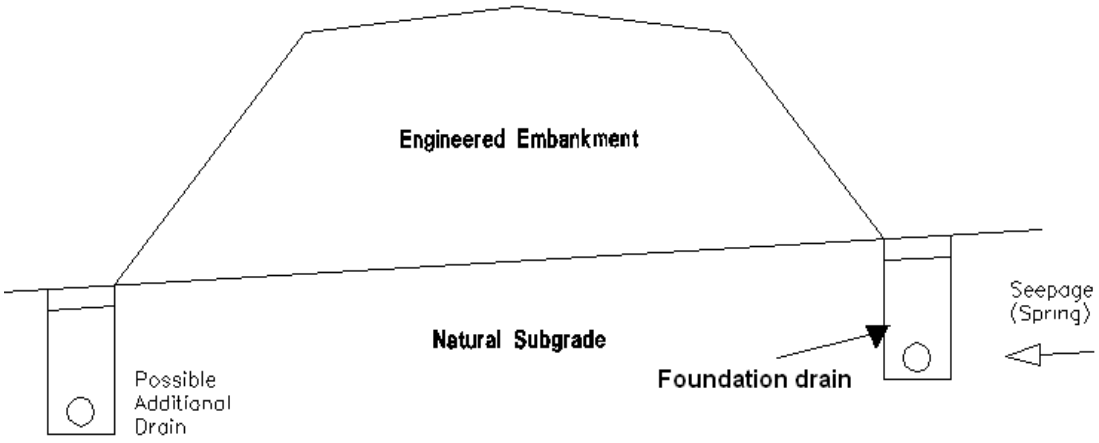


Figure 2.3 Foundation drains

Grade: The minimum design grade is 1.0%. For non corrugated pipes an absolute minimum grade of 0.5% is acceptable.

Trench dimensions: Conform to the following:

- Trench width - 300 mm minimum.
- Trench depth – vary to suit the application and ground conditions on site.

Outlets: Space outlets at maximum intervals of 150 metres or 100 metres if intermediate cleanouts are not provided.

Cleanouts: Where practicable, provide cleanouts at the commencement of each run of foundation drain and at intervals not exceeding 80 metres.

Drainage mats (Drainage blankets)

Requirement: Use the result of the geotechnical survey along the proposed road formation alignment to determine the need to design for the provision of drainage mats.

Type A mats: Select for the following functions:

- To ensure continuity of sheet flow of water under fills.
- To collect surface seepage from a wet seepage area.
- For protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water.

Timing: Construct Type A drainage mats after the site has been cleared and grubbed and before commencement of embankment construction.

Type B mats: Select for the following functions:

- To intercept water which would otherwise enter pavements by capillary action or by other means on fills.
- To intercept and control seepage water and springs in the floors of cuttings.

Timing: Construct Type B drainage mats after completion of the subgrade construction and before construction of the pavement.

3.2 MATERIALS

Subsoil and sub-pavement drain pipe

Slotted pipe: Conform to the following:

- Location: As designated for subsoil, foundation and sub-pavement drains except for cleanouts and outlets through fill batters.
- Size: 100 mm diameter.
- Filter: Suitable geotextile filter tube.

Corrugated plastic pipe: To AS 2439.1.

Slotted rigid UPVC pipe: Type and class approved by Council.

Cleanouts and outlets: Provide 100 mm diameter unslotted pipe.

Joints, couplings, elbows, tees and caps: To AS 2439.1.

Selection criteria: Select the appropriate class of pipe on the basis of expected live loading at the surface.

Intra pavement drain pipe

Slotted thick walled UPVC pressure pipe: Conform to the following:

- Location:
  - For pipes designated for intra pavement drains with crushed rock subbases having layer thicknesses neither less than 150 mm nor more than 200 mm.
  - For pipes for use in Type B drainage mats.

Slotted pipe of a type and class approved by Council:

- Location: For pipes designated for intra pavement drains with crushed rock subbases having layer thicknesses exceeding 200 mm.

Standard: To AS/NZS 1477.

Filter material

Acceptable types of filter material and their use are as follows:

- Type A filter material: Use in subsoil, foundation, and sub-pavement (trench) drains and for Type B drainage mats.
- Type B filter material: Use in subsoil, foundation and sub-pavement (trench) drains.
- Type C filter material comprising crushed rock: Use in Type A drainage mats.
- Type D filter material comprising uncrushed river gravel: Use in Type A drainage mats.

Filter types: Material requirements and gradings for each type of filter material are included in the *1171 Subsurface drainage*.

Backfill filter material

Selection: The type of filter material specified to backfill the sub-surface drainage trenches (subsoil, foundation and sub-pavement drains) depends on the permeability of the pavement layers and/or subgrade and the expected flow rate.

Filter functions:

- Type A filter material is used for the drainage of highly permeable subgrade or pavement layers such as crushed rock or coarse sands.
- Type B filter material is used for the drainage of subgrade and pavement layers of lower permeability such as clays, silts or dense graded gravels.

Reference: Further guidance to the selection of appropriate filter material is contained in ARRB ARR368-*The collection and discharge of stormwater from the road infrastructure.*

Geotextile
Design criteria: Designate Geotextile to encapsulate the filter material to provide separation (i.e. prevent infiltration of fines) between the filter material in the trench and the subgrade or pavement material.

Requirements:

- Comply with the requirements included in *1171 Subsurface drainage*.
- Designate for both Type A and Type B Drainage Mats.

4 DOCUMENTATION

4.1 GENERAL

Calculations
Authorities: Submit to Council for approval with the drawings assumptions and/or calculations made in the determination of the need or otherwise for subsurface drainage in special circumstances or as a variation to the requirements of this worksection.

Specifications
Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11, 13, 14-18.

Design certification
Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS

General
Requirements: Indicate the following:

- The proposed location of all subsurface drains.
- The nominal depth and width of the trench.
- The location with respect to the line of the kerb/gutter or edge of pavement.
- The location of outlets and cleanouts.

4.3 WORK-AS-EXECUTED

General
Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

0044 PATHWAYS AND CYCLEWAYS (DESIGN)

1 GENERAL

1.1 RESPONSIBILITIES

Objective
Activities: Provide design and documentation for cycleways and pathways to support the following objectives:

- Encourage walking and cycling for transportation, healthy lifestyle and recreational purposes.
- Provide safe walking and cycling, including for users with disabilities and limited mobility.
- Ensure satisfactory level of service for all pathway users.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):

- *0010 Quality requirements for design.*
- *0011 Development and subdivision of land*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

Australian standards

AS/NZS 1158	Lighting for roads and public spaces
AS/NZS 1158.3.1:2005	Pedestrian area (Category P) lighting - Performance and design requirements
AS 1158.5:2007	Tunnels and underpasses
AS 1428	Design for access and mobility
AS 1428.1-2009	General requirements for access - New building work
AS 1428.2-1992	Enhanced and additional requirements - Buildings and facilities
AS/NZS 1428.4.1: 2009	Means to assist the orientation of people with vision impairment - Tactile ground surface indicators
AS 1742	Manual of uniform traffic control devices
AS 1742.9-2000	Bicycle facilities
AS 1742.10-2009	Pedestrian control and protection
AS 1798-1992	Lighting poles and bracket arms-Preferred dimensions.
AS 2156	Walking Tracks
AS 2156.1-2001	Classification and signage
AS 2156.2-2001	Infrastructure design
AS 2890	Parking facilities
AS 2890.3-1993	Bicycle parking facilities

Austroads

AP-G88:2011	Cycling aspects of Austroads guides
AGRD06A:2009	Guide to Road Design – Pedestrian and cyclist paths
AGPT02:2012	Guide to pavement technology – Pavement structural design

Other publications

Concrete Institute of Australia

CIA Z15:2011	Cracking in concrete slabs on ground and pavements

1.4 STANDARDS

Design
Standards:

- General: To AGRD06A.
- Cycleways: To AP-G88.

- Walking tracks: To AS 2156.1 and AS 2156.2.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AGPT: Austroads Guide to Pavement Design.
- AGRD: Austroads Guide to Road Design.
- ARRB: Australian Road Research Board.
- CBR: California Bearing Ratio.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Footpath: Any access way with a gradient no steeper than 1:20.
- Gradient: The rate of longitudinal rise or fall of a pathway with respect to the horizontal, expressed as a ratio or as a percentage.
- Ramp: An inclined access way that has a constant gradient anywhere between 1:14 and 1:20.

2 PRE-DESIGN PLANNING

2.1 PLANNING

General: Refer to Councils current Pedestrian and Access Mobility Plan (PAMP)

2.2 CONSULTATION

Council and other Authorities

General: Consult with Council and other relevant Authorities during the preparation of design. In addition to the requirements of this worksection, conform to the requirements for cycleways and pathways in any applicable Council regional or local strategic bicycle plan or subdivision code.

Public consultation

Requirement: Undertake public consultation on designs in conformance with Council policy.

Utilities services plans

Existing services: Obtain service plans from all relevant public utility Authorities and other organisations whose services exist within the area of the proposed works.

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

Heritage considerations

Requirement: Provide a plan for management of any heritage assets that may be impacted by the works.

Protection of existing structures

Existing plans: Obtain drawings of existing structures adjoining the site.

Dilapidation reports: Carry out inspections of all existing structures adjoining the site. Prepare a report on the existing structural condition including a photographic record of any defects.

Site investigations

General: Carry out a survey and geotechnical investigation and prepare reports.

CBR value for the subgrade: To the geotechnical investigation report.

Design consultants

General: Liaise with the following consultants before and during, the cycleway and pathway design:

- Landscape architect.
- Traffic engineer.
- Structural engineer.
- Geotechnical engineer.
- Streetscape artist.
- Environmental engineer.

3 DESIGN

3.1 LOCATION OF PATHS

Requirements

General: Locate the pathways and cycleways as follows:

- Along river frontages.
- On foreshores.
- Through parklands.
- Along railway reservations.
- Abutting bridges.
- Within the reservations of streets which have direct access to property.

Design considerations: Consider the following in the location of pathways and cycleways:

- Proper alignment for cyclists to travel safely at their chosen speed.
- Avoiding sharp horizontal curves at the bottom of steep downgrades.
- Adequate sight distance across the inside of curves.
- Access to emergency service and maintenance vehicles at path entrances.
- Landscaping and planting.

3.2 DESIGN CRITERIA

General

Pavement design life: 40yrs

Geometric design

Design criteria: To the **Design criteria table**.

Design criteria table

Feature	**Cycleway**	**Pathway**	**Shared use pathway**	**Separated paths**	
				One-way	**Two-way**
Path width Desirable minimum (To AGRD06A clause 7.5)	Local access path: 2.5 m Major path: 3.0 m	Minimum width:1.2 m Absolute minimum: 1 m High pedestrian volume: 2.4 m Footway dining: 5 m	Local access: 2.5 m Commuter path: 3.0 m Recreational path: 3.5 m	Cycleway:1.5 m Pathway: 1.5 m	Cycleway: 2.5 m Pathway: 2.0 m
Path width Minimum – Maximum (To AGRD06A clause 7.5)	Local access path: 2.5 – 3 m Major path: 2.5 – 4 m	For disability access: 1.5 – 1.8 m	Local access: 2.5 - 3 m Commuter path: 2.5 - 4 m Recreational path: 3.0 - 4 m	Cycleway: 1.2 – 2 m Pathway: ≥ 1.2 m	Cycleway: 2.0 –3 m Pathway: ≥ 1.5 m
Vertical clearance (To AS 1742.2-2009 and AS 1428.2)	2.5 m	2.0 m	2.5 m	2.5 m	2.5 m
Crossfall	1:40	General: Flat – 2.5% (0 – 1:40)	Maximum: 2.5% (1:40)		

Feature	Cycleway	Pathway	Shared use pathway	Separated paths	
				One-way	**Two-way**
		Sealed surfaces: 2%-4% (1:50 – 1:25) Unsealed surfaces: 5% (1:20)			
Gradient (To AGRD06A, Figure 7.1)	Desirable maximum: 3% Maximum: 5%	NA	2%		
Minimum radius for horizontal curves for cycleways and shared pathways	Without superelevation: To AGRD06A Tables 7.1 With superelevation: To AGRD06A Table 7.2.				
Minimum sight stopping distance for cycleways and shared pathways	To AGRD06A Figure 7.7				
Operating speed	Flat gradients: 35 km/h Moderate gradients: 50 km/h	Walking speed: 1m/s Walking speed at crossings: 1.2 m/s			

Safety

Ramp and footpath landings: Conform to the **Landings table.**

Landings table

Type of path	Longitudinal gradient	Landing requirement
Ramp	1:14	Every 9 m
	1:20	Every 15 m
Footpath	1:20	Every 15 m
	1:33	Every 25 m
	Flatter than 1:33	No landing required

Disabled access

Requirement: In conformance with To AS 1428.1, Council's policy on access and mobility and the Disability Discrimination Act.

Warning Tactile ground surface indicators: To AS/NZS 1428.4.1 and provide at top and bottom of ramps and stairs.

Provision at structures

Uninterrupted movement: Provide uninterrupted movement of cyclists and pedestrians at proposed and existing structures, such as bridges and underpasses.

Provision at road crossings
Requirement: Provide appropriate grades, width adjustment for waiting areas and kerb ramps at road crossings.

Lateral clearance: Minimum lateral clearance where a shared path way crosses a pedestrian bridge:

- 0.5 m on both sides where speed of cyclists is < 20 km/hr.
- 1.0 m on both sides where speed of cyclist is > 20 km/hr.

Signage and pavement marking
Sign posting: Provide signposting to indicate destinations and potential hazards.

Signs and pavement marking: To AS 1742.9 and AS 1742.10.

Facilities
Requirement: Provide design for the following facilities at common destinations of cyclists and pedestrians:

- Street furniture including seats, bins, drinking fountains and telephones.
- Standby areas.
- Secure bicycle parking to AP-G88 and fabricated to AS 2890.3.
- Picnic facilities and viewing platform facilities.
- Information stands/direction signs.
- Connection paths to public transport.
- Bicycle wheeling ramps.
- Bus stop shelter.
- Grates and covers flush with the adjacent path.

Lighting and lighting support structures
General: To AS/NZS 1158.3.1 and AS 1798.

Underpasses: To AS/NZS 1158.5.

Pavement design
Structural design: To AGPT02, Section 12.

Control of cracks: To CIA Z15.

3.3 MATERIALS

Environmental considerations
Trees policy: Consider existing or planned trees policy when selecting pavement materials to minimise pavement maintenance and to limit environmental impact.

Maintenance considerations
General: Document low maintenance materials for pavements and street furniture. Consider exposure conditions and appropriate durability requirements.

Protection of materials: Document protection methods for materials to satisfy durability requirements.

4 DOCUMENTATION

4.1 GENERAL

Design certification
Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS

Drawings content
General: Provide the following:

- Locality plan.
- Site plans showing cycleways and pathways at 1:500 scale.
- Part plans at 1:200 scale, showing merging details of new cycleways and pathways with existing roads.
- Longitudinal sections at scales of 1:500 horizontal and 1:50 vertical.

- Cross sections at 1:100 scale. Provide transition tables if cross falls vary.
- Design traffic loading and design CBR value for the natural subgrade material.
- Details of typical cross sections including pavement materials, pavement layer depths, edge details and details of any retaining walls, batters, fences and drainage works at 1:20 scale.
- Typical details of expansion joints, contraction joints and joints to existing pavements. Show details of additional joints at drainage pits, lighting poles and safety bollards.
- Details of handrails, safety bollards, street furniture, lighting poles and traffic signalling posts at 1:10 scale.
- Traffic management plan.

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

0061 BRIDGES AND RELATED STRUCTURES

1 GENERAL

1.1 RESPONSIBILITIES

Objective

General: Provide design and documentation for the structures covered by this worksection.

Designer's qualifications: A practicing Engineer with qualifications suitable for admission to Engineers Australia as a Structural Engineer.

Evidence of designer's qualifications and experience: Submit to Council Authorities.

Federal legislation: Environment Protection and Biodiversity Conservation Act 1999.

1.2 CROSS REFERENCES

Requirement: Conform to the following worksection(s):

- *0010 Quality requirements for design.*
- *0011 Development and subdivision of land*
- *0074 Stormwater drainage (Design).*
- *0041 Geometric road layout.*
- *0042 Pavement design.*
- *0075 Control of erosion and sedimentation (Design).*
- *1101 Control of traffic.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian Standards

AS 1100	Technical drawing
AS 1100.101-1992	General principals
AS 1158-various	Lighting for roads and public spaces
AS 1428	Design for access and mobility
AS 1428.1-2009	General requirements for access-New building work
AS/NZS 1428.4.1:2009	Means to assist the orientation of people with vision impairment-Tactile ground surface indicators
AS 1798-1992	Lighting poles and bracket arms-Preferred dimensions
AS 1926 various	Swimming pool safety
AS/NZS 2041 various	Buried corrugated metal structures
AS/NZS 3845:1999	Road safety barrier systems
AS 4678-2002	Earth-retaining structures
AS 5100	Bridge design
AS 5100.1-2004	Scope and general principals
AS 5100.2-2004	Design loads
AS 5100.3-2004	Foundations and soil supporting structures
AS 5100.4-2004	Bearings and deck joints
AS 5100.5-2004	Concrete
AS 5100.6-2004	Steel and composite construction
AS 5100.7-2004	Rating of existing bridges

Austroads

AGBT01-2009	Guide to bridge technology - Introduction and bridge performance
AGBT02-2009	Guide to bridge technology - Materials
AGBT03-2009	Guide to bridge technology - Typical superstructures, substructures and components
AGBT04-2009	Guide to bridge technology - Design procurement and concept design

AGBT05-2012	Guide to bridge technology - Structural drafting
AGBT06-2009	Guide to bridge technology - Bridge construction
AGBT07-2009	Guide to bridge technology - Maintenance and management of existing bridges
AGRD06A-2009	Guide to road design-Pedestrian and cyclist paths
AP-T196-2011	Guidelines for design construction, monitoring and rehabilitation of buried corrugated metal structures.

1.4 STANDARDS

General
Bridge design: To AS 5100.

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:

- AGBT: Austroads guide to bridge technology

Definitions
General: For the purposes of this worksection the following definitions apply:

2 PRE-DESIGN PLANNING

2.1 CONSULTATION

Council and other Authorities
Requirements: Consult with Council and other relevant Authorities during the preparation of design.

Public consultation
General: Undertake public consultation on designs in conformance with Council policy.

Utilities services plans
Existing services: Obtain service plans from all relevant public utility Authorities and other organisations whose services exist within the area of the proposed structure.

Heritage considerations
Requirement: Provide a plan for management of heritage assets.

Protection of existing infrastructure
Existing plans: Obtain drawings of existing structures adjoining the site.

Dilapidation reports: Carry out inspections of all existing structures adjoining the site. Prepare a report on the existing structural condition including a photographic record of any defects.

Groundwater control: Identify potential effects of dewatering during construction.

Concept design
Design investigations: Inspect the site and carry out necessary design investigations.

Checklists: Complete the following before commencement of detailed design:

- Action Checklist for preparation of bridge design concept: To AGBT04, Appendix B.
- Matters for resolution before design commences: To AS 5100.1, Appendix A.

3 DESIGN

3.1 DESIGN CRITERIA

Waterways and flood design
Design: To AS 5100.

Geometry
Design: To AS 5100.

Road layout: Conform to *0041 Geometric road layout.*

Aesthetics
General: Consider visual appearance.

Design guidance: AGBT04, Appendix C.

Maintenance considerations

General: To AS 5100 and AGBT07.

Construction considerations

Provisions for traffic: Conform to *1101 Control of traffic.*

Design loads

General: To AS 5100.2.

Serviceability

General: To AS 5100.2.

Environmental constraints

Erosion and sedimentation control: To *0075 Control of erosion and sedimentation (Design).*

3.2 ROAD TRAFFIC AND PEDESTRIAN BRIDGES

General

Design: To AS 5100.

Design guidance: AGBT01, AGBT02, AGBT03,AGBT04 and AGBT06.

Design life maintenance

Requirement: Design for low maintenance.

Procedures for planned maintenance: To AGBT07.

Materials

General: Document low maintenance materials for construction, finishes and fitments. Consider exposure conditions and appropriate durability requirements.

Protection of materials: Document protection methods for materials to satisfy durability requirements.

Drainage

General: Conform to *0074 Stormwater drainage (Design).*

Freeboard

Design: Provide freeboard to suit local conditions and expected amount and size of debris.

Public utilities

General: If public utilities are required, conceal from public view.

3.3 PROVISIONS FOR PEDESTRIANS AND CYCLISTS ON ROAD BRIDGES

Walkways and cycleways

Standard: To AS 5100.1, AGRD06A.

Separate footpaths: Provision for pedestrians on bridges is required in rural residential as well as urban areas. The minimum provision is a 1.5m wide footpath with kerb at the road traffic edge and pedestrian safety rails at the external edge. Council may also require pedestrian provisions on bridges and structures in other areas, should the anticipated traffic warrant it.

Disabled access

Standard: To AS 1428.1 and AS/NZS 1428.4.1.

3.4 STRUCTURES, OTHER THAN BRIDGES, ASSOCIATED WITH ROADS

Buried corrugated metal structures

Standard: To AS 5100, AS/NZS 2041 and AP-T196.

Earth retaining structures

Standard: To AS 5100 and AS 4678.

Detention basins

Hydraulics: Conform to *0074 Stormwater drainage (design)*.

Safety fencing design: To AS 1926.

Culverts

Standard: To AS 5100.2 and AS 5100.3.

Noise barriers

Standard: To AS 5100.1 and AS 5100.2.

3.5 STRUCTURES USED FOR PUBLIC SAFETY.

Barriers and rails

Standard: To AS 5100.1, AS 5100.2 and AS/NZS 3845.

Omitting safety barriers: Conform to AS 5100.1,Cl 10.5.2. Specify flood depth indicators and signposting.

Final design drawings: Show details of all safety barriers and rails, including barrier performance level and support details.

Lighting and lighting support structures

Standard: To AS 5100.2, AS 1158 and AS 1798.

Design: Design street lighting for bridge approaches and crossings.

Final design drawing: Show details of lighting poles and support details.

Protection screens

Standard: To AS 5100.1 and AS 5100.2.

3.6 TEMPORARY WORKS

Design

Standard: To AS 5100.

Construction program

Drawings: Show the construction program, indicating the sequence of events leading from the installation to the removal of any temporary structures.

4 DOCUMENTATION

4.1 GENERAL

Design statement

Concept design: Provide a design statement including the design criteria, design options, recommended solution and recommended construction and maintenance procedures.

Design report

Detailed design: Provide a design report including the design criteria, detailed design calculations, structural design models and reference documents supporting the design, such as hydrological, geotechnical, construction sequence, maintenance schedule vibration study and fatigue study reports.

Specifications

Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11, 13, 14-18.

Design certification

Requirement: Provide a signed and dated design certificate.

Design certificate format: To *0160 Quality (Design)*.

4.2 DRAWINGS

Structural drafting

Standards: To AS 1100.101, AS 5100.5, AS 5100.6 and AGBT05.

Drawing distribution

Transmittal forms: Provide transmittal forms when distributing the drawings for review, information, tender or construction.

Change register: Provide space on the right hand side of each drawing to register changes to the drawings after the construction issue.

Issue numbering: Adopt a consistent and easy to follow numbering system for drawings at different design stages.

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

0071 WATER SUPPLY – RETICULATION (DESIGN)

1 GENERAL

1.1 RESPONSIBILITIES

Objective

Design requirement: Provide design, drawings and specification for the construction of a reticulated water supply system (either drinking or dual drinking/non-drinking) conforming to the requirements of WSA 03 and the Water Agency, as documented.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0010 Quality requirements for design.*
- *0072 Water supply – pump stations (Design).*
- *0319 Minor concrete works.*
- *1341 Water supply – reticulation (Construction).*

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

Standards

AS 1214-1983	Hot-dipped galvanised coatings on threaded fasteners (ISO metric coarse thread series)
AS 1432-2004	Copper tubes for plumbing, gasfitting and drainage applications
AS/NZS 1477:2006	PVC pipes and fittings for pressure applications
AS/NZS 1554	Structural steel welding
AS/NZS 1554.1:2011	Welding of steel structures
AS/NZS 1554.6:2012	Welding stainless steels for structural purposes
AS 1579-2001	Arc-welded steel pipes and fittings for water and waste-water
AS 1646-2007	Elastomeric seals for waterworks purposes
AS 2129-2000	Flanges for pipes, valves and fittings
AS 2200-2006	Design charts for water supply and sewerage
AS/NZS 2280:2004	Ductile iron pipe and fittings
AS 2419	Fire hydrant installations
AS 2419.2-2009	Fire hydrant valves
AS/NZS 2566	Buried flexible pipelines
AS/NZS 2566.1:1998	Structural design
AS/NZS 2566.2:2002	Installation
AS/NZS 2638	Gate valves for waterworks purposes
AS/NZS 2638.1:2011	Metal seated
AS/NZS 2638.2:2011	Resilient seated
AS 2832	Cathodic protection of metals
AS 2832.1-2004	Pipes and cables
AS 2832.2-2003	Compact buried structures
AS/NZS 2845	Water supply - Backflow prevention devices
AS/NZS 2845.1:2010	Materials, design and performance requirements
AS/NZS 3500	Plumbing and drainage
AS/NZS 3500.1:2003	Water services
AS/NZS 3518:2004	Acrylonitrile Butadienne Styrene (ABS) pipes and fittings for pressure applications
AS 3571	Plastics piping systems - Glass-reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin
AS 3571.2-2009	Pressure and non-pressure water supply (ISO 10639:2004, MOD)
AS 3681-2008	Application of polyethylene sleeving for ductile iron piping

AS 3688-2005	Water supply—Metallic fittings and end connectors
AS/NZS 3862:2002	External fusion-bonded epoxy coating for steel pipes
AS/NZS 3879:2011	Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS and ASA pipes and fittings
AS 3952-2002	Water supply - spring hydrant valve for waterworks purposes
AS/NZS 4020:2005	Testing of products for use in contact with drinking water
AS 4041-2006	Pressure piping
AS/NZS 4087:2011	Metallic flanges for Waterworks purposes
AS/NZS 4129:2008	Fittings for polyethylene (PE) pipes for pressure applications
AS/NZS 4130:2009	Polyethylene (PE) pipes for pressure applications
AS/NZS 4158:2003	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS/NZS 4331	Metallic flanges
AS/NZS 4331.1:1995	Steel flanges
AS/NZS 4441:2008	Oriented PVC (PVC-O) pipes for pressure applications
AS/NZS 4765:2007	Modified PVC (PVC–M) pipes for pressure applications
AS 4795	Butterfly valves for waterworks purposes
AS 4795.1-2011	Wafer and lugged
AS 4795.2-2011	Double flanged
AS 4799-2000	Installation of underground utility services and pipelines within railway boundaries
AS/NZS 4853:2012	Electrical hazards on metallic pipelines
AS/NZS ISO 31000:2009	Risk management - Principles and guidelines
ASTM A276:2010	Standard Specification for Stainless Steel Bars and Shapes
Plastics Industry Pipe Association (PIPA)	
POP001-2011	Electrofusion jointing of PE pipe and fittings for pressure applications
POP003-2011	Butt fusion jointing of PE pipes and fittings - recommended parameters
POP007-2006	Metal backing flanges for use with polyethylene (PE) pipe flange adaptors
POP102-2009	Solvent cement jointing of PVC pipe
POP202-2008	Polyethylene (E) pipes and fittings for compressed air
Water Services Association of Australia (WSAA)	
WSA 01-2004	Polyethylene Pipeline Code Version 3.1
WSA 03-2011	Water Supply Code of Australia
WSA 109-2011	Industry standard for flange gaskets and O-rings

Other publications

IPWEA	
IIMM-2011	International Infrastructure Management Manual

1.4 STANDARDS

General

Standard: To WSA 03 Part 1.

1.5 INTERPRETATIONS

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AHBP: Allowable Horizontal Bearing Pressure.
- AHD: Australian Height Datum.
- AMG: Australian Map Grid.
- CIOD: Cast Iron Outside Diameter.
- DI: Ductile Iron.
- FF: Full Face.
- GDA: Geocentric Datum of Australia.
- IBC: Inside Bolt Circle.
- ISO: International Organization for Standardization.
- MAOP: Maximum Allowable Operating Pressure.

- NDH: No Discharge Head.
- PN: Nominal Pressure (megapascals x 10).
- PRV: Pressure Reducing Valve.
- PRelV: Pressure Relief Valve.
- UPCIC: Under pressure cut-in connection.
- WHS: Work Health and Safety.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Booster: In-line pressure booster pumping station used to increase the hydraulic gradient.
- Concept plan: A package of information provided to the designer by the Water Agency to allow the appropriate planning/design of the major water system components to be performed.
- Designer: Person(s) or firm responsible for a design output. Such person or firm may be accountable to a Project Manager or other person having responsibility under a contract or otherwise.
- Document: Record of information in written or graphical form.
- Dual water supply: A system of water supply consisting of dual mains (two pipelines from separate sources) and designed to concurrently provide two separate water supplies. One main conveys drinking (potable) water, the other conveys appropriately treated non-drinking water.
- Link mains: Laying a main between the court bowl or cul-de-sac and a main in an adjacent street via a pathway or right of way.
- Looped mains: A continuation of the water main in the street at the entrance to the court bowl or cul-de-sac, looped around the court bowl or cul-de-sac and then continued along the street.
- Maximum allowable operating pressure: Maximum hydrostatic pressure, including a nominal allowance for surge, that can be sustained with a factor of safety by the class of pipe for its estimated useful life under anticipated operating conditions with the frequency of surges less than that expected to lead to fatigue failure for that life.
- Service pressure: Internal pressure delivered at the point of connection to a customer's installation at zero flow in the service pipe. This does not include surge pressure.
- Surge: A rapid fluctuation of pressure caused by flow alteration over a short period of time.
- Transfer main: A water main that interconnects source(s), treatment works, reservoir and /or supply areas, normally without direct customer connections.
- Water age: The time taken for water to travel through the system, from treatment to customer.
- Water Agency: An authority, board, business, corporation, Council or local government body with the responsibility for planning or defining, design, construction and maintenance requirements for a water supply and/or sewerage systems. This includes Local Water Utilities (LWU).

2 PRE DESIGN PLANNING

2.1 SYSTEM PLANNING

Water supply system

Assessment: Before designing the new water supply system or an upgrade to an existing system, assess the requirements listed in WSA 03 clause 2.2.2 and perform the following:

- When providing a new water supply, determine possible sources of supply.
- Consider drinking water substitution such as provision of a non-drinking water supply system and the impact on the drinking water supply system and pipe sizing.
- Prepare a concept plan to WSA 03 clause 1.2.3.
- Consider special requirements such as hospitals.
- Consider water quality including disinfection.
- Consider demands, system configuration and system hydraulics.

Design brief requirements

Requirement: Determine and document the following:

- Details of acceptable connection points, available flow (Q) and pressure / head (H).

- Minimum and maximum allowable operating (working) pressure.
- Future expansion requirements such as larger through mains.
- Special requirements for critical mains and fire fighting purposes.
- Water supply boundaries.

In-line pressure booster pumping
Planning criteria for boosters: To *0072 Water supply-pump stations (Design).*

Valving system
Concept plan: Consider the following valving systems in the concept plan:

- Pressure reducing valve installations to WSA 03 clause 6.3.
- Pressure sustaining valve installations to WSA 03 clause 6.4.

Future system expansion
Future capacity: Plan water mains with sufficient capacity to cater for all existing and predicted development within the area to be served. Consider water demand allowance and future demand estimations in conformance with WSA 03 clause 2.11.

Minimisation of life cycle costs
Life cycle plan: Submit an asset life cycle plan noting renovation or replacement for items. Conform to typical asset design lives in WSA 03 Table 1.2, without rehabilitation, or submit other source documentation for design life.

2.2 SUBSIDISED SCHEMES

Funding
Government grant funds: If the works form part of a contract attracting Government grant funds, identify the following:

- Items which are not of the least cost option, that:
  - Are intended to have a much longer design life than the normal asset service life detailed in the Asset Management Guidelines of the *International Infrastructure Management Manual*.
  - Do not meet the project objectives and the requirements of the various Agencies for the least Net present value (NPV) but may become the preferred option for construction.
- Particular equipment which is procured without relevant competition through tendering.
- Duplication of equipment or unit processes in a system configuration.

2.3 CRITICAL INFRASTRUCTURE PROTECTION

Asset categorisation
Concept plan: Address the asset categorisation in conformance with WSA 03 Table 1.1 and WSA 03 Appendix A. Provide a risk assessment of the final design for consistency with the asset categorisation and the concept plan.

2.4 CONSULTATION

Council and other Authorities
General: Approval of design proposals is required from Council

3 DESIGN

3.1 GENERAL

Responsibility
Concept plan: Review the concept plan provided and make sure the data listed by WSA 03 clause 1.2.5.1 is available.

Conflicting requirements: If there is conflict between this specification and the Water Agency requirements, seek clarification.

Requirements of design: Provide for water supply to each property by a connection point to a water main or a pre-laid property service from a water main including the following:

- Conform with WSA 03 clause 1.2.5.2.

System review
Requirement: Progressively review the planning and design in conformance with WSA 03 clause 2.12.

3.2 HYDRAULIC DESIGN

General
Loss of supply: If possible, provide service for the development from two or more transfer mains to avoid the loss of supply due to maintenance or breakage.

Maximum pressure: Analyse water hammer and design to control surge pressure and dynamic stresses to WSA 03, clause 3.6.

Elevated pipelines: Design piers for any above ground water main to resist pipeline forces from unbalanced pressures and allow for temperature changes and settlement.

Demands
Base: Nominate the hydraulic design demand rates based on the ultimate predicted development demand and the division of the required drinking and non-drinking water supply.

Demand assessment
Residential demand: Determine the residential demand in conformance with WSA 03 Table 2.2 by multiplying the peak hour demand per property or unit and the number of properties serviced. Estimate the number of properties by either counting actual properties or using a conservative density factor for future zoning.

Non-residential demand: Determine the non-residential demand in conformance with WSA 03 Table 2.2 by modelling the system over a period considering the developments use.

Average day demand: [complete/delete]

Average hour demand: [complete/delete]

Peak day demand: Determine in conformance with WSA 03 clause 2.3.4.2.

Peak hour demand: Determine in conformance with WSA 03 clause 2.3.4.3.

Dual water supply systems
Demand allocation: Determine demands for each system separately in conformance with WSA 03 Table 2.1 and the following:

- Generally, allow an extra 10% of the total average demand for a dual system.
- No allowance is made in design peak demands for rainwater tanks.

Water quality
Prevention of back siphonage: To WSA 03 clause 2.6.2. including the design of steady state pumping pressure, location and operation of hydrants, air valves and scours.

Backflow prevention devices: To AS/NZS 2845.1.

Water age reduction: To WSA 03 clause 2.6.3.

Disinfection: Determine if disinfection plants are required as part of the distribution/reticulation system and locate to conform with WSA 03 clause 2.6.4.

Service reservoirs
Storage capacity: Determine the minimum service reservoir storage capacity and service reservoir location in conformance with WSA 03 clause 2.9.1.

Risk assessment: Assess risk to AS/NZS ISO 31000 as part of sizing reservoirs and associated pumping stations, and determining system configurations. Address the following:

- Available total storage.
- Relative needs for operating.
- Reserve storage capacity in particular locations.
- Pumping requirements.
- Staging requirements.
- Disinfection and maintenance requirements.
- Secondary tank requirements.

Network analysis
Concept plan: Provide a concept plan including servicing options in a network analysis of the reticulation system. Analyse all elements within the system in conformance with WSA 03 clause 2.5.2, including:

- Peak demand conditions for operating/reserve storage.
- Pressure.
- Average demand conditions for water quality.

Design period: Use a design period where the input capacity is less than the total peak day demands.

System configuration

Layout: Position mains considering the concept plan and functional design requirements for the project and to WSA 03 clause 2.4.

Operating pressures

- Desirable allowable service pressure: To WSA 03 Table 2.3.

Non-drinking water supply system: Provide for an available static head or steady state pumping pressure of 5 to 10 m head lower than the drinking water supply system.

Pressure variation analysis

Surge analysis: Analyse surge for zones affected by pressure variations. Determine the magnitude and frequency of surge pressure in the system by analysing for the full range of anticipated rates of change of flow.

Propose design solutions: Submit for approval a design solution for any significant pressure surges or high pressure areas in an existing or proposed supply system. Investigate de-rating of pipes for pumped systems.

Daily pressure variations: Assess and minimise any daily pressure variations under normal operating conditions.

Determine supply zones

Zones to deliver desirable range of pressure: Determine supply zones to provide the desirable range of pressure under peak demand conditions . Provide for service reservoirs, boosters and/or PRV zones to create the zones.

Pipe sizing

Minimum pipe sizes: To WSA 03 Table 3.1 and WSA 03 Appendix B except for the following:

- Mains in dual water supply systems: To WSA 03 clause 3.1.4.
- Reduced sized mains for maintaining water quality: To WSA 03 clause 5.2.4.

Fire flow capability: Design water mains required for fire-fighting purposes in conformance with the requirements of the Water Agency. Consult with the relevant fire authority where the need for alternative emergency water supply sources are identified.

Sizing by analysis

Pipe and network analysis: Analyse the pipe and network to WSA 03 Table 3.2 or hydraulic design based on the forecast demand, acceptable velocity range, allowable head loss and acceptable pressure range.

Head losses: To WSA 03 clause 3.1.6.2 and as follows:

- 5 m head/km for ≤ DN 150 (CIOD) or ≤ DN 180 (ISO).
- 3 m head/km for ≥ DN 200 (CIOD) or ≥ DN 250 (ISO).

Calculating head losses: To AS 2200.

Hydraulic roughness values: To AS 2200 Table 2.

Flow velocities: Conform to WSA 03 clause 3.1.6.4 and the following:

- Optimum velocity: 0.8 m/s to 1.4 m/s.
- < 4 m/s under maximum flow conditions.
- Submit for approval where flow velocities are considered greater than 3 m/s on cement mortar lined pipes.

Travel time: Submit for approval if the proposed system will result in water age of more than 48 hours for an average day demand.

Design pressures

System design pressure: To WSA 03 clause 3.2.

Gravity system: Design pressure is the maximum static pressure in the system, equal to the full supply level of the reservoir or tank minus the lowest ground level along the route of the water mains system, with the following exceptions:

- Any pressure boosted subsystems of a gravity system: To WSA 03 clause 3.6 and WSA 03 section 6.
- If a gravity system supplies a downstream reservoir: Asses the surge effects of inlet control valves to WSA 03 clause 3.6.2.

Systemic surge: To WSA 03 clause 3.2.3.

Dynamic pressure systems: Determine dynamic pressure in conformance to one of the following:

- Pressure due to the NDH of the pump plus the maximum suction pressure minus the lowest ground level along the route of the pipeline.

- Pressure due to the operating pressure of the pump plus the maximum suction pressure minus the lowest ground level along the route of the pipeline plus an allowance for surge due to the pump starting.

Pressure class (PN) of system components: Record the required PN of system components on the drawings. Determine PN to WSA 03 clause 3.7 and 3.8 and as follows:

- For gravity systems: PN > design pressure.
- Allowance for random surges: 10 to 20 % of PN to conform with WSA 03 clause 3.3.1.
- Systems subjected to dynamic pressures: Analyse surge and fatigue and provide all calculations, assumptions and referenced documents in conformance with WSA 03 clause 3.6.
- Mixed gravity and dynamic pressure system: Use the highest PN value.

Thrust and anchor blocks: Design to withstand the system test pressure applied to each section of the water mains network.

System test pressure: Calculate the system test pressure to WSA 03 clause 3.5 and record on the drawings.

Test selections: Determine test sections to avoid exceeding MAOP of individual items.

3.3 PRODUCTS AND MATERIALS

General

Products and materials: Conform to Water Agency product catalogues, WSA 03 *Product and material information and guidance* and WSAA Product specifications, available from WSAA website www.wsaa.asn.au

Pressure piping: To AS 4041.

Differentiation of drinking and non-drinking pipe systems

Identification: Determine the measures to differentiate the drinking and non-drinking water supply to WSA 03 clause 4.2 following a risk assessment in conformance with the *Australian guidelines for water recycling* at www.scew.gov.au/archive/water/index.html. Document one or more of the following requirements:

- Pipes of different colours to WSA 03 Table 4.1 and AS/NZS 4158.
- Warnings printed on non-drinking water mains and/or sleeving.
- Marking tape.
- Marking of surface fittings.
- Identification markers and marker posts.
- Operating systems with a service pressure differential.
- Different pipe locations.
- Maintaining a minimum pipe separation.
- Use of different pipe materials for the drinking and non-drinking water mains.
- Testing of products for use in contact with drinking water: To AS/NZS 4020.

Ductile iron pipeline systems

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe series (CIOD or ISO).
- Pipe pressure classification (PN).
- Joint type.
- Length of pipes.

- Types of fittings.
- Internal and external corrosion protection.
- Tapping the reticulation sized mains: Pre-tapped connectors or mechanical tapping bands to WSA 03 clause 4.3.2 and WSA 03 clause 5.11.

Seal coating of lining: Cement mortar lined pipes to AS/NZS 2280 where the total alkalinity of the water being conveyed is less than 30 mg/L.

Sleeving: PE sleeving to bituminous coated DI pipes to AS 3681.

Flange class DI pipes: Fully support flange in the installed condition. Include instructions for preventing loading of the flange during installation.

Flanged joints to AS/NZS 4087: Document the type of flange gasket and the tightening sequence.

Pipes and fittings: Manufactured in conformance with AS/NZS 2280. Minimum Class PN 20 for elastomeric seal joints.

Epoxy coating: To AS/NZS 3862 (or thermal-bonded polyethylene to AS/NZS 4158).

Elastomeric seals: To AS 1646.

Flanges: Manufactured in conformance with AS/NZS 4087 and AS 2129.

Bolts and nuts for flanged joints: To AS 2129, galvanized in conformance with AS 1214, or stainless steel in conformance with ASTM A276.

PVC pipeline systems

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe series (1 or 2).
- Pipe pressure classification (PN).
- Material classification number (as necessary).
- Length of pipes.
- Type, material and class of fittings.
- Tapping the reticulation sized mains: Pre-tapped connectors or mechanical tapping bands to WSA 03 clause 4.4 and WSA 03 clause 5.11.

Jointing: Solvent cement jointing of PVC mains to AS/NZS 3879 and POP102 available from http://www.pipa.com.au/images/pdf/POP102.pdf.

PVC pipe: To AS/NZS 1477.

PVC-O pressure pipe: To AS/NZS 4441.

PVC-M pressure pipe: To AS/NZS 4765.

PE pressure pipe: To AS/NZS 4130.

PVC curved alignments: To POP202.

PE pipeline systems

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe pressure classification (PN).
- Material class (PE80 or PE100).
- Length and form of pipes (straight lengths or coils).
- Types, materials and classes of fittings.
- Tapping the reticulation sized mains: To WSA 03 clause 4.5 and WSA 03 clause 5.11.

Jointing: Document in conformance with WSA 01.

Mechanical couplings: Self restraining.

Stub flanges and backing rings: To POP007.

Flanges: To AS 2129, AS/NZS 4331.1 and AS/NZS 4087.

Polyethylene (PE) pipe: Manufactured to AS/NZS 4130 and designed to AS/NZS 2566.1.

PE Fittings: To AS/NZS 4129.

PE curved alignments: To POP202.

Butt fusion jointing: To POP003.

Electrofusion jointing: To POP001.

Steel pipeline systems

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter: To AS 1579 Appendix C.
- Rated pressure.
- Joint type: To AS 1579 Appendix E.
- Length of pipes.
- Types of fittings: To AS 1579 Appendix D.
- Internal and external corrosion protection.
- Flanged joints, class of flange, type of flange gasket and the tightening sequence: To AS/NZS 4087.

Steel water mains: Submit for approval by the Water Agency for use in reticulation systems.

Gaskets: To WSA 109.

Insulated flanged joints: Document where steel pipes, fittings and other steel appurtenances are jointed to flanges and/or flange backing plates of dissimilar metals such as copper, copper alloys, galvanized steel and stainless steel. Insulated flanged joints are not required where joining to wrought iron flanges, grey cast iron flanges or ductile cast iron flanges.

Jointing: Provide the pipe jointing as follows:

- Elastomeric seal jointed with seals conforming to AS 1646, or
- Butt welded, welded spigot and socket, or welded using a welding collar and with the application of a polyethylene heat shrunk sleeve over the weld, or wrapped, or
- Flanges: To AS/NZS 4087.

Bolts and nuts for flanged joints: To AS/NZS 4087 clause 3.2.

GRP pipeline systems

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe series (CIUD or ISO)
- Pipe pressure classification (PN).
- Pipe stiffness classification (SN).
- Joint type.
- Length of pipes.
- Types of fittings.
- Type: Centrifugally cast (CC) or filament wound (FW).

GRP water mains: Submit for approval by the Water Agency for use in reticulation systems.

GRP pipes and collars: Manufactured to AS 3571.2 and designed to AS/NZS 2566.1.

Surge cycles: Refer to the manufacturer when the temperatures are likely to exceed 35°C.

GRP fittings: Ductile iron fittings conforming to AS/NZS 2280 with appropriate elastomeric seals conforming to AS 1646 may also be used.

ABS pipes and fittings

Acrylonitrile butadiene styrene (ABS) pipes and fittings: Manufactured in conformance with AS/NZS 3518 and joined in conformance with the manufacturer's instructions using solvent cement to AS/NZS 3879.

Pipe class: Provide for cyclic loading.

Copper pipe and fittings

Copper tube: Manufactured in conformance with AS 1432 in the range of DN 6 to DN 200 for Type A or Type B. Take into account the requirements of AS/NZS 3500.1.

Capillary and compression fittings: Conform to AS 3688 and de-zincification resistant. Document silver brazed joints or solder insert capillary joints for capillary fittings.

Protection against degradation

Detail: Take measures to protect all pipeline system items (e.g. pipes, fittings, appurtenances, elastomeric seals) including the following:

- No contact between dissimilar metals to prevent galvanic corrosion.

- Protective coatings to metallic components and concrete structures suitably designed for various corrosivity levels of soil and groundwater.
- Fully sealed conduits for plastics pipes and fittings in contaminated ground.
- Fully sealed conduits for all elastomeric seal jointed pipes and fittings in contaminated ground.
- Control trench fill and pipe embedment materials.
- Stray current or other effects on buried steel pipelines mitigated in conformance with WSA 03 clause 4.8.6.
- Cathodic protection for buried steel pipelines to AS 2832.1 and AS 2832.2 and in conformance with WSA 03 clause 4.8.5.

Protection against damage to coatings: Provide for more than one thickness of PE sleeving between coated fittings, valves and other appurtenances and thrust and anchor blocks.

Stainless steel: Grade 316 or 316L, welding requirements to AS/NZS 1554.6 and threaded component details.

Protection against contaminated ground: Fully welded externally coated or wrapped steel pipeline. Submit alternatives for approval by the Water Agency.

Bolted galvanized connections: An encapsulating system using priming paste wrapped with petrolatum tape or PE sleeving in conformance with WSA 03 clause 4.8.8.

Miscellaneous

Concrete: To *0319 Minor concrete works*.

3.4 SYSTEM DESIGN CRITERIA

Design Tolerances

Requirement: Determine design location and levels to WSA 03 clause 5.1.1 including the following tolerances:

- Horizontal alignment for mains: Referenced to coordinate system (AMG or GDA) in metres to one decimal place.
- Level: Referenced to AHD and the following:
  - . Reticulation mains in conformance with minimum cover requirements.
  - . Transfer and distribution mains in metres with 2 decimal places.

Longitudinal elevation: Document the longitudinal elevation and include the following levels:

- Along the length of the proposed main.
- Each side of a road crossing.
- Crossings of proposed drains, sewers, cables and other pipes or services.
- Valves adjacent to a road crossing.
- Changes of grade.
- At intervals on vertical curves so that the depth of the main will be within the minimum and maximum depths below the surface level.
- All appurtenances.

Depth of cover: Where unusual circumstances occur, document the depth of cover for both initial and future works.

Electrical safety and earthing to water services

Precautions: Develop safety precautions for all personnel before and after the works in conformance with the Water Agency requirements and WSA 03 clause 5.1.3. Alternatively, include the following requirements:

- Test for defects in the electrical supply.
- Monitor for elevated voltage on pipework.
- WHS.
- Turn off power.
- Provide a conductive bridge around the work area.
- Notify occupants and electricity distributors of changes.
- A written consent from the electricity distributor, that it is safe to proceed when a metallic water main is to be replaced by plastics pipes.

Environmental considerations

Water main route: Conform to state, territory and local government environmental, native title and heritage laws. Avoid, where practical, water main routes through environmentally significant areas such as those listed in WSA 03 clause 5.1.4.

Minimise environmental impacts: Determine any requirements for specific environmental protection such as:

- Trenchless tunnelling, boring or micro tunnelling alternative excavations.
- Minimisation of the impacts of dewatering.
- Minimisation of the impacts of rock excavation.
- Type and size of construction equipment.
- Protective measures for steep slopes.
- Protective measures for unstable areas.
- Protective measures for significant flora.
- Minimisation of area of disturbance.
- Season of construction.
- Minimisation of transport of soil borne disease.
- Rehabilitation of the construction site post construction.

Urban salinity: If required, develop salinity management strategies for positioning of infrastructure, materials or construction methods.

Reticulation design for water quality

Layout of water mains: Position in conformance with the following:

- Avoid termination points or dead ends.
- Use continuous network, link mains, looped mains and reduced sized reticulation mains.

Looped mains stop valves: Locate near the intersection of the street and cul-de-sac (court bowl).

Linked mains: Use the size of the smaller of the two mains being linked.

Reduced sized mains: Conform to the following:

- Use where other options are not feasible.
- Use where the front boundary of the furthest lot is less than 100 m (or the maximum distance specified by the relevant fire authority) from a hydrant on a main greater than DN 100.
- Use for non-drinking water supply.
- Design to supply the maximum number of properties at ultimate development using the minimum diameter PE pipe in conformance with WSA 03 Table 5.1 and Figure 5.2.
- Design the size and length of reduced sized mains based on the average service pressure at that location.

3.5 LOCATION OF WATER MAINS

General

Location: Position water mains in the road reserve in conformance with WSA 03 clause 5.4.2 and as follows:

- Any space allocation agreements, local agreement with road owner or other utility service provider.
- Statutory requirements: *Guide to codes and practices for streets opening* available from http://www.streetsopening.com.au/SOC_Guide_2009.pdf
- Align parallel to property boundaries or road features such as kerbs.
- Maintain adequate clearance from structures and other infrastructure.
- Allow unhindered access for repairs and maintenance.
- On the opposite side of the street to the power cables.
- If laying water mains within another utility service allocation, obtain written consent from the appropriate authority.
- If no space is available in the footway, locate in the kerbside lane within the carriageway. Written consent from the road owner required where locating in motorway reserves.

- In a straight line through roundabout intersections and bus bays. Seek approval if deviation is required.
- If access for maintenance is limited, use a reduced maintenance installation, such as concrete encasement in conformance with WSA 03 clause 7.6.
- Without unnecessary disturbance of any living or dead vegetation.
- Mark all trees for approval to remove where trees are located on the water main proposed route.

Surface fittings: Locate in footpaths, clear of roundabout intersections or bus bays.

Location markers: Document locations showing installation adjacent to surface fittings.

Marking tape

General: Document the type of marking tape, location, method of installation and joins. Conform to WSA 03 clause 5.4.16.

Detectable marking tape: Document for pipe systems as follows:

- Buried non-metallic mains with no fixed reference point.
- Buried metallic mains installed deeper than specified maximum depths of cover.
- Identify any restrained joint system with tape spacing less than 3 m.
- All trenchless installation of non-steel pipe sleeve: Use a minimum 2 mm diameter grade 316 stainless steel tracer wire wound around or affixed to the pipe and terminated and fixed at an accessible point at each end.
- PE property services to the water main: All new property services ≤ DN 32 use PE pipe and marking tape.

Water mains in easements

Easement guidelines: If water mains cannot be located in a dedicated public road reserve or private access way, register an easement that conforms to WSA 03 clause 5.4.4 and Table 5.2 and the following:

- Provide for isolation valves for the section within the easement.
- Easement alignments: Run easement in conformance with the following:
  - Parallel to cadastral boundaries.
  - Across the rear of lots.
  - Down the side of the lots.
  - Along agreed alignment.
- Parks or reserves: Consider the following:
  - Provision of safe water flow paths for burst mains.
  - Suitable vehicle access to the mains.
  - Mains clear of any existing or proposed trees or shrubs.

Position of main in the easement: Conform to the following:

- 1/3 of the width into the easement on the side away from any buildings.
- Position centrally if there are buildings on both sides and if the easement runs through narrow walkways.
- Where there is a crossfall, position the main on the low side.

Water main access

Access: Document the locations of person-access facilities on the design drawings.

Dual water supply systems

Locations: Document on the drawings the location of dual water supply systems in conformance with WSA 03 clause 5.4.5 and the following:

- Shared trench in the footway allocation: Locate with common obvert depth.
- Shared trench in the road carriageway: Locate with common obvert depth.
- Separate trenches in the same footway allocation: Locate the non-drinking water main closest to the property boundary.
- Separate trenches in the footway allocation: Locate drinking and non-drinking water mains on the opposite sides of the road reserve.
- Separate trenches in the road carriageway: Locate non-drinking water main nearer to the centreline.

- Where they cross, lay non-drinking water under the drinking water main.

Crossings

Requirement: Design water main crossings of roads, railway lines, water courses etc. using trenchless techniques and with alignments to minimise the following:

- Failure of the main.
- Future third party interference.
- Conflict with underground structures or foundations.
- Number of joints and surface fittings with the crossing.
- Leakage of joints.
- Necessary restoration of improvements in the crossing.
- Future asset management treatments e.g. condition assessment, replacement, removal etc.

Crossing: Install the water main at 90° to the road.

Allowable variation: [complete/delete]

Protection: Document any required protection from external factors such as external loading, third party intrusion including:

- Encasement in conformance with WSA 03 clause 5.4.9.2.
- Precast reinforced concrete removable slabs.
- Concrete encasement.
- Service duct.
- Security fencing.
- Protection barriers.
- Sleeving.

Crossing of creeks or drainage reserves: Document the following:

- Alignment: 90°±15° to the creek or drainage reserve.
- Mechanical protection.
- Construction details.

Overhead power lines and transmission towers

Investigate: Assess potential safety risks to AS/NZS 4853 if any of the following apply:

- Welded steel pipelines simultaneously run parallel and close to high voltage power lines for more than 1 km parallel and with 500 m of powerlines greater than 50 kV.
- Metal pipelines are located within 5 m of a transmission tower.
- Metal pipeline access is within 50 m of a transmission tower.

Safety risk: If there is a safety risk, document required alignment, electrical protection, corrosion protection measures and construction details.

Water mains in conjunction with landscaping and/or other development

Requirement: Document the design in conformance with the following:

- Access: Clear access or reduced maintenance design, such as concrete encasement in conformance with WSA 03 clause 7.6.
- Avoid detrimental loads such as vehicle, structures, trees, poles, street furniture.
- Structural design: Address anticipated loads and requirement for cover, concrete encasement or other protection methods.
- Cover, as documented.
- Traceability: If necessary, document 10 mm diameter pavement weep holes at maximum 1000 mm spacing along the main line to detect the leakage of water from the surface.
- Minimum clearance from trees and structures for mains ≤ DN 300:
  - If cover ≤ 1500 mm: 750 mm on each side of the centreline of the main.
  - If cover > 1500 mm: Consult the Water Agency.
- Access to surface fittings: Required for all hydrant, stop valve, air valve and water service surface.

Water mains on curved alignments

Requirement: Determine the most appropriate pipeline material and/or combination of components. Include the following details:

- Design radius and tangent point locations.
- Jointing system and allowable joint deflection.
- For deflection joints provide a list of acceptable manufacturers and their products to achieve the specified deflections.
- Material lengths of the cut pipe to achieve the curved alignment.
- Pre-tapped connectors.

Special requirements

Submission: Submit for approval where the proposed route of the water mains includes the following:

- Contaminated sites: Include issues noted in WSA 03 clause 5.4.8.
- Railway reserves: Approval by the railway owner is required. Conform to AS 4799.

Suitable service for mains: Detail within the design if duplicate mains are required.

Separate mains for service connections: Detail within the design including the distribution main, alignments and connection details if rider mains are required.

3.6 INSTALLATION CONSIDERATIONS

Trenchless technology

Geotechnical survey: Investigate the following:

- Soil identification to locate rock, rock inclusions, gravely soils, loose deposits, discontinuities and hardpan.
- Soil strength and stability characteristics.
- Groundwater.
- Pullback loads.
- External service loads.

Trenchless design: Make available all references, assumptions and calculations for the design and documentation of the following:

- Pipe class: Standard dimension ratio (SDR).
- Pipe diameter.
- Bore diameter.
- Minimum and maximum pipe anulus.
- Annulus required.
- Access pits.
- Exit points.
- Clearance from services and obstructions.
- Depth for minimum cover.
- Pipe support and ground compaction.
- Alignment tolerances.
- Grouting requirements.

Shared trenching

Agreement: Design in conformance with the Shared trenching agreement.

Shared trenching design: Submit for approval a detailed design including the following:

- Relative location of services, both horizontal and vertical in the trench.
- Clearances from other services.
- Pipe support and trenchfill material specifications.
- Embedment and trenchfill compactions.
- Trench markings.
- Services location with respect to property boundaries.
- Limitations on future maintenance.

- Drawings showing thrust and anchor block details.

Sections: For each section of shared trench define the following:

- Start and finish points.
- Dimensions.
- Service utilities within.

Vertical alignment: Conform to WSA 03 clause 5.6, Figures 5.4, 5.5 and Table 5.3.

Connection of new mains to existing mains

Eliminate disruption of service: Connect to existing systems with UPCIC to conform with WSA 03 Figure 5.6 and Appendix C. If this method is not appropriate, submit for approval, with reasons, the proposed alternative method, such as the inserted tee method, to conform with WSA 03 clause 5.9.

Connection design: Document the connection design including the following:

- Pipe material requirements and limitations.
- Relative depth of mains.
- Standard valves and fittings.
- Pipe restraint and anchorage.
- Potential for insufficiently restrained/anchored stop valves near the connection.
- Limitations on shutting down major mains to enable connections.
- Existing cathodic protection systems.
- Ease of maintenance.

Termination points

Detail: Document the design for permanent/temporary termination points, chlorination assemblies and flushing points.

Permanent ends of water mains: Conform to the following:

- Do not locate termination points in driveways.
- Do not install hydrants on ends < DN 100.
- Main < 2 m past the property service connection.

Temporary ends of water mains: Locate mains adjacent to the boundary of a subdivision or 2 m beyond finished road works for future subdivision works.

Chlorination assemblies: Provide for a chlorination assembly at all termination points on mains of DN 225 and greater. Include the following within the design:

- Location of the chlorination injection point and swabs.
- Pitot points if required.

Flushing points: Provide for flushing points to conform with WSA 03 clause 5.10.4 and Figure 5.8. Locate as required for maximum intervals and at the end of reduced sized mains. If required, provide a collection structure or make sure space available for a discharge tanker to conform with environmental requirements.

Maximum intervals for flushing points: [complete/delete]

Property services

Design: Document the following:

- Property service layouts.
- Services arrangements and sizes.
- Connection arrangements.
- Methods and sizes for single and split services located in footways and across road carriageways.
- Service duct details and kerb marking.
- Above ground and below ground meter layouts and arrangements.

Connection to water mains: Conform to the following:

- Corner lot connections: To the water main adjacent to the shorter road frontage of the lot.
- Minimum pipe and connection sizes: To WSA 03 Table 5.4.
- Minimum 500 mm spacing between connections (tapping bands and saddles), pre-tapped connectors and/or pipe joints.

- Do not use dry connections (drillings/tappings) for industrial or commercial developments.

Services, outlets and meters: To WSA 03 clause 5.11.3, Figures 5.9, 5.10, 5.11, Table 5.4 and consideration of the following:

- New residential lots: Colour coded PE or copper pipe.
- Existing lots: PE or copper.
- Locations.
- Requirements for split property services.
- Property services within footways: Positioned 90° ± 5° to the water main or kerb.
- Service ducts: Positioned 90° ± 5° to the road carriageway and extending to behind each kerb.
- Locate drinking and non-drinking water services within the same service duct.
- Kerb markers.
- Separate property service outlets for each lot for drinking and non-drinking water.
- Locate meters for drinking and non-drinking water together, near a common boundary or in the middle of the front property boundary or at the side of an access way for battle-axe lots.

Obstructions and clearances

Design: Identify all underground obstructions and services, surface obstructions and structures along the route of the proposed water main. Detail the methods of avoiding obstructions and services including the following:

- Surface obstructions.
- Clearance from transmission towers.
- Clearance from structures and property boundaries. Provide for the following minimum offset from property boundaries:
  . 1 m ≥ DN 100 mains.
  . 0.6 m < DN 100 mains.
- Underground obstructions and services:
  . Contact DIAL BEFORE YOU DIG to identify location of underground utility services, pipes and cables.
  . Hand excavation is recommended to determine exact locations and depth of obstructions.
  . Determine depths of services that the water main will cross.
  . Clearance requirements in conformance with WSA 03 Table 5.5.
- Deviations of water mains:
  . Verify manufacturers nominated deflection joints and maximum allowable angles of deflection.
  . Nominate pipe lengths and angled bends if pipes without deflection joints are specified.
  . Horizontal deviation: To WSA 03 clause 5.12.6.2 and Figures 5.12, 5.13, 5.14.
  . Vertical deviation: To WSA 03 clause 5.12.6.3 and Figures 5.15, 5.16, 5.17, 5.18, 5.19.
- Curving of pipes to avoid obstructions.
  . Local deviations: Select from PE, PVC-M and PVC-O pipes.
  . Document limitations including limiting of radius and curvature in conformance with POP202.
  . Document connectors and joins to conform with WSA 03 clause 5.12.6.4.
  . Document joint deflection, radius, tangent points and defined limits of bending.

Disused or redundant pipelines: To WSA 03 clause 5.13. Document the required action which may include the following:

- Removal or sealing the ends of the water main.
- Removal of surface fittings and restoration of the surface.
- Protection or preservation for heritage restrictions.
- Conditions for removal of asbestos cement pipes.

3.7 STRUCTURAL DESIGN

General

Design: Provide for flexible pipelines to resist structural failure and conform to AS/NZS 2566.1 and WSA 03 Table 7.1.

Structural considerations: Design pipelines and water mains to suit the following criteria:

- Site conditions.
- Internal forces: Including the following:
  - . Transient conditions (surge and fatigue).
  - . Negative pressures: Design for at transient pressure of at least 80 kPa below atmospheric pressure, with a safety factor of 2.
  - . Maximum static head conditions.
  - . Operating temperatures.
- External forces: Including the following:
  - . Trenchfill loadings (horizontal and vertical due to the earth loading).
  - . Surcharge.
  - . Groundwater effects.
  - . Dead weight of pipe and contained water.
  - . Temperature (expansion /contraction).
  - . Traffic.
  - . Pipes stiffness: ≥ 4,000 N/m/m.

Design pipe cover: Document the minimum and maximum depths of cover for each section of water main to WSA 03 clause 7.4.2 and Table 7.2.

Design embedment zone dimensions: Document the embedment zone dimensions to AS/NZS 2566.1, AS/NZS 2566.2 and WSA 03 clause 7.4.3.

Design pipe embedment: Document embedment material, reinforcing details and any special bedding requirements to WSA 03 clause 7.4.4 and Figures 7.2, 7.3.

Above ground water mains: Document details of pipeline items, supports, restraints, loading protection, maintenance and access requirements, protection from exposure conditions and impact loading from traffic.

Pipework through concrete pits: Provide structural pipe through concrete pit walls. Do not run PVC-U or PE through concrete pit walls.

Geotechnical considerations

Geotechnical assessment: Complete a geotechnical assessment, to WSA 03 clause 7.5.1, of the proposed route of distribution or transfer main where the following occurs:

- Size: ≥ DN 375.
- Historical data or other evidence of potential geotechnical problems.

Water mains in engineered or controlled fill: To WSA 03 clause 7.5.2.

Water mains in non-engineered fill: Engage a geotechnical specialist to investigate, design and supervise the support and foundation remediation.

Construction of an embankment: Engage a geotechnical specialist to investigate, design and supervise the construction of an embankment, trench and bedding. Determine the relevant construction requirements.

Unforeseen ground conditions: Document a requirement for a review and amendment of the structural design if unforeseen ground conditions are encountered.

Settlement: Provide for piling support to control settlement if appropriate.

Concrete encasement

Design: Document encasement and connections. If concrete encasement is proposed, submit for approval in conformance with WSA 03 clause 7.6 and the following:

- Design as a beam to withstand external loadings where encased length of pipelines incorporated joints or the AHBP < 50 kPA.

- Do not encase cast iron, wrought iron, PVC, rubber ring joints, AC pipe, lead joints, flanged joints, riveted pipe, sections of any main containing a service connection, hydrant or valve (including air valves).

Encased steel pipelines

Design: Document encased steel pipelines to WSA 03 clause 7.6.3 including protection and connections to existing steel pipelines and the following:

- Welding: To AS/NZS 1554.1 category SP.
- Design each type and profile of steel pipe separately including the method of sealing or replacing seals.
- Procedure for welding while pipe is charged, if required.
- Mains ≥ DN 375 require an internal inspection verification.

Water mains in unstable ground

General: Avoid construction of water mains through unstable ground including mine subsidence areas and slip areas.

Detail: Document the design of water mains constructed in unstable ground, including measures to maintain the integrity of the main to WSA 03 clause 7.7 and Appendix F.

Mine subsidence areas: Submit for approval by the Mine Subsidence Regulator any design for mains located in mine subsidence areas. Include the following information:

- The expected strains on the pipeline resulting from potential subsidence.
- Use area specific ground strains available from the Mines Subsidence Regulator.
- Notate and endorse approved design to WSA 03 clause 7.7.2.

Slip areas: Engage a geotechnical specialist to investigate, design and supervise the construction of water mains in slip areas. Minimise all potential for damage to a water main caused by movement of unstable ground.

Pipe jointing system: Provide for a pipe jointing system capable of accepting ground movements, without impairing the water tightness of the joint, for the ground strain advised by the Mine Subsidence Regulator as follows:

- Non-welded pipe systems in areas with high ground strains: Provide for a pipe jointing system using shorter effective length pipes and/or deep socket fittings.
- If the Mines Subsidence Regulator does not cover an area of known, or suspected, subsidence or slippage, the above requirements still apply.

Pipeline anchorage

Design: Document the pipeline anchorage required at all changes in direction, tees, valves, tapers and termination points. Exceptions include restrained joints and welded pipelines. Consider all horizontal and vertical forces. Conform to WSA 03 clause 7.9, Appendix G, Table 7.3 and Figures 7.11, 7.12, 7.13, 7.14, 7.15, 7.16.

Thrust blocks: Document the design for the thrust blocks including:

- Calculation of unbalanced thrust and resultant thrust to WSA 03 clause 7.9.2.1.
- Temporary thrust blocks to conform to the permanent thrust blocks requirements.
- Size: To WSA 03 Table 7.3.
- Location: Must not protrude beyond the space allocation for the main.
- If required, use puddle flanges to transfer thrust.
- Timber and recycled plastics: To WSA 03 Table 7.4 and Figure 7.17.

Anchor blocks design: Document anchor blocks to:

- Resist the unbalanced thrust due to the greater of the design pressure or test pressure to be imposed at the anchorage location.
- Prevent movement of pipe bends in a vertical direction by consisting of sufficient mass concrete to prevent pipe movement.

Restrained joint ductile iron water mains: Document the details including locations and any special construction techniques required. Use manufacturers recommendations for restrained jointing systems.

Design for restraint requirements for special situations: Document any special requirements such as above ground mains with unrestrained flexible joints, buried steel mains with welded joints, above ground steel mains with welded joints, ductile iron and steel mains with flanged joints, PE mains.

Bulkheads and trenchstops

Design: Document bulkheads and trenchstops in conformance with WSA 03 clause 7.10,Table 7.5 and Figures 7.20 to 7.26.

Drainage: Provide details for trench drainage where required.

3.8 APPURTENANCES

General valves

Design: Document the requirement for valves including the following:

- Type and class.
- End connections.
- Location and arrangement.
- Installation requirements.
- Design considerations: Address the issues listed in WSA 03 clause 8.1.3.
- Plastics identification covers: To WSA 03 Table 8.1 and Figure 8.1.
- Location marking: Prepare a marking schedule and drawing in conformance with WSA 03 clause 8.11 showing the type, colour and locations of all required identification markings including marker posts and plates, pavement markers and kerb markings.

Stop valves

Design: Document the details to WSA 03 clause 8.2 and the following:

- Location and arrangements: To WSA 03 clause 8.2.7.
- Gate valves:
  - Anti-clockwise rotation of the input spindle for closure.
  - Where required document gearing.
  - Where required document a valve chamber.
  - To AS/NZS 2638.1 or AS/NZS 2638.2.
- Butterfly valves: To AS 4795.1 and AS 4795.2 and the following:
  - Do not use in reticulation mains.
  - Geared unless otherwise approved.
  - Do not use where throttle of flow is required.
  - Install with trunnions horizontal and gearing operated from the surface.
  - Provide for valve chamber where the gearbox is not sealed.
- For transfer/distribution mains:
  - Locations and spacing: Consider requirements for special location, size of pipe or WHS requirements.
  - Sizes: Dictated by hydraulic requirements.
  - Use where required, concentric tapered valve connectors or full size valves.
- For reticulation mains:
  - Number of property services connected in a ‘shut-off’ area: To WSA 03 Table 8.2.
  - Single water service for multi-unit developments: Two-directional supply to WSA 03 Figure 8.14.
  - Arrangement similar: To WSA 03 Figure 8.14 Example B. Submit details similar to example A and C for approval.

Bypass of stop valves: Document type and arrangement for bypassing of stop to valves WSA 03 clause 8.2.6. Submit for approval if not standard default setup.

Verification: Verify with manufacturer’s and suppliers if selecting stop valves with integral bypass arrangements.

Rider mains: If it is necessary to provide water services from a distribution main, design and document rider mains to WSA 03 clause 8.2.9 and Figure 8.15.

Crossing mains: Document pipework and valving for crossing mains interconnection to WSA 03 clause 8.2.10 and Figures 8.16 to 8.19.

Control valves

Automatic inlet control valves (AICV) design: Document the location, type and size of valve in conformance with the Concept plan, WSA 03 clause 8.3.2 and the following:

- Make sure compatibility with the existing system, e.g. electrically or hydraulic actuated, fully modulating or two-state open/closed control.
- Nominate the most suitable valve for the application.

Pressure reducing valves (PRV): Document the location, type and size of valve in conformance with the concept plan, WSA 03 clause 6.3 and 8.3.3.

Pressure relief valves (PReIV): Document the location, type and size of valve in conformance with the concept plan, WSA 03 clause 8.3.4.

Pump control valves: Document the location, type and size of electrically operated butterfly valve in conformance with the concept plan and WSA 03 clause 8.3.5.

Pressure sustaining valves (PSV): Document the location, type and size of valve in conformance with the concept plan, WSA 03 clause 6.4 and 8.3.6.

Air valves: Design and document the requirement for air valves including the type, size and location to WSA 03 clause 8.4.

Non-return valves: Document the requirements for non-return valves including location, type, supports and size.

Maintenance facilities

Scours and pump-out branches: Document the location of scours and pump out branches for maintenance to WSA 03 clause 8.6 and the size to WSA 03 Table 8.4.

Swabbing points: If required, provide for adequate drainage facilities for dewatering and flushing operations.

Disinfection facilities: Document chlorination installation to WSA 03 clause 8.9 and Appendix I and include the following:

- Fittings as permanent fixtures.
- Identification and appropriate location of hydrants if utilised for disinfection purposes.
- Fittings for transfer and distribution mains.
- Discharge points.

Hydrants

Requirement: Document hydrants to WSA 03 clause 8.8 and include the following:

- Siting.
- Type.
- Installation requirements.
- Outlet connections: Conform to AS 2419.2.
- Hydrant size.
- Spacing: To WSA 03 Appendix H and as agreed with Local fire authorities. Identify and resolve any conflicting needs.
- Location.
- Spring hydrant valve: To AS 3952.

Surface fittings

Requirement: Document the type and locations of surface fittings required for all buried appurtenances, including the following:

- Marking of surface fittings: To WSA 03 clause 8.10.3.
- Installation requirements: To WSA 03 clause 8.10.4.

4 DOCUMENTATION

4.1 GENERAL

Design

Concept plan: Document and review the concept plan for the water supply system.

Design review: Demonstrate conformance with the approved concept plan and WSA 03 clause 9.1.

Project design documentation: Include project-specific information such as the following:

- Location of pipelines, valves, hydrants, pipe materials, size pressure class, jointing methods and corrosion protection measures.
- Detailed drawings including location of all relevant obstructions.
- Specifications for products, materials, site investigation, excavation/trench details and other technical matters.
- Document design assumptions and constraints.

Asset categorisation:

- Risk assessment of final design for consistency with asset categorisation of concept plan.
- Surge analysis and design for surges.
- Water age.
- PN of system components.

Specifications

Construction documentation: Prepare a project specific completed specification *1341 Water supply – reticulation (Construction)*.

Design certification

Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS

General

Design drawings: Provide design drawings to WSA 03 clause 9.2 and the following:

- Pipeline acronyms: Use the WSAA acronym's provided at www.wsaa.asn.au.

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Document the requirements for recording work-as-executed including GPS coordinate points. Provide an additional set of final construction drawings for this purpose.

0072 WATER SUPPLY – PUMP STATIONS (DESIGN)

1 GENERAL

1.1 RESPONSIBILITIES

Objective
Design requirement: Provide design, drawings and specification for the construction of an in-line pressure booster pump station(s) and ancillaries for a reticulated water supply system (either drinking or dual drinking/non-drinking) conforming to the requirements of WSA 03 and the Water Agency, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0010 Quality requirements for design.*
- *0071 Water supply – reticulation (Design).*
- *1341 Water supply – reticulation (Design).*
- *1342 Water supply – pump stations (Construction).*

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

Standards

AS 1657-1992	Fixed platforms, walkways, stairways and ladders—Design, construction and installation
AS/NZS 1680	Interior lighting
AS/NZS 1680.2.4:1997	Industrial tasks and processes
AS 2184-1985	Low voltage switchgear and controlgear. Moulded-case circuit breakers for rated voltages up to and including 600 V a.c. and 250 V d.c.
AS/NZS 3000:2007	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS /NZS 3111:2009	Approval and test specification - Miniature overcurrent circuit-breakers
AS 3439	Low-voltage switchgear and controlgear assemblies
AS 3439.1-2002	Type-tested and partially type-tested assemblies
AS/NZS 4020:2005	Testing of products for use in contact with drinking water
AS 4041-2006	Pressure piping
AS/NZS 4158:2003	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes.
AS 60947	Low-voltage switchgear and controlgear
AS 60947.4.1-2004	Contactors and motor-starters - Electromechanical contactors and motor-starters
AS 60947.4.2-2004	Contactors and motor-starters - A.C. semiconductor motor controllers and starters
AS 61800	Adjustable speed electrical power drive systems
AS 61800.2-2004	General requirements - Rating specifications for low voltage adjustable frequency a.c. power drive systems
AS 61800.3-2005	EMC requirements and specific test methods
AS/NZS ISO 31000:2009	Risk management - Principles and guidelines
IEC 61643	Low-voltage surge protective devices
IEC 61643-11:2011	Surge protective devices connected to low-voltage power systems - Requirements and test methods
IEC 61643-12:2008	Surge protective devices connected to low-voltage power distribution systems - Selection and application principles

NSW Department of Commerce

MEW E101-2007	Electrical Services Minimum Requirements.

Water Services Association of Australia (WSAA)

WSA 03-2011	Water Supply Code of Australia.
WSA 03-2002	Product and Material Information and Guidance for Water Supply Code of Australia
WSA 04-2005	Sewage Pumping Station Code of Australia Version 2.1. Parts 0-4.(Part 4 standard drawings) CD
WSA 130-2011	Industry standard for ISO end suction centrifugal pumps
WSA 131-2011	Industry standard for ISO end suction centrifugal motor pumps

Other publications

IPWEA

IIMM-2011	International Infrastructure Management Manual

1.4 STANDARDS

General

Standard: To WSA 03 Part 1.

1.5 INTERPRETATIONS

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AICV: Automatic inlet control valves.
- CT: Current transformers.
- PFD: Process Flow Diagram.
- P&ID: Process and Instrumentation Diagram.
- PN: Nominal Pressure (megapascals x 10).
- PRV: Pressure Reducing Valve.
- PRelV: Pressure Relief Valve.
- PSV: Pressure Sustaining Valve.
- SCADA: Supervisory Control and Data Acquisition System.
- SCR: Silicon controlled Rectifiers.
- VS: Variable Speed Drive.
- WHS: Work Health and Safety.

Definitions

General: For the purposes of this worksection the definitions given in WSA 03 Part 0 and the following apply:

- Booster: In-line pressure booster pumping station used to increase the hydraulic gradient.
- Commissioning: Running of the plant and equipment to make sure flow through the pumping system, carrying out any necessary testing and adjustments until the plant is ready and suitable for normal starting and running under service conditions.
- Concept plan: A package of information provided to the designer by the Water Agency to allow the appropriate planning/design of major water system components to be performed.
- Designer: Person or firm responsible for a design output. Such person or firm may be accountable to a Project Manager or other person having responsibility under a contract or otherwise.
- Document: Record of information in written or graphical form.
- Pre-commissioning: Preparation of plant or equipment so that it is in a safe and proper condition and ready for commissioning and operation, including safety, electrical, mechanical and instrumentation.
- Service pressure: Internal pressure delivered at the point of connection to a customer's installation at zero flow in the service pipe. This does not include surge pressure.
- Surge: A rapid fluctuation of pressure caused by flow alteration over a short period of time.
- Water Agency: An authority, board, business, corporation, Council or local government body with the responsibility for planning or defining, design, construction and maintenance requirements for a water supply and/or sewerage systems. This includes Local Water Utilities (LWU).

2 PRE DESIGN PLANNING

2.1 GENERAL

Water supply system

Reticulation: Conform to *0071 Water supply – reticulation (Design).*

System concept plan: Prepare plan in conformance with WSA 03 clause 1.2.3.

Valving system

Concept plan: Consider the following valving systems in the concept plan:

- Pressure reducing valve installations to WSA 03 clause 6.3.
- Pressure sustaining valve installations to WSA 03 clause 6.4.

Future system expansion

Future capacity: Plan pump stations with sufficient capacity to operate for all existing and predicted development within the area to be served by the reticulation system. Consider water demand allowance and future demand estimations in conformance with WSA 03 clause 2.11.

2.2 BOOSTER SYSTEM

Booster planning considerations

General: During planning, avoid the use of pumping stations for the following:

- Hospitals.
- Heavy industry customers.
- Commercial or industrial customers on lots larger than 1 hectare.
- Existing customers in separate occupancies of multi-storey buildings if there is no agreement related to boosted supply.
- Parts of a supply network where the peak instantaneous un-boosted pressure is below 2 to 8 m head.
- Areas remote from maintenance works depots.

Concept design

Requirement: Provide a concept design for the proposed pumping station in conformance with WSA 03 clause 6.2.2 including the following:

- Design to optimise construction, operation and maintenance costs for the total life cycle of infrastructure and equipment.
- Risk analysis of total station failure and contingency plan including provisions for emergency bypass, mobile generator, stand-by pumping equipment and associated controls, spare pumps, maintenance and emergency access.
- Operating licence, customer contract and local zoning requirements.
- A maximum of 500 lots in the ultimate boosted zone.
- Fire fighting requirements.
- Environmental and WHS requirements.
- Remote monitoring, control and telemetered alarms.
- Reliability, maintainability, materials design, location, site selection, noise control, services, access, site drainage, landscaping, security, signage, supporting systems.

Modelling

Requirement: Model the system in conformance with WSA 03 clause 6.2.4 and the following:

- To satisfy flow and pressure requirements for current, future and ultimate conditions including receipt of basic water supply at times of power failure or other times when the booster is not operational.
- Fire flows.
- Assume the minimum pressure affecting the area as that predicted by an accurately calibrated maximum hour model.
- To predict the number of affected properties within the low pressure zone.

Life cycle costs

Evaluation: Complete a life cycle evaluation in conformance with WSA 03 clause 6.2.2.2.

Life cycle plan: Submit an asset life cycle plan noting renovation or replacement for items. Conform to typical asset design lives in WSA 03 Table 1.2 or submit other source documentation for design life.

2.3 SUBSIDISED SCHEMES

Funding

Government grant funds: If the works form part of a contract attracting Government grant funds, identify the following:

- Items which are not of the least cost option, that:
  - Are intended to have a much longer design life than the normal asset service life detailed in the Asset Management Guidelines of the *International Infrastructure Management Manual*.
  - Do not meet the project objectives and the requirements of the various Agencies for the least Net present value (NPV) but may become the preferred option for construction.
- Particular equipment which is procured without relevant competition through tendering.
- Duplication of equipment or unit processes in pump station configuration.

2.4 CRITICAL INFRASTRUCTURE PROTECTION

Concept plan

Asset categorisation: Address the asset categorisation in conformance with WSA 03 Table 1.1 and Appendix A. Provide a risk assessment of the final pump station design for consistency with the asset categorisation and the concept plan.

2.5 CONSULTATION

Council and other Authorities

General: Approval of design proposals is required from the following public authorities:

- Consulting authority: [complete/delete]

Environmental impact statement (EIS): [complete/delete]

Public consultation

Requirement: [complete/delete]

Utilities services plans

Requirement: [complete/delete]

3 DESIGN

3.1 GENERAL

Responsibility

Concept plan: Review the concept plan and make sure the data listed by WSA 03 clause 1.2.5.1 is available.

Conflicting requirements: If there is conflict between this specification and the Water Agency requirements, seek clarification.

Requirements of design: Provide for in-line pressure booster pumping stations to increase pressure to the supply zones of the reticulation system, including the following:

- Conform with WSA 03 clause 1.2.5.2.
- [complete/delete]

3.2 HYDRAULIC DESIGN

General

System requirement: Conform to the hydraulic design requirements of *0071 Water supply – reticulation (Design).*

Pressure and demand: Use the demand rates, operating pressures and design pressures determined from *0071 Water supply – reticulation (Design)* and WSA 03 clause 2.3, 3.2 and 3.6.

3.3 BOOSTER DESIGN

General

Design: Design boosters to WSA 03 clause 6.2.5 and to provide the following:

- Boost pressure only, not to be the only means of supplying pressure to services.
- Fire fighting capability: [complete/delete]
- Efficiency, particularly for low flows. Efficient flow and pressure: [complete/delete]
- Non-boosted gravity water supply pressure:
  - Minimum head and location: [complete/delete]
- Non-return valves to maximise flow to the maximum hour demands when the booster is inoperative.
- Mechanical design to Water Agency requirements.

Connections to the network: To WSA 03 clause 6.2.5.2.

Maximum flow and pressure requirements: Carry out hydraulic modelling to determine the pressure required at the booster discharge to provide the minimum zone pressure under the maximum minute demand conditions. Determine under maximum hour conditions the following:

- Required discharge pressure. Use this as the booster control.
- Minimum suction pressure and flow.
- Maximum duty Head and Flow (H, Q).

Minimum pressure boost conditions: Use historical pressure data to make sure stable operation without pump overload or cavitation.

Minimum flow conditions: Carry out risk analysis and design for zero flow conditions.

Booster configuration design: To WSA 03 appendix D.

Booster set and pump selection: Provide for minimum life cycle, deliver diurnal flows, peak or maximum hour flows, fire flows.

Equipment and devices: To WSA 03 clause 6.2.5.9.

Site specific requirements: To WSA 03 clause 6.2.5.10.

Pressure accumulator tank: To WSA 03 clause 6.2.7. Prepare an inspection and maintenance schedule to WSA 03 appendix E and manufacturer's recommendations.

Pumps

Booster set and pump selection: Conform to WSA 03 clause 6.2.5.7 and the following:

- Standard pump specifications available in the WSA product specifications for configurations described in WSA 03 Appendix E.
- Provide identical pumps in the booster and interchangeable with other approved Water Agency makes/models.
- Design to the maximum duty land flow (H, Q) under the worst conditions.
- Number of pumps: < 4.
- Pump operation: ≤ 47.5 Hz.
- Temperature sensors for no-flow protection.
- Readily available in the market place.
- End suction centrifugal pumps: To WSA 130 or WSA 131 as appropriate.
- Submit proposals if using triple-pump system for approval.
- Select motors in conformance with WSA 131.
- Detail discharge connection including anchoring.
- Pump casing: To WSA 131 clause 3.4.2.
- Stop valves: To WSA 03 clause 8.2.5.
- Pump starters: To **MOTOR STARTERS**.
- Variable speed drives: To **MOTOR STARTERS**.

Hydraulic performance: Determine in conformance with WSA 03 clause 6.2.5.7 the required duty range of the booster set and individual pumps or pump combination, including the requirements for ancillary equipment.

Pump capacity: Calculate capacities of the pump unit from the intersection of the pump performance curve and the pipeline characteristic curve calculated at mid water level of the service reservoir involved with this duty point. Provide for the following:

- Delivery of the required transfer capacity over a period of 22 hours.
- Standby pumping capacity such that if one pump is out of service, the pump station will remain able to supply the required transfer capacity.
- Capability of the pump unit to operate near optimal efficiency within the range of operating conditions.
- Average and peak demand rate: To WSA 03 clause 2.8.3 (a).

Pump prime: If there is negative suction head at the pump inlet, make provision to facilitate priming of each pump.

Removal: To facilitate removal of the pumps for maintenance, provide for dismantling joints and valves in the pipework.

Surge control: Provide for appropriate surge control devices.

Certificate: Require verification that the Contractor's proposed pumps conform to the design requirements.

Risk assessment

Requirement: Assess risk to AS/NZS ISO 31000 as part of the process for sizing pump stations and determining system configurations. Address the following:

- Relative needs for operating.
- Pumping requirements.
- Staging requirements.
- Maintenance requirements.

Commissioning plan

Requirement: Provide a commissioning plan in conformance with WSA 03 clause 6.2.3 including the following:

- Pre-commissioning procedures, including schedules, record sheets for each item of equipment and checklists.
- Commissioning procedures, including procedures, schedules, notice periods for independent testing.
- Handover requirements.
- Sign-off requirements.
- Supply documentation requirements at handover and sign-off.
- Documentation required to operate, maintain and resource the facility including equipment technical specifications, work-as-executed drawings, risk analysis, operation and maintenance manuals, resource requirements for ongoing operation of the facility.
- Following final design, update the commissioning plan in conformance with design documentation.

3.4 BOOSTER PIPEWORK AND MANIFOLDS

Design

General: To WSA 03 clause 6.2.5.8 and 6.2.6.

Individual booster pump pipework and manifolds: Size so that maximum velocities do not exceed the values in WSA 03 Table 6.1.

Booster equipment and devices: Size in conformance with PFD's, P&ID's and process data sheets.

Verification: Require verification by the manufacturer and supplier of all pumps, valves, pressure accumulator tanks that the products and materials supplied are approved by the Water Agency.

Protection: Protect above ground pipework and fittings, outside the station, from fire and impact.

3.5 POWER SYSTEM AND SUPPLY

General

Primary power supply requirements: [complete/delete]

Electrical design: To AS/NZS 3000 and WSA 03 clause 6.2.8.

Primary supply: Provide for 3 phase, 4 wire, 400V, 50Hz, MEN system with capacity to operate at full pumping load.

Fault level protection: Determine the prospective fault current and design the electrical protection to withstand the prospective fault current level of the incoming supply at the equipment location.

Power supply security

Requirement: Carry out a risk analysis for each station in relation to the reliability/security issues raised in WSA 03 clause 6.2.2.4 and clause 6.2.8.2.

Alternative power supplies: If required, consider the following:

- Duplicate power supplies.
- An emergency on-site power generator.
- Provision for the connection of a mobile diesel generator to the Water Agency requirements.
- Security requirements against theft of on-site generators and connections for mobile generators.

Site supply

General: Determine the primary power supply requirements in conformance with AS/NZS 3000 and WSA 03 clause 6.2.8.3.

Off site electrical services: Liaise and provide for all off-site electrical services as required by the local electricity distributors.

Site specific substation

Electricity distributor dedicated substation: If required for the pumping station, determine the following:

- Location of substation.
- Type of service.
- LV connection point and route of the distribution mains to the point of supply.
- Protection equipment, particularly any LV transformer output protection.
- Easement details.

LV transformer output protection: Provide for short circuit and overload protection at the transformer secondary supply using fault current limiting circuit breakers with adjustable overload and short circuit current setting features, where secondary output supplies are required to be installed by the electricity distributor.

Cascade protection: Include full discrimination and cascade protection with the electricity distributor's incoming supply protection system and the downstream site protection devices.

Customer owned substation

HV customer service: If an HV supply is provided to the pumping station site, meet the requirements of the electricity distributor for the following:

- HV reticulation.
- HV protection.
- Transformer and LV protection: Set out LV facilities and LV transformer protection in electricity distributor dedicated substations.

Electrical mains

On-site electrical mains: Run on-site electrical mains underground between the electricity supply and the switchboard for the pumping station.

Point of Supply for LV sites: Conform to the following types:

- Pole mounted at the site boundary where from overhead supplies.
- A private underground termination enclosure at the site boundary, where from underground supply.
- Direct connected customer's mains run underground from the electricity distributor's connection point to the main switchboard.

Customer's Mains: Provide for customer's mains, associated services and all necessary fault and overload current protection equipment to AS/NZS 3000 Section 3, the local electricity distributor's standards, the local Service and Installation Rules.

Minimum size of the customer mains: Conform to the following requirements:

- Current carrying capacity to suit the maximum demand with an excess current carrying capacity of 30% minimum.
- A voltage drop less than 1.5% of the maximum demand as calculated.

- Single core PVC/PVC cables or XLPE insulated cable.
- Pole termination method: Determine in consultation with the Local Supply Authority.

Protected customer's mains: Provide for short circuit and overload protection, where required by the electricity distributor.

Electricity distributor's service protective devices:

- Low voltage service protective devices: To AS/NZS 3000, the electricity distributor's requirements and the supply authority service and installation rules.
- For service protective devices > 100 A: Provide for fault current limiting circuit breakers with adjustable overload and short circuit current facilities with full discrimination and cascade protection between the incoming supply protection systems and the downstream protection systems.

3.6 ELECTRICAL DESIGN

General

Standard: [complete/delete]

Automatic operation: Design the pump station for fully automatic operation in the unmanned condition.

Power and control cubicle

General: Document the power and control cubicles in conformance with AS 3439.1.

Inter-changeability: If more than one item of equipment is designed to perform a particular function, make sure that all such items of equipment are identical and completely interchangeable (e.g. pilot lights, pushbuttons, relays, etc).

Switchboard: Provide for installation in a visible location which is physically accessible above all areas at risk of flooding.

Ambient conditions: Determine the ambient conditions for the local area.

Switchboard construction form: Generally Form 2 to AS/NZS 3439.1. Segregate telemetry and communications equipment from the power and control sections of the switchboard.

Switchboard location:

- General: Locate switchboard on concrete plinth. Provide plinth details and physical protection.
- Flood prone areas: Locate switchboards above the flood level on suitable support structures. Detail switchboard support structures and location. Provide for suitable access facilities and working platform in front of switchboard for safe operation of the equipment.

Phase failure protection: Provide for electronic phase failure relay to monitor the incoming power supply, incorporating:

- Detection of undervoltage (80% of normal voltage).
- Voltage or phase angle imbalance.
- Reverse phase sequence.
- 10 A fuse protection for connection to the three supply phases.

Surge protection: Provide for Type I SPD shunt connected metal oxide varistor based SPDs between each phase and neutral at assembly incoming supply terminals, if required by the electricity distributor.

Surge protection devices: Conform to IEC 61643.11 and IEC 61643.12 and install to AS/NZS 3000 Appendix F.

Lighting requirements: To WSA 03 clause 6.2.8.9.

Power factor correction: Consider power factor correction requirements as set out in WSA 04 clause 7.2.9, the energy cost in running the pumping station and cost savings to justify the installation of power factor correction equipment.

Connection facilities for mobile diesel generators: In addition to the requirements of WSA 04 clause 7.2.7, consider incorporation of safeguards to prevent inadvertent simultaneous connection of mains and generator power. Where necessary, provide for mechanical interlocks and an isolation device or changeover switch to switch the mobile generator supply to the switchboard.

Anti-condensation heaters: Provide for thermostatically controlled anti-condensation heaters to weatherproof switchboards with an external surface area greater than 4 m^2 based on 40 watts/ m^2 of exposed surface area, where environmental conditions may cause condensation to occur within the switchboard. Provide for heaters of the black heater type, mechanically protected and able to be touched without harm.

Provide lightning and surge protection: To all incoming power supply and control power supply.

3.7 MOTOR STARTERS

General: Provide for electronic Variable Speed Drive (VSD) starters and motor control devices for the control of water booster pumps to AS 60947.4.2.

Each boost pump shall include the following electrical control and protection equipment:

- Circuit breaker rated to protect the pump submain and the motor,
- Hybrid VSD motor controller/starter.

Circuit breakers

General: Moulded case or miniature circuit breaker to AS/NZS 2184 and ASNZS 3111 and WSA 04 clause 8.8.8.2 or 8.8.8.3 as applicable.

Selection: Provide for full discrimination and cascade protection for overload and short circuit conditions.

Hybrid VSD motor controller/starter

General: Provide for hybrid VSD motor controller/starter to AS 60947.4.2 comprising:

- Main line contactor rated for the motor current.
- Electronic VSD starter and controller.
- Thermal overload protection.
- Thermistor protection of motor windings on motors nominally over 15kw.

Main line contactor: To AS/NZS 60947.4.1 and the following features:

- Block style electromagnetic, air break type generally from the one manufacturer.
- Rated duty: Intermittent class 12.
- Utilisation category: AC-3 or DC-3 as applicable.
- Mechanical durability: 10.
- Contact life: 1 million operations at AC-3 or DC-3 as applicable.
- Three phase contactors: Minimum rating of 16 A, 415 V at category AC-3, rated for the actual motor current at category AC-3.
- Design: To allow for fitting of auxiliary contacts with rating (Ie) of 4 A at 240 Va.c.
- Electronic VSD starter and controller: Generally to AS/NZS 60947.4.2, AS 61800.2, AS 61800.3 and the following:
  - Functional features: To AS 61800.2 clause 3.
  - Automatic restart in the event of failure: Additional following features:
  - Breakaway torque adjustment.
  - Motor starting current limit adjustment.
  - Adjustable acceleration time.
  - adjustable deceleration time.
  - Phase loss trip.
  - Shorted SCR trip.
  - Open circuit output trip.
  - Motor stalled trip.

Thermal overload protection: To AS/NZS 60947.4.1 and the following additional features:

- Single phase fault protection utilizing differential trip bar mechanisms operating at 60% of motor full load rating under single phasing conditions particularly for delta wound motors.
- Incorporated in motor protection design where thermistor protection is required.
- Manual reset on overload trip unless design conditions dictate automatic reset.

Motors rated 45kW and above: Provide for electronic motor protection relays in lieu of thermal overload protection relays to WSA 04 clause 8.8.8.6.

Protection CTs: Provide for protection CTs and connection of electronic motor protection relays to the secondary side of the CTs where motor currents do not allow for direct connection of the relays into the motor circuit.

3.8 CONTROL AND TELEMETRY SYSTEM

General

Control, telemetry and alarms: Document control, telemetry and alarm systems in conformance with WSA 03 clause 6.2.9, clause 6.2.10 and clause 6.2.11.

Booster pump variable speed drive control: Control the speed of the pump as set out in WSA 03 clause 6.2.9.3. Select equipment to achieve the required output from the booster set without reduction in service life of pumps.

Monitoring incoming power supply: Provide for continuous monitoring of the availability of the power supply at the station and the control power supply to WSA 03 clause 6.2.8.3.

Emergency power for telemetry system: Provide for a minimum 8 hour battery backup supply to the control and monitoring system to WSA 03 clause 6.2.8.5.

Selection of equipment and devices: To WSA 03 clause 6.2.9 and 6.2.10.

Instrumentation: Suitable to monitor flow, pressure, level, speed, voltage, current, power factor, hours run and any other suitable parameters. Connection to SCADA for monitoring and control including water pump station, reservoirs and tanks, control valves, flow meters and chambers.

3.9 PUMP STATION BUILDING

General

Requirement: Secure pump units in a purpose-designed building subject to the Development Approval (DA). Considerations include aesthetics, climate, acoustics, WHS, clearance for maintenance, trip hazards, confined spaces and ventilation.

Location: Consider site access, site maintenance and restoration, easement, power supply and working area when locating pump stations in road reserves or on private property.

Dimensions: Provide structure of dimensions to suit the selected equipment including support, handling and access.

Protection against flooding: Locate the floor of the pump station or top of pump well, as appropriate, 1 m above the 1 in 100 year flood level.

Structure

Structural design: Conform to the NATSPEC *03 Structure* worksections relevant to the structure being designed.

Substructure: If below ground level, mount pumps on plinths and house in a single pump well. Provide for drainage to prevent flooding of the well.

Protection against flotation: Design pump wells against flotation, both during the construction/installation and operation under flood conditions designed as above. Provide a factor of safety of 1.25.

Ladders

Ladders: Conform to AS 1657.

Ladder landings: Set intermediate landings in wells to achieve the minimum head room clearance. Wherever possible, locate the landing adjacent to fittings and machinery requiring maintenance.

Ladder cages: Do not use on ladders in pump station wells.

Covers

General: Design for the possibility of site flooding ingress and overflow, and WHS requirements in providing for access and inspection covers.

Electrical requirements for Pump Station Buildings

General: Where the pumping equipment is installed within a pump station building, provide for the following:

- Fluorescent lighting within the building utilising sealed corrosion resistant lighting fittings with electronic ballasts.
- 10 A, 240 V switched power outlets. Quantity and location to suit pumping station requirements.
- 15 A, 240 V switched power outlet suitable for electric welding requirements.
- RCD protection to AS 3000 requirements.

Lighting switches and power outlets: Ironclad or high impact polycarbonate industrial type.

Conduits:

- Electrical accessories :Heavy duty UPVC conduit.
- Pumping equipment: Heavy duty conduit on tray or on cable ladder.

3.10 PRODUCTS AND MATERIALS

General

Products and materials: Conform to Water Agency product catalogues, WSA 03 *Product and material information and guidance* available and WSAA Product specifications from WSAA website www.wsaa.asn.au

Pressure piping: To AS 4041.

Requirement: Conform to the material requirements of *0071 Water supply – reticulation (Design).*

Differentiation of drinking and non-drinking pipe systems

Identification: Determine the measures required to differentiate the drinking and non-drinking water supply to WSA 03 clause 4.2 and carry out risk assessment in conformance with the *Australian guidelines for water recycling* at www.scew.gov.au/archive/water/index.html. Include one or more of the following requirements:

- Pipes of different colours to WSA 03 Table 4.1 and AS/NZS 4158.
- Warnings printed on non-drinking water mains and/or sleeving.
- Marking tape.
- Marking of surface fittings.
- Identification markers and marker posts.
- Operating systems with a service pressure differential.
- Different pipe locations.
- Maintaining a minimum pipe separation.
- Use of different pipe materials for the drinking and non-drinking water mains.
- Testing of products for use in contact with drinking water: To AS/NZS 4020.

3.11 APPURTENANCES

General valves

Design: Document the requirement for valves in conformance with *0071 Water supply – reticulation (Design).*

Stop valves

Design: To WSA 03 clause 8.2.5.

Control valves

AICV design: Document the location, type and size of valve in conformance with the Concept plan, WSA 03 clause 8.3.2 and the following:

- Make sure compatibility with to the existing system, e.g. electrically or hydraulic actuated, fully modulating or two-state open/closed control.
- Nominate the most suitable valve for the application.

PRV's: Document the location, type and size of valve in conformance with the concept plan, WSA 03 clause 6.3 and 8.3.3.

PRelV's: Document the location, type and size of valve in conformance with the concept plan, WSA 03 clause 8.3.4.

Pump control valves: Document the location, type and size of electrically operated butterfly valve in conformance with the concept plan and WSA 03 clause 8.3.5.

PSV's: Document the location, type and size of valve in conformance with the concept plan, WSA 03 clause 6.4 and 8.3.6.

Air valves: Design and document the requirement for air valves including the type, size and location to WSA 03 clause 8.4.

Non-return valves: Document the requirements for non-return valves including location, type, supports and size.

4 DOCUMENTATION

4.1 GENERAL

Design

Concept: Document the concept design and include in the concept plan for the water supply system.

Design review: Demonstrate conformance with the approved concept plan and WSA 03 clause 9.1.

Commissioning plan: Document and review the commissioning plan and pre-commissioning checklist for the pump station.

Project design documentation: Include project-specific information, such as the following:

- Location of pipelines, valves, hydrants, pipe materials, size pressure class, jointing methods and corrosion protection measures.
- Specifications for products, materials, site investigation and other technical matters.
- Document design assumptions and constraints.

Asset categorisation:

- Risk assessment of final design for consistency with asset categorisation of concept plan.
- Surge analysis and design for surges.
- PN of system components.

Specifications

Construction documentation: Prepare a project specific completed specification *1342 Water supply – pump stations (Construction)*.

Design certification

Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS

General

Design drawings: Provide design drawings to WSA 03 clause 9.2 and the following:

- Pipeline acronyms: Use the WSAA acronym's provided at www.wsaa.asn.au.
- [complete/delete]

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Document the requirements for recording work-as-executed including GPS coordinate points. Provide an additional set of final construction drawings for this purpose.

Drawing format: [complete/delete]

Final certification of completed works: [complete/delete]

0074 STORMWATER DRAINAGE (DESIGN)

1 GENERAL

1.1 RESPONSIBILITIES

Objective

General: Provide stormwater drainage systems design and documentation to meet the following requirements:

- Reduced frequency of flooding of private and public buildings in flood-prone areas.
- Control of surface flows to prescribed velocity/depth limits.
- Control of surface flows to minimise the effect on pedestrians and traffic in more frequent stormwater conditions.
- Within each catchment, retention of incident rainfall and runoff consistent with the planned use of the area.
- Conformance with the Australian Rainfall & Runoff (ARR) 'major/minor' system concept.
- A constant average recurrence interval (ARI) for existing and reconstructed works.
- Adoption of Water Sensitive Urban Design (WSUD) principles.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *0010 Quality requirements for design.*
- *0075 Control of erosion and sedimentation (Design).*
- *1121 Open drains, including kerb and channel (gutter).*
- *1351 Stormwater (Construction).*

Related worksections:

- *1352 Pipe drainage.*
- *1353 Precast box culverts.*
- *1354 Drainage structures.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian standards

AS/NZS 1254: 2010	PVC pipes and fittings for storm and surface water applications.
AS 1289	Methods of testing soils for engineering purposes
AS 1289.4.2.1-1997	Soil chemical tests - Determination of the sulfate content of a natural soil and the sulfate content of the groundwater - Normal method
AS 1289.4.3.1-1997	Soil chemical tests - Determination of the pH value of a soil - Electrometric method
AS 1289.4.4.1-1997	Soil chemical tests - Determination of the electrical resistivity of a soil - Method for sands and granular materials
AS/NZS 2032: 2006	Installation of PVC pipe systems
AS 2200-2006	Design charts for water supply and sewerage
AS/NZS 2566	Buried flexible pipelines
AS/NZS 2566.1: 1998	Structural design
AS/NZS 2566.2:2002	Installation
AS/NZS 3500	Plumbing and drainage
AS/NZS 3500.3: 2003	Stormwater drainage
AS/NZS 3725: 2007	Design for installation of buried concrete pipes

AS/NZS 4058: 2007	Precast concrete pipes (pressure and non-pressure)
AS 4139-2003	Fibre reinforced concrete pipes and fittings
AS/NZS 5065: 2005	Polyethylene and polypropylene pipes for drainage and sewerage applications

Austroads

AGRD05-2010	Guide to road design – Drainage design
AP-R232: 2003	Guidelines for treatment of stormwater runoff from the road infrastructure

Other publications

Council

Handbook for drainage design criteria

Engineers Australia

Australian Rainfall and Runoff (ARR) Volume 1 - A guide to flood estimation

- Book II - Design rainfall considerations
- Book III - Choice of flood estimation methods and design standards
- Book IV - Estimation of design peak discharges
- Book VII – Aspects of hydraulic calculations.
- Book VIII - Urban stormwater drainage.

ARQ 2006 Australian runoff quality – A guide to Water Sensitive Urban Design

Concrete Pipe Association of Australasia

Hydraulic Design Manual for precast concrete pipes

Refer to www.concpipe.asn.au for the design of steel reinforced concrete pipelines

Australian National Conference On Large Dams, Leederville WA

ANCOLD, Guidelines on Acceptable Flood Capacity for Dams (2007)

Australian and New Zealand Environment and Conservation Council

ANZECC- 2000 National Water quality management strategy No.10 Guidelines for urban stormwater management

NSW RTA

Model analysis to determine hydraulic capacities of kerb inlets and gully pit gratings

1.4 STANDARDS

General

Standard: Conform to the following:

- Rainfall and runoff: To ARR.
- Water sensitive urban design: To ARQ.
- To Council's Handbook for drainage design criteria (Handbook).

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the abbreviations given below apply:

- ARI: Average Recurrence Interval.
- ARR: Australian Rainfall and Runoff.
- ARQ: Australian Runoff Quality.
- BPP: Best Planning Practices.
- BMP: Best Management Practices.
- GPT: Gross Pollutant Trap.
- IFD: Intensity-Frequency-Duration.
- HGL: Hydraulic Grade Line.
- JP: Junction pits.
- OSD: On-site detention.
- SEP: Side entry pit.
- SMP: Stormwater Management Plan.
- SQID: Stormwater quality improvement devices.

- WSUD: Water Sensitive Urban Design.

Definitions

General: For the purposes of this worksection the definitions given below apply:

- Average Recurrence Interval (ARI): Average interval in years is the average or expected value of the period between exceedances of a given discharge.
- Catchment: A topographically defined area drained by a stream such that all outflow is directed to a single point.
- Catchment area: The catchment area of any point is defined by the limits from where surface runoff will make its way, either by natural or man made paths, to this point.
- Dual drainage: The major/minor approach to street drainage.
- Handbook: Council Handbook for drainage design criteria.
- Major system: The network of planned and unplanned drainage routes which provides safe, well-defined overland flow paths for rare and extreme storm runoff events. It includes roads, natural channels, streams, culverts, community retention/detention basins and other facilities.
- Minor system: The gutter and pipe network capable of carrying and controlling flows from frequent runoff events. It includes kerb and channels, inlet structures, open drains and underground pipes and on-site detention facilities.

Primary treatment SQID: Removal of the majority of gross pollutants and coarse-medium grained sediments by screening or sedimentation e.g. GPT's, trash racks, sediment trap.

- Redevelopment site: A site which had (or was originally zoned to have) a lower density development than is proposed.

Secondary treatment SQID: Removal of the majority of coarse, medium and fine grained sediments, as well as a significant proportion of the pollutants attached to sediments, by enhanced sedimentation and filtration e.g. Infiltration basins and wet ponds.

- Stormwater Management Plan: Plan to manage the stormwater quantity and quality within a catchment and protect receiving water features, such as the protection of existing waterways, lakes and wetlands.
- Sub-catchment: A topographically defined area drained by a tributary or branch drain of a primary stream or main drain draining a catchment.
- Tertiary treatment SQID: Removal of the majority of sediments, attached pollutants and dissolved pollutants by sedimentation, filtration and biological uptake e.g. Constructed wetlands.
- Time of concentration: The time required for storm runoff to flow from the most remote point on the catchment to the outlet of the catchment or to the inlet of a drainage structure within the catchment.
- Treatment train: Sequencing of SQID's to optimise treatment performance.
- Trunk drains: Large capacity channels or conduits which carry runoff from local street drainage systems to receiving waters. For example, natural or artificial channels, transitions and hydraulic structures, culverts and road crossings, naturally occurring ponds and lakes, artificial detention or retention storages.
- Water Sensitive Urban Design (WSUD): Design principles aimed at improving the sustainable management of the urban water cycle. It integrates the planning and design of urban water cycle, water supply, waste water, stormwater and groundwater management, urban design and environmental protection.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Best Planning Practices (BPP)

General: Carry out BPP including the following:

- Capability assessment: Assess the existing physical and natural attributes of the site including the following:
  - . Area and shape of the catchment area.
  - . Slopes and existing channels.
  - . Vegetation affecting run-off and/or loss factors.

  . Existing works at risk of inundation.
  . Existing drainage works location and capacity.
  . Sensitive inhabited locations to be protected.
  . Services and transport works to be protected.
  . Any tidal considerations.
  . Pollution control requirements.
- Planning and design for WSUD.

Best Management Practices (BMP)

General: Evaluate the structural and non-structural elements of a design that perform the prevention, collection, treatment, conveyance, storage and re-use functions of a water management scheme.

BMP: Include the following:

- BPP:
  . Land and water use planning.
  . Regulation assessment.
  . Urban design.
- Source control:
  . Land management.
  . Enforcement.
  . Education and awareness.
- System management measures:
  . Stormwater management plan.
  . Stormwater treatment.
  . Flow management.

Water Sensitive Urban Design

General: Plan and design stormwater drainage using WSUD principles including the following:

- On-site detention (OSD).
- Capture and use of stormwater as an alternative source of water to conserve potable water.
- Use of vegetation for filtering purposes.
- Water-efficient landscaping.
- Protection of water-related environmental, recreational and cultural values.
- Localised water harvesting for re-use.
- Localised wastewater treatment systems.

2.2 CONSULTATION

Calculations

Certified design calculations: Engage a qualified hydrologic and hydraulic design professional to perform all required calculations.

Major structures

Certified structural design: Engage a professional engineer for all bridges, major culvert structures and specialised structures in conformance with *0160 Quality (Design).*

3 STORMWATER DRAINAGE SYSTEMS

3.1 GENERAL

Stormwater drainage

Design requirements: Consider the following elements in designing the stormwater drainage system:

- Determination of design flows.
- Hydraulic design of pipelines.
- Appropriate inlet and discharge structures.
- Structural elements of the drainage system.

Easements
Easements over private property: Do not surcharge major system flows across private property. Contain flows of ARI 100 years.

Collaboration: Plan services layout to avoid clashes with other services.

Control of erosion and sedimentation
Requirement: To *0075 Control of erosion and sedimentation.*

3.2 WATER CYCLE MANAGEMENT

Design for stormwater harvesting and re-use
General: Design for re-use of locally generated roof water, stormwater and wastewater. Adopt BPP and BMP systems to integrate the urban water cycle for collection, drainage and re-use.

Stormwater re-use scheme: Design the re-use scheme for ease of operation and maintenance. Consider the following when designing for collection, storage, treatment and distribution:

- End use requirements for water quality and quantity.
- Reliability of supply (varies with local climate and rainfall).
- Estimated demand for water with regard to peak flow. (Depends on the variable rainfall pattern).
- Assessment of water balance for sizing and storage.
- Storage requirements considering average annual volume and diversion flow rates.
- Treatment system based on:
  - Diversion flow rates before storage.
  - Distribution flow rates both before and after storage.

Roofwater: Provide an integrated design with rainwater tanks, coordinate with the appropriate engineering consultation and comply with the requirements of any authorities or local government.

Stormwater runoff: Design for the utilisation of stormwater runoff at the following scales:

- Allotment scale.
- Subdivisional/regional scale.

Wastewater and grey water: Design for wastewater and grey water re-use where it impacts the stormwater drainage design. Utilise professional engineering input where appropriate.

Stormwater collection
Requirement: Design the stormwater collection system to meet the following objectives:

- Extraction of sufficient water to meet the end use requirements without compromise to downstream aquatic eco systems.
- Potential to stop collection in the event that stormwater is contaminated by an incident within the catchment.
- Minimisation of the risk and/or impact of upstream flooding.

Stormwater storage
Requirement: Design the stormwater storage system to meet the following objectives:

- Storage of sufficient water to balance supply and demand.
- Above-ground storage: Minimisation of mosquito habitat (virus control), risks to public safety and risks to water quality and maximisation of dam safety.

Stormwater treatment
Treatment: Design appropriate stormwater treatment techniques to meet the following objectives:

- Minimisation of public health risks for the adopted public access arrangements.
- Minimisation of environmental risks.
- Additional end use requirements: [complete/delete]
- Additional stormwater quality criteria: [complete/delete]

Stormwater distribution
Requirement: Minimise the potential for:

- Contaminant inputs downstream of the final treatment facilities.
- Public exposure to untreated stormwater.
- Cross-contamination with mains water distribution networks or confusion with mains water supplies.

Irrigation: Design the irrigation system to the following requirements:

- Minimise run off, groundwater pollution and soil contamination.
- Minimise spray to areas outside the access control zone where access control is adopted to reduce public health risks.
- Application rate of stormwater: Uniform for the irrigation scheme and at a rate less than the nominal infiltration rate to avoid surface runoff.

3.3 STORMWATER MANAGEMENT

General

Requirement: Integrate management activities at the catchment, waterway and local development level in conformance with the *Guidelines for urban stormwater management* and the following:

- Restore of existing stormwater systems.
- Minimise the impacts of stormwater from new developments.
- Hydrological: Minimise the impacts of urbanisation on the hydrological characteristics of a catchment including wet weather and low flows. Mitigate pre-development inappropriate flows where practical.
- Water quality: Minimise the amount of pollution entering the stormwater system and remove residual pollution by implementing stormwater management practices.
- Vegetation: Maximise the value of indigenous riparian, floodplain and foreshore vegetation.
- Aquatic habitat: Maximise the value of physical habitats to aquatic fauna within the stormwater system.
- Processes for management: Submit processes for management for the following as applicable:
  - Runoff.
  - Water quality.
  - Riparian vegetation.
  - Watercourse and aquatic habitat.
  - Urban bushland.
  - Bridges and culverts across waterways.
  - Water sensitive urban design.

Stormwater management plan

Requirement: Provide a stormwater management plan in conformance with the *Guidelines for urban stormwater management* and the following:

- Describe the catchment or sub-catchment area.
- Identify stakeholders and partnership mechanisms.
- Outline agreed values, issues and management objectives.
- Identify management strategies for land and water use and practices.
- Address implementation instruments and programs including education and training, planning, infrastructure provision, operation and maintenance, regulation and economic incentives.
- Address assessment and performance review including monitoring of values and conditions, monitoring of strategy implementation and review time frames.
- Link water quantity controls with water quality controls.
- Integrate permanent stormwater management features into overall development.
- Identify legal point(s) of discharge (prior to Development Approval).
- Address ecological protection issues that are influenced by the management of stormwater (e.g. waterway corridor vegetation and habitat management issues).
- Clearly identify pollutants of concern and their sources for both the construction and operational phases of development.
- Identify an optimum combination of structural and non-structural Stormwater Quality Best Management Practices to limit the pollutant export potential of the site for both the construction and operational phases of development.
- Address the management of specific water quality issues (where relevant).
- Specify a water quality monitoring program where necessary.

- Outline maintenance requirements.
- Ensure site-based measures complement regional water quantity and water quality management measures already planned through Council Stormwater Management Plans or Waterway Management Plans.

3.4 HYDROLOGY

Design rainfall data

Design Intensity-Frequency-Duration (IFD): Derive rainfall relationships for a particular catchment from the *Handbook*.

Alternatively: Derive rainfall relationships for a particular catchment from the following options:

- ARR volume 1 Book II section 1.
- AS/NZS 3500.3 Appendix E.
- Bureau of Meteorology IFD tool website www.bom.gov.au
- Geoscience Australia website www.ga.gov.au.

Record IFD: Document the adopted IFD data used in the hydrological calculations to the sample summary sheet in the *Handbook*.

Design ARI: To the *Handbook*.

Alternative: If there is no *Handbook* provided, derive the ARI from ARR Book III and AGRD 05.

Record ARI: Document the adopted ARI data in the hydrological calculations to the sample summary sheet in the *Handbook*.

Catchment area

Extent: To the *Handbook*.

Alternative: If the catchment area is not defined in the *Handbook*, determine the extent of the catchment area from current topographical mapping, aerial photographs or field survey.

Site inspection: Verify catchment boundaries by site inspection.

Catchment definition: To AGRD05 clause 4.5.3.

Record: Document the design to the **Catchment areas plan**.

Design variations: Consider potential changes to individual catchment areas due to the full development of the catchment, including changes in run-off coefficients and irrigation of areas effecting loss factors.

Catchment area land use: Establish catchment area land use on current available zoning information or proposed future zonings, where applicable.

Methods of analysis

Peak flows: Determine peak flows using Rational Method Calculations in conformance with ARR Book IV Section 1 and the requirements of this worksection.

Flow studies: Prepare flow studies including the following:

- A relevant range of ARI's for each sub-catchment.
- Calculation of total flows at junctions of existing drainage works.
- Assessment of allowable flows from catchment/sub-catchments for release to downstream areas or drainage systems.
- Assessment of release from dams/detention works affecting capacity of drainage works to avoid surcharge/inundation.

Run-off coefficients: To the *Handbook* for specific locations and zonings or ARR or AS 3500.3.

Record: Document details of adopted coefficients in the hydrological calculations summary sheet in the *Handbook*.

Percentage impervious: To the *Handbook* for specific locations and zonings or ARR.

Time of concentration

Time criteria: Conform to the following:

- Minimum time of concentration: 5 minutes.
- Maximum time of concentration in a urban area: 20 minutes unless sufficient evidence is provided to justify a greater time.

Flow time: If the flow path is through areas having different flow characteristics or includes property and roadway, calculate the flow time of each portion of the flow path separately.

Flow paths to pits: Show each collection pit on the catchment area plan for the fully developed catchment. Consider fencing, potential locations of buildings and changes to individual flow paths due to the full development of the catchment including proposed detention works.

Pipe and channel flow: Calculate pipe flow using the following formulae:

- Mannings formula: To AGRD05 clause 4.6.6 or AS/NZS 3500.3 Table 5.5.
- Colebrook-White formula (used in computer modelling where conduits are designed to act under pressure. HGL must not be above the surface level at any pit otherwise overflow will occur. Minimum freeboard: 150 mm): To AGRD05 clause 4.6.3 or AS/NZS 3500.3 Table 5.6.

Mannings roughness co-efficient ('n') for specific zonings: To the Handbook or ARR Book VII Section 1 Table 1.1 or AGRD05 Commentary 31 Table C31 1.

Modelling

Use of hydrological models or computer analysis is permitted provided the following requirements are met:

- Satisfy the requirements of ARR.
- Submit summaries of calculations.
- Submit details of all program input and output.
- Submit copies of the final data files.

3.5 HYDRAULICS

General

Design concept: To the ARR major/minor drainage concept as defined in AGRD05 and ARR Book VII.

Hydraulic grade line

Hydraulic grade line (HGL): Perform calculations to ARR.

Record: Document hydraulic calculations to the sample summary sheet given in the *Handbook* including the following:

- A summary of design calculations.
- Detailed drawings of the grade line.
- Listing of all programme input and output.

Downstream control: Adopt the appropriate downstream water surface level requirements from the following options:

- Known HGL level from downstream calculations including pit losses at the starting pit in the design event.
- If the downstream starting point is a pit and the HGL is unknown, adopt a level of 0.15 m below the invert of the pit inlet in the downstream pit.
- If the outlet is an open channel and the design storm is minor, the top of the outlet pipe is the downstream control.
- If the outlet is an open channel, the design storm is major and downstream flood levels are not known, the top of the outlet pipe is the downstream control.
- If the outlet is an open channel, the design storm is major and downstream flood levels are known, the downstream control is the ARI 100 years flood level.

Water surface limits: Limit the water surface in drainage pits as follows:

- Inlet pits: To 0.150 m below the gutter invert.
- Junction pits: To 0.150 m below the underside of the lid.

3.6 HYDRAULICS - MINOR SYSTEM CRITERIA

General

Gutter flow widths: Maximum 2.5 m for ARI 5 year event. Submit for approval for wider flow widths for roads with flat grades.

Conduit sizes: Minimum conduit sizes as follows:

- Pipes: 375 mm diameter.

- Box culverts: 600 mm wide × 300 mm high.

Velocity limits: Flow in stormwater pipelines as follows:

- Minimum: 0.6 m/sec.
- Maximum: 6 m/sec.

Pits

Pit location: To AGRD05 clause 2.2 and Commentary 14.

Spacing: In conformance with the following:

- Flow width:
  - . Minor systems: To AGRD05 Commentary 12 Table C12 1.
  - . Major systems: To AGRD05 Commentary 12 Table C12 2.
- Maximum recommended spacing of pits where flow widths are not critical: To the **Pit spacing table**.
- Inlet efficiency is not effected by adjacent inlet openings.
- Give preference to the location of drainage pits at the upstream side of allotments.

Types of pits: Provide other pits as follows:

- Access chambers: To enable access for maintenance.
- Gully pits: To provide drainage path into sections minimising overland flow.
- Junction pits: At changes in direction, grade, level or class of pipe.

Pit spacing table

	Pipe size (mm)	**Spacing (m)**
Generally	Less than 1200	100
	1200 or larger	150
In tidal influence	All	100

Inlet capacity: Kerb inlet lengths to side entry pits as follows:

- Preferred maximum: 3.0 m.
- Maximum 5.0 m where the grade is 10% or more.
- Maximum 4.0 m where the grade is less than 10%.

Pit capacities: To the following:

- The *Handbook*.
- Pit relationships in ARR Volume 1.
- (NSW) Roads and Traffic Authority *Model analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings*, with due allowance to inlet bypass due to grade, for grade inlet pits, and recognised orifice or weir formulae for sag inlet pits.

Allowable pit capacities: To the **Allowable pit capacities table**.

Allowable pit capacities table

Condition	**Inlet type**	**Percentage of theoretical capacity allowed**
Sag	Side entry	80%
Sag	Grated	50%
Sag	Combination	Side inlet capacity only Grate assumed completely blocked
Sag	'Letterbox'	50%
Continuous Grade	Side entry	80%
Continuous Grade	Grated	50%
Continuous Grade	Combination	90%

Hydraulic losses

Pit pressure change co-efficient 'K_e': To the *Handbook*. Consider the following:

- Allowable reduction due to benching.

- Any approved bends, clashes with existing sewer mains.
- Ensure computer program default is consistent with the *Handbook*.

Record: Document the chart adopted and relevant co-efficients to the hydraulic summary sheet included in the *Handbook* and on the final design drawings.

Bends: Before detailed design, submit for approval any use of bends. Include the explanation.

Service entry requirements: For roof and subsoil pipes from private properties entering Council's system, conform to the following:

- All pipe inlets enter the main pipe system at junction pits.
- Flush, grouted junction pipes in the pit wall.
- Smaller inlets: Break into the drainage pipes for interconnection with the main line, finish flush and grout the sideline into the main line.

Pipe junctions: Submit for approval where a junction without an inlet structure is required. Include the pressure change co-efficients K_u for the upstream pipe and K_l for the lateral pipe determined from the *Handbook.*

Contraction/expansion: Do not transition from larger upstream to smaller downstream pipes. Submit for approval where required, including the detail for pit benching for smooth flow transition. Determine losses in expansion and contraction from the *Handbook.*

Pipe friction: Design drainage pipe systems as an overall system including upstream and downstream systems, not as individual pipe lengths.

Drainage pipeline systems: Design as gravity systems flowing full at design discharge. Pressurise with the use of appropriate pits and joints.

Pipe friction losses and pipe sizes: In relation to discharge, calculate using the Colebrook-White formula and roughness co-efficients to AS 2200.

3.7 HYDRAULICS - MAJOR SYSTEM CRITERIA

General

Surcharging: Do not permit any surcharging of drainage systems where the water depth is above the top of kerb, except for the following:

- Storm frequencies greater than ARI 20 year event and only across the road centreline where the road pavement is below the natural surface of the adjoining private property.
- Submit details for approval for flow across footpaths, providing there is no flooding of private property.

Velocity/depth criteria: Consider safety of children and vehicles in the design of velocity $\times$ depth product flow across the footpath and within the road reserve. Conform to the following:

- Maximum depth of water: 0.2 m.
- Maximum velocity $\times$ depth product: 0.4 m^2/s.
- Maximum velocity $\times$ depth product (where the safety of only vehicles can be affected): 0.6 m^2/s.
- Child safety: Address the requirements for safety in relation to children by providing safe egress points from any channel.

Freeboard: Design for minimum freeboard for floor levels and levee bank levels from flood levels in roadways, stormwater surcharge paths and open channels as follows:

- Roadways:
  - 0.3 m between the 100 year flood level and floor levels on structures and entrances to underground car parks. A higher freeboard may be required in certain circumstances.
  - 0.1 m freeboard between the ponding level of water in the road and the high point in the footpath if the road is in fill or overtopping of kerbs and flow through properties may occur. Driveway construction in these instances needs to consider this requirement.
- Stormwater surcharge paths: 0.3 m between the 100 year flood level and floor levels on structures and entrances to underground car parks.
- Open channels: 0.5 m between the 100 year flood level and floor levels on structures and entrances to underground car parks.

Fixing of roadway reserve capacity flows: Calculate roadway reserve capacity flow for each carriage way used in the catchment and apply storage correction for each type to AGRD05 clause 4.5.3.

Roadway capacities: To the *Handbook* and Council's standard road designs. For other road designs, calculate flow capacities of roads using ARR with the flow adjustment factors to the *Handbook*.

Open channels

Design open channels: To ARR and the following:

- Contain major system flow less any flow in the minor system allowing for blockage of the minor system.
- Open channels are permitted as follows:
  - Where they form part of the trunk drainage system.
  - Designed for smooth transitions with adequate access provisions for maintenance and cleaning.
  - To convey flows from a works site to the receiving water body, only if Council has approved the use of an open channel.

Channel roughness: Determine friction losses in open channels using Mannings 'n' values to the **Specific channel type 'n' values table**.

Safety of persons: If the product of average velocity and average flow depth for the design flow rate is greater than 0.4 m^2/s, design in conformance with ARR and Council's standard documentation to specifically provide for the safety of persons who may enter the channel.

Side slopes on grassed lined open channels:

- Prefer 6H:1V.
- Maximum 4H:1V.

Channel inverts: Minimum cross slopes of 20H:1V.

Low flow provisions in open channels (man-made or altered channels): Contain flows within a system or concrete lined channel section at the invert of the main channel.

Subsurface drainage: Design subsurface drainage in grass lined channels to prevent waterlogging of the channel bed.

Width of the drain invert: Equal to the width of the concrete lined channel section or at least to accommodate the full width of a tractor.

Hydraulic jumps: Design transition in channel slopes to avoid or accommodate any hydraulic jumps without generating erosion.

Specific channel type 'n' values table

Channel type	**'n'**
Concrete pipes or box sections	0.011 – 0.012
Concrete (trowel finish)	0.012 – 0.015
Concrete (formed without finishing)	0.013 – 0.018
Sprayed concrete (gunite)	0.016– 0.020
Bitumen seal	0.018
Bricks or pavers	0.014– 0.016
Pitchers or dressed stone on mortar	0.015– 0.017
Rubble masonry or random stone in mortar	0.020– 0.035
Rock lining or rip-rap	0.025– 0.030
Corrugated metal	0.020– 0.033
Earth (clear)	0.018– 0.025
Earth (with weeds and gravel)	0.025– 0.035
Rock cut	0.035– 0.040
Short grass	0.030– 0.035
Long grass	0.035– 0.050

3.8 MAJOR STRUCTURES

Design criteria

Design ARI: Design all major structures in urban areas, including bridges and culverts for 100 year ARI storm event without afflux.

Afflux and upstream inundation: Permitted, provided the increased upstream flooding is minimal and does not inundate private property.

Minimum clearance for passage of debris without blockage: 0.3 m between the 100 year ARI flood level and the underside of the superstructure.

Minimum floor levels of dwellings: Freeboard 0.5 m above the 100 year ARI flood level in the basin.

Routing: Model flood routing to ARR.

Pipe and culvert bedding: Design to minimise permeability and provide cut off walls and anti-seepage collars where appropriate.

Harvesting: Design stormwater harvesting options in locating diversion or detention systems.

Culverts

Design culverts (either pipe or box section): To the *Handbook* and consider the following:

- Inlet and exit losses.
- Inlet and outlet control.
- Scour protection.

Basins

Critical storm duration: For each ARI, consider a range of storm events to determine the critical storm duration, the peak flood level and discharge from the retarding basin. Provide a graph showing the range of peak flood levels in the basin and peak discharges from the basin for the storms examined.

Storm patterns: Adopt storm patterns given in ARR and check the sensitivity to storm pattern by reversing the storm patterns.

Public safety issues: Design for the following:

- Side slopes: Flatter than 6H:1V to allow easy egress.
- Handrails required: Where steeper than 4H:1V to assist in egress.
- Water depths: Maximum 1.2 m in the 20 year ARI storm event. Submit for approval greater depths including the design of safety refuge mounds.
- Document depth indicators for maximum depth in the basin.
- Protection for the low flow intake pipe to reduce hazards for any person trapped in the basin and prevent blockages.
- Document signage of the spillway to indicate the hazard.
- No ponding of water on private property or roads.
- No planting of trees in basin walls.
- No basin spillway located directly upstream of urban areas.

Stilling basin dissipaters: Provide appropriate dissipaters at high velocity outlets to prevent erosion.

High level outlet: Capacity capable of containing a minimum of 100 year ARI flood event.

Hazard category: Determine the hazard category to ANCOLD *Guidelines on acceptable flood capacity for dams.*

Check: Additional spillway capacity requirement due to the hazard category of the structure.

Spillway design: To **Open channels**.

Salinity prevention: Design basins to prevent surface drainage water leaking to the subsurface, recharging groundwater in areas known to be affected by high water tables and/or salinity of ground water. Conform to the requirements of the land and water resources authority for salinity levels where discharging to natural watercourses.

Basin location: Locate basins for stormwater detention, stormwater treatment or sedimentation purposes to avoid areas that are known permanent or seasonal groundwater discharge areas to reduce recharge into the groundwater.

Pipe systems: Design the pipe system to contain the minor flow through the retarding basin wall.

Outlet pipes: Provide rubber ring jointed with lifting holes securely sealed.

On-site stormwater detention

Stormwater detention: Required on work sites or redevelopment sites where under capacity drainage systems exist.

3.9 INTERALLOTMENT DRAINAGE

General

Requirement: Provide interallotment drainage for every allotment that does not drain directly to the frontage street or a natural watercourse. See the *Handbook*.

Easement: Contain interallotment drainage within an easement minimum 1.0 m wide and in favour of the upstream allotments.

Concentrated drainage: Design the interallotment drain to accept concentrated drainage from buildings and paved areas on each allotment for flow rates having a design ARI the same as the 'minor' street drainage system.

Impervious surface: Areas of impervious surface are assumed to contribute runoff to the interallotment drain to the **Runoff contribution to interallotment drains table**.

Runoff contribution to interallotment drains table

Development type	**% of lot area**
Residential (2a)	40
Residential (2b)	70
Industrial	80
Commercial	90

Pipes

Design requirement: Design pipes to flow full at the design discharge without surcharging inspection pits.

Minimum longitudinal gradient: 1%

Construction requirement: Design for pipes with rubber ring joints in conformance with the following:

- Fibre reinforced concrete pipes: To AS 4139.
- Precast concrete pipes: To AS/NZS 4058.
- PVC pipes: To AS/NZS 1254.
- Polypropylene pipes: To AS/NZS 5065.
- Buried flexible pipes: To AS/NZS 2566.1 and AS/NZS 2566.2.

Pits

General: Design and detail pits as follows:

- Locate interallotment drainage pits at all changes of direction.
- Detail concrete pits, with:
  - 100 mm thick walls and floor.
  - Minimum 600 × 600 internal plan dimensions.
  - 100 mm concrete lid finished flush with the surface of works.
- Depressed grated inlets are acceptable.
- For high water tables design, to resist flotation.

Sewer mains relationship

Interallotment drainage and sewer mains laid adjacent to each other: Provide space of 1.5 m between pipe centrelines (where the pipe inverts are approximately equal).

Disparity in level between inverts: Submit the spacing for approval.

Sewer mains in close proximity to interallotment drainage lines: Show on the interallotment drainage plan.

3.10 GROSS POLLUTANT TRAPS (GPT) AND SEDIMENT TRAPS

General

Locating a GPT/sediment trap: Determine the best location(s) for GPT(s)/sediment trap(s) and its catchment size in conformance with ARQ clause 8.4 and the following:

- Complementary with the strategic catchment treatment objectives.
- Topography.
- Available space.

- Proximity to pollutant source areas.
- Outlet approach: Use a single device to treat a whole catchment (up to 200 ha or more).
- Distributed approach: Target smaller individual catchments with many traps.
- Site constraints: Including topography, soils and geology, groundwater, space, access, odour problems, visual impacts, safety concerns and vermin.

GPT/sediment trap performance and type

Design: Determine the performance for GPT and sediment traps in conformance with ARQ clause 8.5 including the following:

- Treatment objectives: Define the objectives for the project e.g. Gross pollutants: Remove litter and vegetation larger than 5 mm. Sediment: Remove particles larger than 0.125 mm. e.g. Remove 90% of all material greater than 0.125 mm.
- Operating design flows: Select the design flow in conformance with ARQ chapter 7 e.g. 3 month ARI.
- Flood capacity: Analyse hydraulics of the drainage system including the headloss of the GPT and diversion weir under flood conditions. Check the design of the bypass system for impacts on the local drainage system and consequences on flooding.
- Trapped pollutant storage: Assess the pollutants that are likely to be collected and determine the holding capacity with respect to the maintenance operations and frequency.
- Maintenance requirements: Design the GPT for maintainability and operability including the following considerations:
  - Ease of maintenance and operation.
  - Access to the treatment site.
  - Frequency of maintenance.
  - Disposal.

Assessment of GPT performance: Include in the maintenance program requirements for validating the GPT performance by field monitoring, physical laboratory models or computer simulation.

Selection of the GPT: Design the GPT with consideration of the following and the checklist available in ARQ Appendix 8A:

- Life cycle costing.
- Footprint and depth of the unit.
- Hydraulic impedance and requirements.
- Disposal costs.
- Occupational health and safety.

Hydrocarbon management: Where required, design and size water/oil separators or interception devices in conformance with ARQ clause 9.7.

3.11 CONSTRUCTED WETLANDS AND PONDS

General

Assess the treatment process: Determine the pollutant requirements in conformance with ARQ clause 12.3 and the following:

- Sedimentation.
- Filtration.
- Adsorption.
- Biological uptake.
- Pollutant transformation.
- Pollutant storage.

System design: Design the system in conformance with ARQ clause 12.4 and 12.5 including the following:

- Hydrological effectiveness: Quantify the effects of the interaction between the following:
  - Volume of the detention system.
  - Hydraulic capacity of the outlet structure of the system.
  - Variability of runoff inflow to the system.

- Hydraulic efficiency: Control the flow patterns for uniform distribution throughout the system to provide optimal treatment on the inflow.
- Notional detention time: Select the design detention period.
- Facilitate and optimise water quality treatment processes.
- Locate ponds and wetland systems.
- Select treatment device or treatment train.
- Select wetland vegetation, fish or fauna.

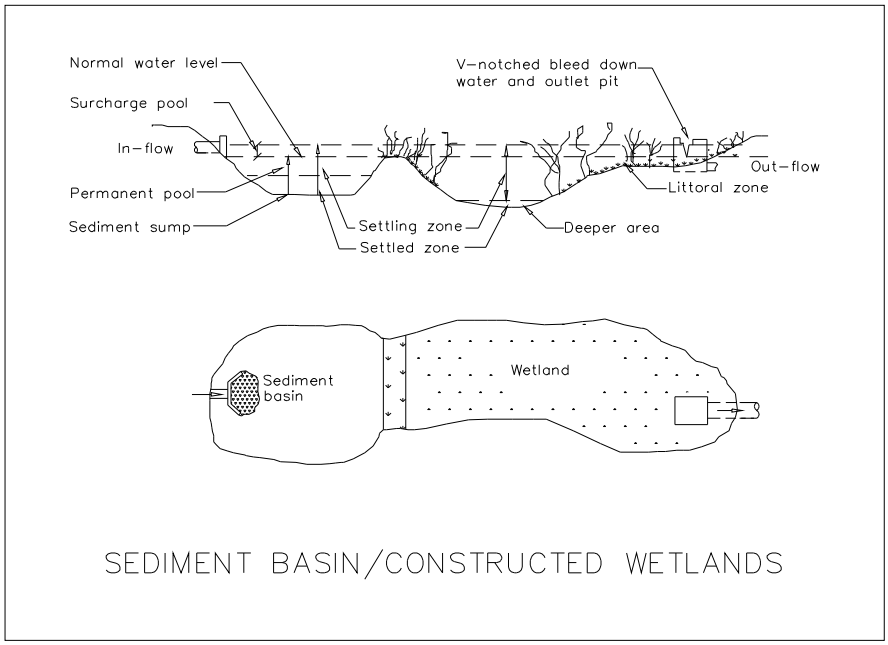


Figure - Sediment trap/constructed wetland

3.12 DETAILED DESIGN

Conduits

Pipe bedding and cover: Conform to the following:

- Reinforced and fibre reinforced concrete pipes: To AS/NZS 3725 or to the *Concrete Pipe Association of Australasia* (CPAA) publication *A rational approach to hydraulic design of pipe conduits* available from www.concpipe.asn.au.
- PVC pipes: To AS/NZS 2032.
- Polyethylene and polypropylene pipes: To AS/NZS 5065.
- Buried flexible pipes: To AS/NZS 2566.1. Submit for approval for use.

Location: Locate drainage lines in:

- Road reserves behind the kerb line and parallel to the kerb.
- Easements over private property centrally within the easement.

Bulkheads: Design bulkheads on drainage lines where the pipe gradient exceeds 5%, include details to address the size and position in the trench and the spacing along the line.

Pits

Bench: Design pits with benching to improve hydraulic efficiency and reduce water ponding.

Safety and safe access: Detail step irons and provide bicycle-safe grates.

Ventilation: Provide ventilation for pits and other confined structures requiring access for maintenance, inspection or repairs.

Stormwater discharge

Salinity prevention: Locate stormwater discharge to avoid recharging groundwater and creating or worsening salinity degradation of adjacent land.

Kerb and channel (gutter) termination: Extend kerb and channel (gutter) to drainage pit or natural point of outlet. Provide protection to prevent scour and dissipate the flow where outlet velocity is greater than 2.5 m/s or where the kerb and gutter discharge would cause scour.

Easements

Adjoining owners: Identify points of discharge of gutters or stormwater drainage lines or any concentration of stormwater on to adjoining properties. Where the discharge point is not to a natural water course or drainage depression the flow path must be contained in an easement in favour of the benefitting property(ies). If the stormwater discharge carrys any water from a Council owned area (Reserve or road) the easement must be in favour of Council.

Easement width:

- Minimum: 3.0 m.
- Overall: To contain the full width of overland flow or open channel flow in the major system design event.

Other authorities' requirements: Where drainage discharge is under the control of another statutory authority, e.g. public works, conform to the design requirements of that statutory authority.

Recreation reserves: For piped stormwater drainage discharging to recreation reserves, conform to the following:

- Discharge through an outlet structure to a natural water course.
- Direct to the nearest trunk stormwater line.

Trench subsoil drainage

Subsoil drainage in pipe trenches: If pipe trenches are backfilled with sand or other pervious material, provide the following:

- 3 m length of 100 mm diameter agricultural pipes, butt jointed with joints wrapped with geotextile, or slotted PVC pipe of subsoil drain in the bottom of the trench immediately upstream from each pit or headwall.
- Seal the upstream end of the subsoil drain with cement mortar, and the downstream end to discharge through the wall of the pit or headwall.

Durability

Requirement: Design for the service life of the drainage system including the following:

- Thickness and type of base material of drainage structures including pipes and culverts.
- Life expectancy of the coating.
- pH and resistivity of water and backfill material.
- Presence of impurities such as chloride, sulfate and aggressive CO_2 in the groundwater or soil.

Geotechnical NATA test: Determine the pH and resistivity of water and soil in conformance with AS 1289.4.3.1 and AS 1289.4.4.1.

Test for concentration of impurities: Carry out groundwater or soil extract testing for chloride, sulfate and aggressive CO_2. Testing to conform with AS 1289.4.2.1.

3.13 BUFFER STRIPS, VEGETATED SWALES AND BIORETENTION SYSTEMS

Buffer strips

Urban catchments: Design for grassed areas to direct runoff from adjoining impervious areas to the stormwater discharge location.

Design: Consider the following:

- Maximum slope: 5%.
- Maximum velocities: 0.4 m/s.
- Usage of flow spreaders.
- Vegetation density.
- Distribution/spread of stormwater over the buffer strip.
- Prevention of the formation of rills through properly designed entry conditions and vegetation.
- Design vegetation: Conform to ARQ clause 10.3.

Vegetated swales

Location: At any point of the flow including the following:

- Applied to the top of a catchment: Serve minor drainage requirements.
- Applied further downstream: Generally will require a parallel underground pipe network.

Geometry: Trapezoidal or parabolic shapes.

Side slopes: No steeper than 1V:3H.

Longitudinal slope: 1 – 4%. If greater or less than 1 – 4%, conform to the following:

- Slopes greater than 4%: Design for check dams.
- Slopes less than 1%: Design for under drains.

Maximum swale width: 2.5 m.

Maximum flow velocity: Conform to the following:

- For 1 year ARI: 0.5 m/s.
- For 100 year ARI: 1.0 m/s.

Mannings 'n' value:

- For flow conditions where depth of flow is below the height of the vegetation: 0.15 to 0.3.
- For 100 year event: approximately 0.03.
- Design vegetation: Conform to ARQ clause 10.4.2.

Bioretention systems

Requirement: Design the bioretention system of 2 or 3 subsurface layers including:

- Base or drainage layer.
- Transition layer.
- Filtration layer.

Design vegetation: To complement the landscape of the area. Conform to ARQ clause 10.5.1.

3.14 INFILTRATION SYSTEMS

General

Requirement: Design infiltration and aquifer recharge systems: Submit calculations demonstrating the effectiveness of the infiltration device for successions of storms and hydrological effectiveness to ARQ clause 11.4.

System design: Conform to ARQ clause 11.3.4 for the following:

- Unsuitable soils: Test solis for permeability and assess for suitability.
- Clearance distances to building footings and boundaries: Conform to ARQ clause 11.3.1 with regard to the soil classification.
- Rock and shale: Test for permeability and assess for suitability.
- Shallow soil cover over rock: Test for permeability and assess geology for weathered or fractured rock.
- Steep terrain: Check soil depth on a downslope and assess suitability.
- Watertable interaction with infiltration systems: Check watertable stability and salinity for suitability and the presence of any aquifers that may interact.
- Watertable effected by upstream infiltration devices: Assess geology for any likely upstream infiltration devices that may limit retention.
- Aquifer recharge/retrieval annual balance: Assess for continual equilibrium of local potentiometric levels.
- Water quality inflows to infiltration devices: Provide treatment is required for all water running directly into soakaways in conformance with ARQ clause 11.2.3.

Flood control: Design on-site storage for flood control to ARQ clause 11.6.

Constructed wetlands and ponds: Design hydrological effectiveness and location of wetlands or ponds to ARQ chapter 12.

4 DOCUMENTATION

4.1 GENERAL

Approvals
Authorities: Document the approval conditions established by the appropriate authority which form the basis of the design.

Design reports
A design report containing all assumptions and design parameters use in the design must be furnished to Council prior to issue of the construction certificate. The design report must demonstrate compliance with Council's criteria.

Calculations
Design: Provide a design report incorporating the criteria, computer studies, calculations and references supporting the design.

Specifications
Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11, 13, 14-18.

Design certification
Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS

General
Requirements: Provide drawings and/or computer output defining the works and assumed operating and maintenance procedures.

Catchment areas plan
Catchment area drawings: Provide drawings showing the following:
- For any variation: Submit for approval.
- Scale 1:1000 or 1:5000.
- Contour interval: 1 – 2 m (closer if the area is very flat).
- Grade direction for kerb and gutter.
- General layout of the drainage system with pit locations.
- Catchment limits.
- Any other information necessary for the design of the drainage system.

Drainage system layout
Drainage system layout drawings: Provide drawings showing the following:
- For any variation: Submit for approval.
- Scale 1:500.
- Drainage pipeline location.
- Drainage pit location.
- Number and road centreline chainage.
- Size of opening.
- Drainage easements.
- Reserves and natural water courses.
- Location of buffer strips, vegetated swales and bioretention systems.
- Location and details of infiltration systems.
- Any other information necessary for the design and construction of the drainage system.
- If appropriate, combine with the road layout plan.

Longitudinal section
Drainage system longitudinal sections: Provide drawings showing the following:
- For any variation: Submit for approval.
- Horizontal scale: 1:500.

- Vertical scale: 1:50.
- Pipe size, class and type.
- Pipe support type to AS/NZS 3725 or AS/NZS 2032.
- Pipeline and road chainages.
- Pipeline grade.
- Hydraulic grade line.
- Any other information necessary for the design and construction of the drainage system.

Open channels

Open channel cross sections: Provide drawings showing the following:

- For any variation: Submit for approval.
- Scale: 1:100.
- The direction of the view of cross sections, normally downstream.
- Reduced levels to Australian Height Datum (AHD).
- Provide a data input file for the design flow rates.

Other

Detailed drawings: Provide details including standard and non-standard pits and structures, pit benching, open channel designs and transitions to scales appropriate to the type and complexity of the detail being shown.

Easements for subdivision: Submit witnessed letters by the landowners in agreement of any increased flood levels on their property or other adverse effects to their property. Prior to issue of the subdivision certificate, create any required easements.

Submit hydrology and hydraulic summary sheets: To the *Handbook*.

Computer data files and output: Submit final hydrological and hydraulic computer data files.

Landscape plans and planting plans: For inclusion of buffer strips, vegetated swales and bioretention systems.

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

5 ANNEXURE

5.1 ANNEXURE A – COUNCILS HANDBOOK FOR DRAINAGE DESIGN CRITERIA

Record of design requirements

General: The following table outlines the design criteria referenced in this worksection and available in Councils *Handbook for drainage design criteria (Handbook)*.

Council's Handbook for drainage design criteria table

Design requirements	**Worksection clauses**
Design IFD rainfalls for specific locations and individual zonings	**HYDROLOGY / Design rainfall data**
Average recurrence interval (ARI)	**HYDROLOGY / Analysis**
Percentages impervious for specific locations and individual zonings	**HYDROLOGY / Analysis**
Run-off co-efficients for specific locations and individual zonings	**HYDROLOGY / Analysis**
Sample summary sheet for hydrological calculations	**HYDROLOGY / Alternative models and computer analysis**
Sample summary sheet for hydraulic calculations	**HYDRAULICS / Hydraulic grade line**
Pit capacities	**HYDRAULICS / Pits**
Pressure change co-efficient 'K_e' charts	**HYDRAULICS / Hydraulic losses**

Design requirements	**Worksection clauses**
Allowable reductions in 'K_e' due to benching	**HYDRAULICS** / **Hydraulic losses**
Pit pressure change co-efficients at bends	**HYDRAULICS** / **Hydraulic losses**
Chart for pressure change co-efficient K_p	**HYDRAULICS** / **Hydraulic losses**
Junction pressure change co-efficients K_l and K_u chart	**HYDRAULICS** / **Hydraulic losses**
Sudden expansion and contraction losses	**HYDRAULICS** / **Hydraulic losses**
Road capacity charts and flow adjustment factors to Tech Note 4 Book 14 of ARR 1987	**HYDRAULICS** / **Major system criteria**
Culvert Design Charts—inlet and exit losses, inlet and outlet control and scour protection	**MAJOR STRUCTURES** / **Culverts**
Inter allotment drainage requirements	**INTER ALLOTMENT DRAINAGE** / **General**

0075 CONTROL OF EROSION AND SEDIMENTATION (DESIGN)

1 GENERAL

1.1 RESPONSIBILITIES

Objective
General: Provide control of erosion and stormwater management systems design and documentation incorporating all reasonable and practicable measures to prevent or at least minimise environmental harm.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- *0010 Quality requirements for design.*
- *0074 Stormwater drainage (Design).*
- *0167 Integrated management*.
- *0257 Landscape – Roadways and street trees.*
- *1102 Control of erosion and sedimentation (Construction).*
- *1111 Clearing and grubbing.*

1.3 REFERENCED DOCUMENTS

Other publications
General: The following documents are incorporated into this worksection by reference:

Department of Sustainability, Environment, Water, Population and Communities

DEWHA 2002 Introduction to urban stormwater management in Australia.

Engineers Australia

ARQ 2006 Australian runoff quality: a guide to water sensitive urban design.

International Erosion Control Association

IECA 2008 Best practice erosion and sediment control for building and construction sites Books 1 to 4.

1.4 STANDARDS

General
Standard: To IECA Best practice erosion and sediment control for building and construction sites Books 1 to 4.

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the abbreviations given in IECA Book 3 Appendix N and those below apply:
- ARI – Average Recurrence Interval.
- DECCW: Department of Environment, Climate Change and Water.
- DEWHA: Department of Sustainability, Environment, Water, Population and Communities.
- EMP: Environmental Management Plan.
- ESCP: Erosion and Sediment Control Plan.
- GPT: Gross Pollutant Trap.
- IECA: International Erosion Control Association.
- SWMP: Stormwater Management Plan.
- WSUD: Water Sensitive Urban Design.

Definitions

General: For the purposes of this worksection the definitions given in IECA Book 3 Appendix N and below apply:

Catchment: A topographically defined area drained by a stream such that all outflow is directed to a single point.

Clean water: Water that is one of the following:

- Water that enters the property from an external source and has not been further contaminated by sediment within the property.
- Water that has originated from the site and does not require treatment to reach water quality standard.
- Water that would not be further improved if it was to pass through the sediment trap for the sub-catchment.

Dirty water: Water not classified as clean water.

Drainage control measures: Temporary management of stormwater during construction and building phase to prevent or reduce soil erosion caused by concentrated flow, including the management of rill and gully erosion and to appropriately manage the movement of clean and dirty water through the site.

Erosion and sediment control: The adoption of drainage, erosion and sediment control measures.

Erosion control measures: Measures to prevent or reduce soil erosion caused by raindrop impact, sheet flow (i.e. the control of splash and sheet erosion) and runoff from construction sites.

Microclimate: Small microclimates can be generated by a dense stand of tree's, a deep gully, or a meander in a creek channel and can significantly influence the success of a design.

Sediment control measures: Measures to trap and retain sediment that is either moving along the land surface (bed load) or contained within flowing water (suspended sediment).

Subcatchment: A topographically defined area drained by a tributary or branch drain of a primary stream or main drain draining catchment.

2 PRE-DESIGN PLANNING

2.1 CONSULTATION

Council and other Authorities

Data collation: For input into the documentation listed, consult with the appropriate authorities:

Procure approvals as required:

- Development approval certification: Bellingen Shire Council

2.2 CONTROL OF EROSION PLANNING

Planning phase

Requirement: Document the following planning phase activities:

- Data collection including soil testing and site constraints: Align extent with the potential environment risk and the complexity of the soil disturbance.
- Site hazard assessment.
- Conceptual ESCP.

Data collection

Requirement: Assess available soil data to carry out the following actions:

- Assess the erosion risk and/or environment of the site.
- Identify potential soil problems such as unstable, dispersive or acid sulphate soils.
- Assist in the selection, design and operation of various drainage, erosion and sediment control measures.
- Assist in the design of site revegetation.
- Identify necessary soil treatments to facilitate site revegetation.
- Identify non-erodible areas which may be preferred diversion routes.

Site hazard assessment

Requirement: Identify high risk areas including the following:

- Areas with high potential for soil loss.
- Areas with high potential to cause environmental harm.
- Areas located within or within close proximity to critical habitats such as wetlands, creeks and waterways.

Identify: High risk construction activities including the following:

- Activities which disturb natural wetlands or flowing streams.
- Activities which disturb threatened species, habitats or environmental values.
- Activities which disturb protected vegetation.
- Activities with the potential to cause significantly more soil loss and/or environmental harm when compared to alternative construction practices.

Conceptual erosion and sedimentation control plan (ESCP)

Requirement: Prepare a Concept ESCP if any of the following applies to the site:

- Average slope of proposed land disturbance > 10%.
- Required for planning negotiations.
- High risk areas identified.
- High risk construction identified.
- Emerson class 1 or 2 soils.
- Expected soil disturbance > 6 months.
- Expected soil disturbance > 1 ha.
- Earthworks or construction within a natural water course.
- Complete the erosion hazard assessment form in IECA Book 2 Appendix F for evaluating any requirement for a concept ESCP.

Submission: Submit the Concept ESCP for approval prior to detailed design work. Identify the following:

- Specific requirements for soil data.
- Site constraints.
- Feasibility of construction while protecting the environment.
- Any requirements for sediment basins on site.
- Adequate space for construction and operation of major sediment traps and essential flow diversion systems.
- Problem soil areas including dispersive soils, acid sulphate soils, areas of potential mass movement.
- Protected environmental features.

3 DESIGN

3.1 DESIGN CRITERIA

Site planning

Site planning checklist: Assess the site in conformance with the Site planning checklist in IECA Book 1 clause 3.6.

Sub-catchments: List the data available for each sub-catchment affected by the construction and include the following:

- Contour plans.
- Soil types.
- Vegetation.
- Salinity.
- Natural water courses, swamps, springs and artesian features.

Pollutant characteristics: Assess the storm flow quality for pollutant characteristics to ARQ clause 3.4. Include an assessment of possible sedimentation transportation from vehicles leaving the site.

Sequential control measure: Prepare criteria for the integration of sequential control measures with construction schedules for the site works.

Protection measures: Document and provide for the following requirements:

- Evaluate the existing buffer zones protecting the site.
- Identify sensitive natural and indigenous features for protection.
- Fencing and isolation measures to protect features including habitats.
- Temporary drainage works to allow diversion through works in progress.
- Determine flow capacities or temporary detention works by reference to the Stormwater Management Plan in conformance with *0074 Stormwater drainage (Design)*.
- Time-zoned documentation of sub-catchment works to minimize risk of uncontrolled erosion for the recurrence interval matching the construction period exposure.

Development planning

Requirement: Minimise the risk of erosion within downstream waterways. Take all reasonable and practicable measures to minimise changes to the volume, frequency, duration and velocity of stormwater runoff effecting the natural water cycle.

Erosion and sediment control techniques and practices: To IECA and the following:

Development planning requirement: Submit the following information:

- A catchment map defining sub-catchment boundaries.
- The preferred location and area requirements of major sediment traps such as sediment basins and whether they can be permanently incorporated into the stormwater management system. e.g. Detention basin or wetland.

Modelling

Site evaluation tools: If required, use the appropriate mapping tools to determine the risks and hazards that may occur in erosion control as follows:

- Urban capability mapping.
- Erosion risk mapping.
- Erosion hazard assessment.

Site constraints

Soil limitations: Provide a soil survey identifying the existence of any problematic soils and the recommended soil treatment and management technique. Consider IECA Book 2 Appendix C.

Topographic limitations: Minimise land reshaping and identify potential limitations due to topography on the development design and layout including the following:

- Costal and intertidal areas: Identify and provide protection as required. Mitigate the potential for acid sulphate soil, dunal systems, wind erosion, wave refraction/reflection, marine plants and coastal buffer zones.
- Drainage problem areas: Identify and avoid the potential for salinity problems, soil moisture and advise groundwater levels, and decrease of flood storage volume.
- Existing erosion problems: Identify the potential to aggravate existing erosion problems. Do not locate structures within 3H:1V from the toe of a watercourse bank.
- Flood prone land: Provide dynamic flood modelling to identify potential impacts of filling flood prone land. Place sediment basins and other major sediment traps above the 1 in 5 year ARI flood level.
- Land prone to mass movement erosion: Identify the potential for landslip or landslide. Consider the impacts of clearing within the past 5 years and in the future, removal of material from the toe of a steep slope, changes to the natural flow of groundwater on steep slopes, placing of load bearing fill or structures on unstable slopes, perched water tables, seepage zones, plastic clays or with visual features such as slip scars.
- Local microclimates or storm surges: Identify the potential for microclimates or storm surges and allow for the associated constraints in the design assessment.
- Rock outcrops: Identify areas of rock outcrops and shallow soil depths.
- Steep slopes: Provide effective drainage and erosion control. Ensure space is available for sediment control measure and identify slope instabilities. Limit vegetated final slopes to a vertical fall of 10 m between cross drainage systems. Avoid slab on ground construction near steep slopes.

- Waterways and wetlands: Stabilise existing bank erosion. Identify and protect essential riparian zones. Where required expand the waterway corridor for natural or induced channel erosion/expansion or stream migration. Do not locate structures within 15 m of the crest of a watercourse bank nor within the zone of 3H:1V gradient from the toe of a watercourse bank. Protect wetlands from sediment inflow.

Water limitations: Determine the expected seasonal water quality, quantity and supply cost. Allow for sediment basins where appropriate.

Vegetation limitations: Retain or rehabilitate critical areas, and select trees for preservation before locating roads, buildings and open works. Locate roadways, construction storage areas and parking bays away from the drip zone of preserved trees. Avoid excavation, traversing, filling, trenching within the drip zones of preserved trees. Identify preserved trees within the ESCP. Retain existing ground cover on slopes steeper than 10%. Retain deep rooted vegetation on slopes steeper than 20%. See IECA Book 2 Appendix C for further discussion.

Ecological limitations: Consult with the appropriate authorities for any limitations to type of erosion and control measures within the particular site. e.g. Fisheries authority for instream options.

Geotechnical investigations

Assessment report: Provide a soil assessment report in conformance with IECA Book 1 clause 3.5 and Book 2 Appendix C including the following:

- Integration of the development into the site.
- Integration of erosion and sediment control issues into site and construction planning.
- Development of effective and flexible ESCP based on anticipated soil, weather and construction conditions.
- Minimisation of the extent and duration of soil disturbance.
- Control of water movement through the site.
- Minimisation of soil erosion.
- Prompt stabilisation disturbed areas.
- Maximisation of sediment retention on the site.
- Maintenance of all ESC measures in proper working order at all times.
- Monitoring of the site and adjusting ESC practices to maintain the required performance standard.

3.2 DRAINAGE CONTROL

Design standards

Permanent drainage design: To *0074 Stormwater drainage (Design)*.

Temporary drainage works: Design all temporary drainage works in conformance with IECA Book 1 Table 4.3.1.

ARI: 1 in 10 year

Technique selection

Flow diversion around soil disturbances: Provide for up-slope stormwater runoff where the up-slope catchment area exceeds 1500 m².

Design: Document drainage control techniques in conformance with IECA Book 1 clause 4.3, including the following:

- Spacing of lateral drains down long continuous slopes.
- Low gradient drainage.
- Drainage down slopes.
- Outlet structures for temporary drainage systems.
- Velocity control structures.
- Selection of channel and chute linings.
- Drainage controls on unsealed roads.
- Temporary watercourse crossings.
- ‘No access’ fenced areas for vegetation protection.

Techniques: Use symbols for documenting the various drainage techniques in conformance with IECA Book 1 clause 4.3. Alternatively adopt a technique schedule.

For various channel linings: Conform to IECA Book 2 Appendix A Tables A22 to A27.

Flow velocity: Where required, reduce the flow velocity by either:

- Reducing the depth of flow (increase the width of the channel).
- Reducing the bed slope.
- Reducing the peak discharge (reduce the effective catchment area or diverting water away from the channel).
- Increasing the channel roughness.
- At all times when reducing the flow velocity the flow capacity must be maintained.

Hydraulic capacity: Design drainage channels with sufficient gradient and surface conditions to limit the maximum flow velocity to a value not exceeding the maximum allowable flow velocity for the given surface material.

Considerations for technique selection

Sandbags: Use for shallow drains of depth < 500 mm.

Rock check dams: Use for deep drains of depth > 500 mm.

Track drainage: To IECA Book 3 Appendix K4.

Stripped topsoil: Where possible re-use stripped topsoil to form flow diversion banks up-slope of the soil disturbance.

Watercourse crossings: Filter runoff through surrounding grass or bush land before it enters streams.

Temporary culvert crossings: Limit the head loss across the structure to < 300 mm at the point when over topping first begins to occur.

Divide into areas: Divide any long slope of disturbed or unstable soil into smaller areas to prevent or minimise rill erosion.

Fish passage at temporary culvert crossings: Provide for minimum flow area of 80% of normal channel cross sectional area below the crest of the crossing. Conform to Fisheries Management Act.

Dispersive soils: Show details for stabilising dispersive soils.

Scour protection: Provide scour protection to all stormwater outlets, chutes, spillways and slope drains to dissipate flow energy and minimise soil erosion risk.

3.3 EROSION CONTROL

Design standards

Erosion control risk assessment: Determine the erosion control risk in conformance with IECA Book 1 clause 4.4 in terms of the following factors:

- Monthly rainfall erosivity: IECA Book 1 Table 4.4.1.
- Monthly rainfall depth: IECA Book 1 Table 4.4.2.
- Estimated soil loss rate: IECA Book 1 Table 4.4.3.
- Monthly rainfall by town: Conform to IECA Book 1 Table 4.4.4.
- Queensland average monthly rainfall depth by town: Conform to IECA Book 1 Table 4.4.5 and Table 4.4.6.

Technique selection

Best practice land clearing and rehabilitation requirements: Document any best practice requirements in conformance with IECA Book 1 Table 4.4.7.

Techniques: Use the symbols for documenting the various control techniques in conformance with IECA Book 1 clause 4.4. Alternatively provide a technique schedule.

Design: Document erosion control techniques in conformance with IECA Book 1 clause 4.4., including the following:

- Soil stabilisation and protection.
- Mulching.
- Erosion control blankets.
- Control of soil erosion on slopes.
- Dust control techniques.
- Stabilisation of major drainage channels and watercourses.

Protect from raindrop impact erosion: Lightly mulch grass seeded areas immediately after seeding.

Prevent soil crusting: Mulch to insulate the soil against rapid temperature changes to IECA Book 2 Appendix C.

Disturbed areas water course: Extend revegetation into the water to link aquatic and riparian habitats. Stabilise by rock protection during plant establishment, to IECA Book 3 Appendix I clause 7.10.

3.4 SEDIMENT CONTROL

Design standards

Sediment control standard: To IECA Book 1 Table 4.5.1 for soil loss rate limit.

Classification of sediment traps: Type 1, 2, or 3 to IECA Book 1 Technical note 3.1 and Table 4.5.5.

Classification of sediment control techniques: To IECA Book 1 Table 4.5.3 and Table 4.5.4.

Design storm for sediment traps: 0.5 times the 1 in 1 year ARI peak discharge.

Technique selection

Design: Document sediment control techniques in conformance with IECA Book 1 clause 4.5, including the following:

- Sediment control measure in areas of sheet flow.
- Sediment controls at kerb inlets.
- Sediment control at field (drop) inlets.
- Sediment control measures in areas of minor concentrated flows.
- Sediment control structures in areas of concentrating flow.
- Sediment traps at pipe and culvert inlets.
- Sediment traps at temporary stormwater outlets.
- Dewatering sediment control measures.
- Sediment controls at entry/exit points.
- Also see DEWHA Chapter 8 on sediment and erosion control.

Sediment runoff: Collect and retain wholly within the work site. Trap prior to entry onto a road surface.

Sediment runoff originated from the road surface: Prevent sediment entering a sealed (e.g. hard lined) drainage system or permanent drainage system (e.g. piped or open channel drain).

Sediment controls within or adjacent roadside stormwater outlets: Provide for gully bags in preference to sag and on-grade kerb inlet sediment traps.

Kerb inlet sediment traps: Adopt the requirement for Type 1, 2, 3 sediment traps up-slope of all stormwater inlets as required by the **Design standard**.

Temporary stormwater outlet sediment traps: Locate downstream of the influence of outlet “jetting” (10-13 x pipe diameters downstream of the outlet).

Instream sediment traps: To IECA Book 3 Appendix I.

Location: Locate sediment traps in conformance with the following:

- Trap sediment as close to the source as possible wholly within property boundaries.
- Sediment trap: Divert clean water around sediment traps in a manner that maximises the sediment trapping efficiency. Where required, use the checklist for selecting a GPT in ARQ clause 8.9.
- Sediment: Protect adjacent properties and downstream environments from the adverse effects of sediment and sediment laden water discharged from the site.
- Environmental protection: Do not rely solely on sediment control measures.
- Straw bales as sediment traps: Do not use unless the site conditions prevent the use of other more appropriate sediment control systems.

3.5 STOCKPILE MANAGEMENT

General

Location: Indicate the location of stockpiles in conformance with the following:

- Clear of existing or proposed drainage works.
- Clear of areas likely to be disturbed during construction.
- Clear of the drip zone of trees.
- On reasonably flat areas.

Topsoil stockpiles: Isolate topsoil from subsoil material in separate stockpiles.

Erosion control measures

Requirement: Divert up-slope stormwater around stockpiles in conformance with the following:

- During periods when rainfall is possible.
- Up-slope catchment area > 1500 m².
- Average monthly rainfall > 45 mm.

Protection: Protect sand and soil stockpiles from wind and rainfall to IECA Book 1 Table 4.6.1.

Sediment control measures

Down-slope of stockpiles: To IECA Table 4.6.2.

3.6 EROSION AND SEDIMENT CONTROL PLANS

Development of ESCP

Requirement: Provide an ESCP for the site in conformance with IECA Book 1 clause 5.3 and incorporating the following:

- Assessment: Consider local issues, concerns, site constraints and development approval conditions. Review the proposed development layout.
- Soil maps: Prepare soil maps for the site where appropriate to identify problems soils including dispersive and acid sulphate soils, define areas of sandy soils and clayey soils.
- Cut and fill plan: Prepare a cut and fill plan if not already completed.
- Locate traffic entry/exit points and specify control measures to *1101 Control of traffic*.
- Identify potential areas of non-disturbance.
- Locate and stabilise temporary construction roads and watercourse crossing.
- Divide the site into hydraulically manageable drainage areas and prepare construction drainage plans.
- Determine the required sediment control standard.
- Locate major sediment traps (including truck cleaning facilities where required).
- Review proposed staging of works.
- Control clean water runoff.
- Control flow velocities in drains.
- Control dirty water runoff.
- Control erosion on disturbed boundary.
- Establish sediment traps within the development.
- Define the final limits of disturbance.
- Prepare the site revegetation/rehabilitation plan.
- Prepare the installation sequence.
- Specify emergency ESC measure.
- Prepare the monitoring and maintenance program.
- Prepare inspection and test plans.
- Prepare the supporting documentation.
- Include technical notes.
- Assign a unique identification number to each ESC measure within the ESCP.

Erosion and sediment control plan checklist: Complete and submit the Erosion and sediment control plan checklist from IECA Book 1 clause 5.10.

Construction drainage plans

Disturbances > 1500 m²: Prepare construction drainage plans for each stage of the earth works, they can be submitted as part of the ESCP or separate showing the following:

- Flow entry and exit points.
- Areas of sheet flow and lines of concentrate flow (including all drainage channels).
- Sub-catchment boundaries.
- All permanent and temporary roads.

Technical notes
Conditions: Prepare technical notes that include directions to the Contractor in conformance with examples in IECA Book 1 clause 5.8 and incorporating the following:

- Land clearing.
- Site management.
- Maintenance of ESC measure, drainage, erosion and sediment.
- Watercourse management.
- Site rehabilitation.
- Vegetation management.
- Soil management including earthworks, topsoil and problematic soils.
- Dust control.
- Site inspection and monitoring.

Additional certification
Sites with a soil disturbance > 2500 m²: Provide certification by a professional engineer that the ESCP conforms to the following:

- Satisfies the intent and design/performance standards established by all relevant local state and federal policies relating to erosion and sediment control.
- Has been reviewed and approved for construction, soil science, hydrology/hydraulics and site revegetation/rehabilitation.

Certification by a hydrology and hydraulics professional engineer: Required for sites > 1 ha or where the ESCP incorporates a sediment basin.

Certification by a geotechnical specialist: Provide if ESCP incorporates a sediment basin with a constructed earth embankment with a height > 1 m.

4 DOCUMENTATION

4.1 GENERAL

Approvals
Conditions: Document the approval conditions advised by the appropriate authority which contribute to the basis for the design of erosion control measures.

Calculations
Requirement: Provide a design report incorporating the criteria, computer studies, calculations and references supporting the design and maintenance requirements.

Program
Recurrence interval storms: Provide drawings and/or computer output defining the works and the sequential program to minimise exposure to erosion from ARI storms.

Specifications
Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11, 13, 14-18.

Design certification
Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS

Drawing content
Drawings: Prepare to the minimum drafting requirements in *0160 Quality (Design)* and include the following as a minimum:

- Existing and final contours.
- Location of all earthworks including roads, areas of cut and fill and re-grading.
- Location of access haulage tracks and borrow pits.
- Location and design criteria of erosion and sediment control structures.
- Location and description of existing vegetation.

- Proposed vegetated buffer strips and 'no access' areas.
- Location of critical areas (vegetated buffer strips, drainage lines and structures, water bodies, unstable slopes, flood plains and seasonally wet areas).
- Type and location of diversion works that direct uncontaminated run-off around areas of future disturbance.
- Protection of channels and outfall zones.
- Revegetation program.
- Procedures for maintenance of erosion and sediment control.
- Details for staging of works.

Sample design

Guidance: Obtain example design details of water quality structures, sediment and erosion control devices from Council.

Erosion and sediment control plans

Conceptual ESCP scale: < 1:1000.

Erosion and sediment control plans: Include the following:

- North point and plan scale.
- Site and easement boundaries and adjoining roadways.
- Construction access points.
- Site office, car park and location of material stockpiles.
- Limits of disturbance.
- Retained vegetation including protected trees.
- General soil information and location of problematic soils.
- Location of critical environmental values (where appropriate).
- Existing site contours (unless the provision of these contours adversely impacts the clarity of the ESCP).
- Final site contours including locations of cut and fill.
- Construction drainage plans for each stage of earthworks, including land contours for that state of construction, sub-catchment boundaries and location of watercourses.
- General layout and staging of proposed works.
- Location of all drainage, erosion and sediment control measures.
- Full design and construction details (e.g. cross sections, minimum channel grades, channel linings) for all drainage and sediment control devices, including diversion channels and sediment basins.
- Site revegetation requirements (if not contained on a separate plan required to be submitted to Council).
- Site monitoring and maintenance program, including the location of proposed water quality monitoring stations.
- Technical notes relating to the following:
  - Site preparation and land clearing.
  - Extent, timing and application of erosion control measures.
  - Temporary ESC measures installed at end of working day.
  - Temporary ESC measures in case of impending storms, or emergency situations.
  - Installation sequence for ESC measures.
  - Site revegetation and rehabilitation requirements.
  - Application rates (or at least the minimum application rates) for mulching and revegetation measures.
  - Legend of standard symbols used within plans.
- Calculation sheets for the sizing of ESC measures.
- A completed Erosion and sediment control plan checklist to IECA Book 2 Appendix E.
- Any other relevant information Council may require to properly assess the ESCP.

0076 SEWERAGE SYSTEMS – RETICULATION (DESIGN)

1 GENERAL

1.1 RESPONSIBILITIES

Objective

Design requirement: Provide the design drawings and specification for the construction of a sewerage system to transport sewage or effluent from properties to the treatment plant or to a defined discharge point on an existing sewerage reticulation conforming to the requirements of WSA codes and the Water Agency as documented. Provide an appropriate point of connection for each individual property to meet consumer requirements. Designer responsibilities include the following:

- Translate the planning output into a detailed system/network design. Prepare design drawings compatible with the Water Agency's concept plan and the design parameters.
- Identify potential problems and provide appropriate solutions.
- Justify any variation from the requirements set out in this worksection or specified by the Water Agency.
- Obtain written approval from the Water Agency for any variation.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *0010 Quality requirements for design.*
- *0077 Sewerage systems – pump stations (Design)*

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

Standards

AS 1102-series	Graphical symbols for electrotechnical documentation (Various)
AS 1214-1983	Hot dipped galvanised coatings on threaded fasteners (ISO metric coarse thread series)
AS/NZS 1260:2009	PVC pipes and fittings for drain, waste and vent application
AS/NZS 1477:2006	PVC pipes and fittings for pressure applications
AS/NZS 1554	Structural steel welding
AS/NZS 1554.6:2012	Welding stainless steels for structural purposes
AS 1579-2001	Arc welded steel pipes and fittings for water and waste-water
AS 1646-2007	Elastomeric seals for waterworks purposes (Series)
AS 2129-2000	Flanges for pipes, valves and fittings
AS 2200-2006	Design charts for water supply and sewerage
AS/NZS 2280:2004	Ductile iron pipes and fittings
AS/NZS 2566	Buried flexible pipelines
AS/NZS 2566.1:1998	Structural design
AS 2832	Cathodic protection of metals
AS 2832.1-2004	Pipes and cables
AS 2832.2-2003	Compact buried structures
AS 2865-2009	Confined spaces
AS/NZS 3500	Plumbing and drainage
AS/NZS 3500.2:2003	Sewerage
AS/NZS 3518:2004	Acrylonitrile Butadienne Styrene (ABS) pipes and fittings for pressure applications
AS 3571	Glass filament reinforced thermosetting plastics (GRP) pipes – Polyester based – water supply, sewerage and drainage applications
AS 3571.2:2009	Pressure and non-pressure water supply (ISO 10639:2004, MOD)
AS 3680-2008	Polyethylene sleeving for ductile iron pipelines

AS 3681-2008	Application of polyethylene sleeving for ductile iron piping
AS/NZS 3725:2007	Design for installation of buried concrete pipes
AS 3735-2001	Concrete structures retaining liquids
AS 3735 Supp1-2001	Concrete structures retaining liquids - Commentary (Supplement to AS 3735-2001)
AS/NZS 3862:2002	External fusion-bonded epoxy coating for steel pipes.
AS 3879-2011	Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS and ASA pipes and fittings
AS 3996-2006	Access covers and grates
AS/NZS 4058:2007	Precast concrete pipes (pressure and non pressure)
AS 4060-1992	Loads on buried vitrified clay pipes
AS/NZS 4087:2011	Metallic flanges for waterworks purposes
AS/NZS 4129:2008	Fittings for polyethylene (PE) pipes for pressure applications
AS/NZS 4130:2009	Polyethylene (PE) pipes for pressure applications
AS/NZS 4158:2003	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS/NZS 4331	Metallic flanges
AS/NZS 4331.1:1995	Steel flanges
AS/NZS 4441-2008	Oriented PVC (PVC-O) pipes for pressure applications
AS/NZS 4765:2007	Modified PVC (PVC–M) pipes for pressure applications
AS 4799:2000	Installation of underground utility services and pipelines within railway boundaries
AS/NZS 5065:2005	Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
ASTM A276:2010	Standard Specification for Stainless Steel Bars and Shapes
BS EN 295	Vitrified clay pipes and fittings and pipe joints for drains and sewers
BS EN 295-1:1991	Requirements
BS EN 681	Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications
BS EN 681-1:1996	Vulcanized rubber
ISO 10467:2004	Plastics piping systems for pressure and non-pressure drainage and sewerage - Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin

Water Services Association of Australia (WSAA)

WSA 01-2004	Polyethylene Pipeline Code 2004 3rd edition Version 3.1
WSA 02-2002	Sewerage Code of Australia, 2nd Edition Ver. 2.3 Product and material information and guidance for sewerage code of Australia WSA 02-2002
WSA 03-2011	Water Supply Code of Australia, Version 3.1
WSA 04-2005	Sewerage Pumping Station Code
WSA 06-2008	Vacuum Sewerage Code of Australia Version 1.1 Parts 0-4 and WSA 06 Standard drawings CD
WSA 07-2007	Pressure Sewerage Code of Australia Version 1.1 Parts 0-4 and WSA 07 Standard drawings (CD)
WSA 109-2011	Industry standard for flange gaskets and o-rings
WSA 113-2002	Reinforced concrete pipes with flexible thermoplastic linings

Plastics Industry Pipe Association

POP 007-2006	Metal backing flanges for use with polyethylene (PE) pipe flange adaptors

Other publications

IPWEA

IIMM-2011	International Infrastructure Management Manual

Melbourne and Metropolitan Board Works

MMBW-1989 Hydrogen Sulphide Control Manual Volume 1 and 2

1.4 STANDARDS

General
Planning and design of sewerage system: To WSA 02 Parts 0, 1and 2.

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:

- AHBP: Allowable horizontal bearing pressure.
- CIOD: Cast iron outside diameter.
- EP: Equivalent population.
- ERS: Emergency relief system.
- FF: Full face.
- FSL: Finished surface level.
- GRP: Glass reinforced plastic.
- IBC: Inside bolt circle.
- ISO: International standards organisation.
- MH: Maintenance hole.
- NPV: Net present value.
- PN: Pressure class (number).
- SN: Stiffness class (number).
- SR: Spigot and recess.
- STEP: Septic tank effluent pump.
- TG: Tongue and groove.
- TMS: Terminal maintenance shaft.

Definitions
General: For the purposes of this worksection the following definitions apply:

- Concept plan: A package of information provided to the designer by the Water Agency to allow the appropriate planning/design of major sewerage system components to be performed. Designer: The person(s) responsible for a design output in accordance with the Water Agency's project brief, contract or development agreement.
- Document: Record of information in written or graphical form.
- Water Agency: An authority, board, business, corporation, Council or local government body with the responsibility for planning or defining, design, construction and maintenance requirements for a water supply and/or sewerage systems. This includes Local Water Utilities (LWU).
- Septicity: The prolonged retention of sewage under anaerobic conditions, particularly during low flow periods.

2 PRE DESIGN PLANNING

2.1 SYSTEM PLANNING

Sewerage system
Sewerage system strategy: Define the processes such as the transportation subsystem and the operating units for the design of a complete system.

Planning principles: Document the following:

- Concept plan: If setting out the initial inputs of catchment area, flows, average recurrence interval (ARI), sizing, upstream controls, recommended sewer layout and any other requirements is not provided by the Water Agency, develop the concept plan to WSA 02 clause 2.2.2 and obtain approval from the Water Agency.
- Concept design: Consider factors of life cycle planning, functionality, maintainability, reliability and due diligence in conformance with WSA 07 clause 2.1 to 2.5, WSA 06 clause 2.1 to 2.7, WSA 02 clause 1.4.2, and WSA 04 clauses 2.1 to 2.17.

- Pressure network: Consider additional information requirements including collection/pump unit type, discharge point, entrapped air management.
- Catchment analysis: Calculate the anticipated total design flow of both the proposed development and any future developments. Assess the adequacy of the existing system and determine the extent and sizing of the new sewer system with sufficient capacity to cater for all existing and predicted development within the area served. Determine catchment/ sub-catchment boundaries.
- Future gauging needs: Provide flow gauge network at overflow points, pumping stations and gravity subsystem outlets.
- Terrorism: Incorporate safeguards to minimise the risk and impact of terrorist attack.

Planning parameters: Document the following to WSA 02 clause 3.3:

- Loading for each serviced property: Use average loading rates as a basis for calculating future load assessments.
- Assessment of future loads.
- Assessment of existing system loads.
- Environmental considerations: Consider the environmental impact and conform to the local government environmental and heritage requirements.
- Geotechnical investigations: Engage a geotechnical engineer to assess if any special investigation is required for ground instability and ground water infiltration.
- Operation and maintenance considerations: Locate the sewers to provide safe and easy access for maintenance and condition assessment.
- Land use both current and future.
- Analyse for NPV.

Sewage quality: Document the following factors to maintain the sewage quality:

- Septicity: Determine adequate grades for self cleaning, reducing detention periods, avoiding any unnecessary turbulence at the pressure sewer delivery point, dosing or ventilation to minimise likelihood of septicity.
- Sewage quality/Trade waste management: Determine any trade waste programs to monitor and control the waste entering the system from commercial and industrial sources.

Planning review: Review the layout to WSA 02 clause 2.5.

2.2 SUBSIDISED SCHEMES

Funding

Government grant funds: If the works form part of a contract attracting government grant funds, identify the following:

- Items which are not of the least cost option, that:
  - . Are intended to have a much longer design life than the normal asset service life detailed in the Asset Management Guidelines of the *International Infrastructure Management Manual*.
  - . Do not meet the project objectives and the requirements of the various Authorities for the least Net Present Value (NPV) but may become the preferred option for construction.
- Particular equipment which is procured without relevant competition through tendering.
- Duplication of equipment or unit processes in a system configuration.

2.3 CRITICAL INFRASTRUCTURE PROTECTION

Asset categorisation

Concept plan: Address the asset categorisation to WSA 03 clause 1.2.4.1. Provide a risk assessment of the final design for consistency with asset categorisation and the concept plan.

2.4 CONSULTATION

Council and other authorities

Approval: Obtain approval from the following public authorities:

- Consulting authority: Bellingen Shire Council

3 DESIGN CRITERIA

3.1 GENERAL

Responsibility

Concept plan: Review the concept plan provided and make sure the data listed by WSA 02 clause 2.2.2 is available.

Conflicting requirements: If there is conflict between this specification and the Water Agency requirements seek clarification.

Requirements of design: Provide sewerage system to each property by a connection point to a pre-laid property service including the following:

- Gravity system.
- Pressurised or vacuum system.

Minimisation of life cycle costs

Design life: > 100 years without rehabilitation.

Life cycle plan: Provide an asset life cycle plan noting renovation or replacement for items. Conform to typical asset design life values to WSA 02 Table 1.1 or submit other source documentation for design life.

Catchment and upstream provision

General: Determine the area served in conformance with WSA 02 clause 2, including provision for an upstream sewer involving future loads.

Utilities services plans

Future loading: Determine the future and ultimate upstream sewer loading and make adequate allowance for such loadings.

Commissioning plan

Requirement: Provide a commissioning plan including the following:

- Pre-commissioning procedures, including schedules, record sheets for each item of equipment and checklists.
- Commissioning procedures, including procedures, schedules, notice periods for independent testing.
- Handover requirements.
- Sign-off requirements.
- Documentation requirements at handover and sign-off.
- Documentation required to operate, maintain and resource the facility including equipment technical specifications, work-as-executed drawings, risk analysis, operation and maintenance manuals, resource requirements for ongoing operation of the facility.
- Following final design, update the commissioning plan in conformance with design documentation.

3.2 SEWERAGE DESIGN

Flow estimation

Design flow estimation: Determine the design flow estimation (L/s) in conformance with WSA 02 clause 3.

Equivalent population: Determine the equivalent population in conformance with WSA 02 Appendix A.

Flow estimation for undeveloped areas: To WSA 02 Appendix B.

Flow estimation incorporating existing systems: Determine using flow modelling in conformance with WSA 02 Appendix D.

Flow estimation for partially pumped systems: Calculate in conformance with WSA 02 clause 3.2.4, where using modelling determine in conformance with WSA 02 Appendix D.

Flow schedule: Document the flow schedule.

Design flow verification: Design flow limits for pressure sewers for certification by the system supplier.

Detailed design

Catchment: Provide for sewers to drain the specified catchment and determine optimum depth and diameter for any future extensions.

Design accuracy: Document location and design elevations of sewer(s) with the following accuracy:

- Plan: To 0.01 m.
- Level if grade is < 0.5%: To 0.005 m.
- Level if grade is > 0.5%: To 0.01 m.
- Levels: Referenced to Australian Height Datum (AHD).
- Plan location: Referenced to local cadastral boundaries or the geodetic datum of Australia (GDA 94).

Sewer layout: Document sewer layout conforming to the natural gradient, to WSA 02 clause 4.2.3 and the following:

- Position within the street reserve in conformance with the locally applicable utilities' allocation code or, where no code is applicable, locate clear of carriageways.
- Position within public land with the permission of the controlling Authority.
- Position within drainage reserves outside 1 in 100 year flood area.
- Position within private property parallel to front, rear and/or side boundaries.
- The final sewer alignment must conform with Water Agency and statutory requirements and any local space allocation code.

Pressure sewer layout: Provide for the pressure sewer system in conformance with WSA 07 clause 5.1.4 and 5.1.5 and the following:

- Create shut down zoning of equal size to WSA 07 clause 5.1.
- Locate in the road reserve.
- Avoid slip and unstable areas.

Environmental considerations: Conform to the following environmental requirements:

- The project Environmental impact assessment.
- Avoid sensitive areas as defined in WSA 02 clause 4.2.4.
- Vegetation: Address the following:
  - Preserve trees of significance and habitat of fauna.
  - Tree removal permits.
  - Make sure preserved and/or replacement trees are appropriate species with root systems which are not detrimental to sewerage works.
- Contaminated sites: Submit for approval from Water Agency and/or Environmental regulator, conform to the requirements in WSA 02 clause 4.2.4.4.

Tidal zones: For sewers located below high tide level, conform to WSA 02 clause 4.2.4.5.

Disused sewers: Document the treatment of disused sewers including any demolition, capping or removal.

Colour coding: If proposed sewer pipes or rising mains are located in close proximity to other service pipes or if there is the likelihood of the pipes not being recognised as sewerage pipes, document colour coded pipes as follows:

- Sewer pipes: Cream colour.

Overhead power lines and transmission towers: Do not locate pipelines under overhead high voltage (> 50 kV) power lines unless approved by the relevant authority.

Site safety plan: If pipelines under overhead high voltage power lines are approved, develop a site safety plan.

Trenchless techniques: Document trenchless methods, if appropriate, for environmentally sensitive areas, built-up or congested areas, beneath buildings or overhead power lines or at road crossings. Locate on the drawings all access pits and exit points to conform with WSA 07 clause 3.13.

Confined space risks: Design and document the technical requirements to minimise all risks associated with entry into confined space to AS 2865.

Easements

Requirement: Document easement widths, locations and placement of the sewer within the easement.

Sewers: If it is necessary to locate a sewer in locations other than dedicated public road reserves or private access way, register an easement that conforms to WSA 07 clause 3.7 and Appendix B.

Position of sewer in the easement: Conform to the following:

- 1/3 of the width into the easement on the side away from any buildings.

- Position central if there are buildings on both sides and if the easement runs through narrow walkways.
- Where there is a crossfall, position the main on the low side.

Horizontal alignment of sewers

Crossings: Conform to the following:

- Roads, creeks, drains and underground services: At right angles in conformance with WSA 02 Standard drawings SEW-1400, SEW-1401, SEW-1402, SEW-1403, SEW-1404 and WSA 07 Standard drawings PSS-1002 or PSS-1003.
- Freeways, arterial roads and other major road reserves: In conformance with WSA 02 clause 4.3.2.
- Railway reserves: In conformance with AS 4799 and WSA 02 Standard drawings SEW-1401 or WSA 07 Standard drawings PSS-1004. Submit for approval.

Public and private property: Conform to WSA 02 clause 4.3.4.

Changes in direction using MH: Maximum allowable deflection of sewer through MH to conform with WSA 02 Table 4.1 and clause 4.3.7 unless otherwise noted.

Dead ends: Terminate sewer end > 1.0 m past the boundary.

Horizontal curves: Locate and size deflection in conformance with WSA 02 clause 4.3.7.

Obstructions and clearances

Sewer route: Determine all underground obstructions and services, surface obstructions and structures and design to avoid the obstructions.

Clearances: Conform to WSA 02 clause 4.4 for the following:

- Clearances from transmission towers and power lines.
- Clearance from structures.
- Clearance from underground services in conformance with WSA 02 Table 4.2 or WSA 07 Table 3.1 or WSA 06 Table 3.1, as appropriate.

Pipe sizing and grading

Sewerage design charts: To AS 2200.

Design: Document pipe sizes and grades to transport the design flow and achieve a self-cleansing velocity. Conform to the following:

- Avoid excessive grades.
- Minimum grades for slime control in particular for sewers ≥ DN 300.
- Environmental protection requirements for design flow containment.
- Minimum grades for self cleansing: To WSA 02 clause 4.5.7 Tables 4.5, 4.6 and 4.7.
- Maximum grades for septicity.
- De-rate pipes for fatigue and temperature where appropriate.

Ventilation: Provide for sewer ventilation to conform to WSA 02 clause 4.5.3. Generally provide air space in the pipe at either peak dry weather flow or at design flow.

Minimum pipe sizes for maintenance purposes: Provide for property connections and reticulation sewers to the minimum requirements of WSA 02 Tables 4.3.

Maximum EP for reticulation sewers: Conform to WSA 02 Table 4.4.

Downstream sewer sections: Do not reduce pipe size.

Additional requirements for pressurised sewer systems: Conform to the following:

- Property discharge lines: ≥ DN 40 where 1 or 2 pumps are connected to any property discharge.
- Pressure reticulation sewers: ≥ DN 50 for residential, industrial and commercial zones unless smaller size required for WSA 07 clause 4.5.3.4.
- Internal pipe diameters for PE pipes: To WSA 07 Table 10.2.
- Head loss due to air entrapment: To WSA 07 Appendix A.
- Hydraulic roughness value: To WSA 07 clause 4.5.3.3.
- Grinder pump pressure sewers: Minimum flow velocity of 0.6 m/s at least every 24 hours.
- STEP systems: Minimum flow velocity of 0.3 m/s at least every 24 hours.
- Grinder pump pressure sewers and STEP systems: Maximum flow velocity of 3.5 m/s.

Vertical alignment of sewers

Design: Document the vertical alignment of sewers in conformance with the topography, minimum pipe size and grade to transport the design flows. Include the following:

- Adequate depth to service property connections by gravity.
- Adequate depth to achieve clearances from utility services and obstructions.
- Adequate grade for self-cleansing and slime stripping.
- Allowance for losses through maintenance structures affecting the hydraulic grade line.
- Minimum cover over sewers.

Long section design plan: Document longitudinal sections and provide a level schedule in conformance with WSA 02 Standard Drawing SEW-1101. Provide levels at each side of any road crossing, at crossings of existing and proposed creeks, drains, cables, pipes, at changes in grade including MS and vertical bends, at regular intervals on vertical curves.

Minimum cover: Document minimum cover measured from the top of the pipe to finished surface to conform to WSA 02 Table 4.8 and WSA 07 Standard drawings PSS-1000. If minimum cover is not achievable, document protective measures.

Lot servicing requirements and control: Conform to WSA 02 clause 4.6.4 for all service area requirements for residential, industrial, commercial, partial and basement servicing.

Minimum depth of sewer connection point: Determine controlling factors of soffit and physical losses in conformance with WSA 02 clause 4.6.5 and document depth requirements.

Grading through MHs: Document the grades through the MHs in conformance with WSA 02 clause 4.6.6.

Vertical and compound curves: Document vertical and compound curves as required and in conformance with WSA 02 clause 4.6.7 and 4.6.8.

Property connection

Levels and vertical risers: Document the levels of property connections and requirements for vertical risers providing a property connection point for each existing and proposed property serviced by a network. Conform to the methods of property connection in WSA 02 clause 5.3.

Limitation of connection to sewers: Make property connections to reticulation sewers only, not on branch and trunk sewers, unless otherwise approved and suitable provisions are made in conformance with WSA 02 clause 5.2.

Maximum depth of property connection: ≤ 2.5 m below FSL.

Number of property connections: One connection per single or multiple occupancy lot in conformance with WSA 02 clause 5.5.

Undeveloped and developed lots: Document the location of the connection points in conformance with WSA 02 clause 5.6 and Standard drawings SEW-1401 and SEW-1105. Provide Y connections as approved.

Length of property connection sewers: Design the lengths in conformance with WSA 02 clause 5.8.

Pressure sewer laterals: Provide isolation valves and pipework in conformance with WSA 07 clause 8.2 and 8.3.

Depth of pipework: Minimum and maximum depths of service connection pipework in conformance with WSA 07 Standard Drawing PSS-1000.

Surface boxes: Provide all buried assemblies, valves and clean-outs with surface boxes with removable watertight lids.

Corrosion protection

Internal corrosion: Document protection against hydrogen sulphide (H_2S) and conform to MMBW Hydrogen sulphide control manual volume 1 and 2.

External corrosion: Document protection by selecting corrosion resistant material, coatings, sealed conduits and fittings, refer to AS 3735 and AS 3735 Supplement 1.

Sewage quality

Septicity: Design the system in conformance with WSA 07 clause 3.15 and the following:

- Adequate velocities for self-cleansing and slime control to WSA 07 clause 4.5.3.4.
- Minimal detention times and low sewage age to WSA 07 Table 3.2.

Pressure system discharging to a gravity sewer: Provide for all of the following:

- Avoid any unnecessary turbulence at the discharge point.

- Adequately ventilate the gravity sewer (natural and forced) downstream of the discharge point.
- Provide a Water Agency approved coating to the inside of the discharge maintenance hole.

Odour control: Design to minimise sewerage odours generally found in pressure sewers, collection tanks, valve pits and maintenance/relief structures. Detain sewerage in the sewer for the minimum time, reduce turbidity and provide for ventilation or dosing.

Detention time: Determine allowable detention time of fresh sewerage for the catchment based on average flows with consideration given to temperature, occupancy profile (e.g. residential versus commercial) and lot density.

Odour control dosing: Determine the locations required for dosing to control odour in conformance with WSA 07 Table 3.2 and MMBW Hydrogen sulphide control manual volume 1 and 2.

Trade waste management: Document any requirements for trade waste management for industrial or commercial developments.

Provision for condition monitoring, sampling and maintenance

Monitoring: Provide for condition monitoring and maintenance of the system in conformance with the following requirements:

Flushing points and scours: Provide all dead ends to pressure sewers with an end flushing point if the number of connections on a branch line exceeds 5.

In-line flushing points: Provide as follows:

- Downstream of isolating valves, except where there is a downstream flushing point within 100 m.
- Where there is more than one upstream connecting line.
- At intervals not exceeding 500 m.

Document size and location: Locate flushing points in pits with appropriate covers.

Sampling points and flow meters: Provide sampling points and flow meters in conformance with WSA 07 clause 5.6.3 and 5.7.

Chambers: Locate flushing and sampling points in chambers with appropriate clearances, drainage or water tight cover. Provide permanent signage.

3.3 PRESSURE SEWERAGE

Application of pressure sewerage

Pressure sewerage design: Consider the application of pressure sewerage in conformance with WSA 07 clause 1.2.2. Choose the system dependent on cost, downstream treatment and available space for installation of on-lot facilities. Address the following in the pressure system design:

- Pressure network configuration.
- Locations for the discharge point.
- Locations for the collection/pump units.
- System characteristics including design flows, flow velocities, pressure and discharge capacity, collection/pump type, emergency storage volume (hours), pressure sewer and appurtenances, lateral pipe and property boundary assembly, locations of cleanouts, flushing points, isolation valves, property discharge line and appurtenances, collection tank and collection sump volumes, operating levels, size(s) of pipes for each length of the proposed pressure system to meet the concept plan requirements, appropriate pipeline material type(s) and class(es) in conformance with concept plan.
- Sewer layouts and alignments including route selection, topography and environmental aspects, easements, foundation and geotechnical aspects, provision for future extensions, types and locations of cleanouts, isolation valves and air release valves, types and locations of pressure monitoring stations and flow meters, delivery pipe connection locations.
- Document all assumptions and the requirement to review assumptions during construction.
- Unforeseen ground conditions arising during construction.

Maximum system operating pressure: 120 m head.

Valves for pressure systems

Valves design and location: Document the location, type, class, end connections and arrangement for all valves in conformance with WSA 07 clause 5.3 and WSA 07 Standard Drawing PSS-1005.

Isolation valves: Locate isolation valves in conformance with WSA 07 clause 5.4.2 and the following:

- At intervals < 500 m or 30 service connections whichever is the lesser.

- At both ends of bridge crossings.
- At both sides of areas of unstable ground.
- On the branch (riser) of each tee immediately adjacent to an air release and vacuum break valve.
- Document covers and surrounds including the permanent marking of boxes.

Air release and vacuum break valves: Document in conformance with WSA 07 clause 5.5, WSA 07 Standard Drawing PSS-1006 and the following:

- Investigate whether air release or vacuum break valves are required for all high points.
- On-line cleaning and maintenance or replacement without having to shut down the sewer.
- Use air release valves suitable for use with pressure sewers.
- Do not use manually operated air release valves.
- Avoid major roadways and areas subject to flooding. Locate above flood level.
- Provide vacuum break valves, if negative pressure of 10 m head occurs.
- Provide permanent access for maintenance.
- Provide covered concrete chambers with adequate ventilation and permanent signage. Eliminate any odour issues and provide appropriate drainage for a water tight environment.

Verification: Verify that the depth of the pressure main accommodates the height of any specified air release or isolating valve.

Collection/pump units for pressure sewerage

Design flow: Provide the collection/pump capacity and overflow storage time based on minimum design flow in conformance with WSA 07 clause 7.1.

Design: To *0077 Sewerage systems-pump stations (Design).*

3.4 MAINTENANCE STRUCTURES

General

Location: Document the locations of all maintenance structures in conformance with WSA 02 clause 6.2 and 6.4 and Table 6.1.

Spacing of maintenance structures: Design the maintenance structures and spacing to allow access to every part of a sewer by using equipment installed on a service vehicle parked near to the boundary of the nearest road or readily accessible public land in conformance with WSA 02 clause 6.3.

Connections of new to existing sewer: Document the connection method and any necessary construction details.

Maintenance holes (MHs)

Design: Document the construction requirements and any proprietary items for the MH in conformance with WSA 02 clause 6.6 and WSA 02 Standard drawings SEW-1300 to SEW-1308. Including the following:

- Property connections into MHs.
- Diameters of MHs.
- MH base layout, including channels.
- Flotation.
- Ladders, step irons and landings.

Access covers: Document the details, crossfall and location of covers in conformance with AS 3996 and WSA 02 clause 6.6.9.

Maintenance shafts (MSs), Terminal maintenance shafts (TMSs) and Inspection shafts (ISs)

Design: Document location, depth and riser shafts for MSs, TMSs and ISs in conformance with WSA 02 clause 6.7. Document the tolerance for verticality so that the grade of the incoming sewer is within design tolerance.

3.5 ANCILLIARY STRUCTURES

General

Water seals, boundary traps and water-sealed MHs: Document location and type of water seal, boundary trap and/or water sealed MHs in conformance with WSA 02 clause 7.2 and WSA 02 Standard drawings SEW-1409, SEW-1410 and SEW-1411 and AS/NZS 3500.2.

Gas check MHs: Document the location and type of gas check MHs and provide for easy accessibility for maintenance in conformance with WSA 02 clause 7.3.

Vertical and near vertical sewers: Document location and construction details for vertical and near vertical sewers including any safety measures and access structures to WSA 02 clause 7.4.

Ventilation: Document location, type, materials and construction details for vents including any additional structures, equipment and protection measures, conform to WSA 02 clause 7.5 and WSA 02 Standard drawings SEW-1408 and SEW-1407.

Vortex inlets and water cushions: Document the location, type, materials and all the necessary structures, equipment and protection measures in conformance with WSA 02 clause 7.7.

Inverted syphons: Document the location, hydraulic capacity, driving head and the additional items listed in conformance with WSA 02 clause 7.8.2.

Overflows and emergency relief structures (ERS): Document the location and construction details in conformance with WSA 02 clause 7.9 and WSA 02 Standard drawing SEW-1412.

Flow measuring devices: Document the location, type, materials and all necessary equipment details for installation and testing of flow measuring devices, including any additional measures relating to recording and transmission of data in conformance with WSA 02 clause 7.10, Appendix B and Appendix C.

Wet weather storage: Determine and document the requirements for wet weather storage in conformance with WSA 02 clause 7.11, including the following:

- Capacity: Submit calculations for approval.
- Proposed method of releasing stored flows back into the system.
- Proposed cleaning and washing arrangements.
- Proposed ventilation arrangements.
- Proposed alarm devices for linkage to the remote monitoring system to alert when flow into the storage facility occurs.

Near horizontal boreholes

Near horizontal boreholes: Document the location, type, materials and construction details including any additional structures, features, equipment and protection measures in conformance with WSA 02 clause 7.6. Design for maintenance requirements as follows:

- Provide silt traps to conform with WSA 02 Table 7.2.
- Provide seamless, light coloured pipe liner keyed into wall of portal access or silt trap hole.
- Provide all weather access to the silt trap.

Maximum limits of deviation from level (vertical) and from line (horizontal): Do not exceed the greater of the following:

- Numerical value of the design grade (mm), providing no backfall > WSA 02 Table 6.1 at any point.
- Sewer ≤ DN 1000.
  - . Vertical deviation mm/100 m length: ± 30 (± 0.03%).
  - . Horizontal deviation mm/100 m length: ± 50 (± 0.05%).

3.6 STRUCTURAL DESIGN

General

Design: Determine pipelines to resist structural failure and conform to AS/NZS 2566.1, AS/NZS 3725 or AS 4060 as relevant.

Structural considerations: Design pipelines to suit the following criteria:

- Site conditions.
- External forces: Including:
  - . Trench fill loadings (horizontal and vertical due to the earth loading).
  - . Surcharge.
  - . Impact loads.
  - . Groundwater effects.
  - . Dead weight DN ≥ 1000.
  - . Traffic loads.
  - . Pipe stiffness.

. Embankment compaction strength of native soil live loads.

Foundation design and ground water control: Document special design details or construction details as required to mitigate difficult foundations and/or groundwater.

Piling: Provide structural support for buried pipelines if there is settlement potential.

Flotation: Provide resistance to flotation of empty pipe in water charged ground.

Trench design: Document minimum trench widths in conformance with SEW-1201, AS/NZS 2566.1 or AS/NZS 3725.

Pressure sewers: Do not use shared trenching for pressure sewers without approval.

Geotechnical considerations

Geotechnical assessment: To WSA 02 clause 8.6.

Sewers in engineered or controlled fill: Document to support the predicted settlement and the capacity of the pipeline to accommodate the movement in conformance with WSA 02 clause 8.6.2.

Sewers in non-engineered fill: Engage a geotechnical specialist to design the support and foundation remediation.

Construction of an embankment: Engage a geotechnical specialist to design the construction of an embankment, trench and bedding. Determine the relevant construction requirements in conformance with WSA 02 clause 8.6 and WSA 02 Standard drawings SEW-1203, SEW-1204 and SEW-1205.

Unforeseen ground conditions: If unforeseen ground conditions are encountered, review the structural design and make appropriate amendments.

Sewers in unstable ground

Avoid: Make all attempts to avoid construction of sewers through unstable ground including mine subsidence areas and slip areas.

Mine subsidence areas: Submit for approval by the Mine subsidence regulator any design for mains located in mine subsidence areas Conform to WSA 02 clauses 8.6.5 and 8.6.6, include the following:

- The expected strains on the pipeline resulting from potential subsidence.
- Use area specific ground strains available from the Mines subsidence regulator.
- Notate and endorse approved design.
- Jointing system.

Slip areas: Engage a geotechnical specialist to design the construction of sewers in slip areas. Minimise all potential for damage to a sewer caused by movement of unstable ground.

Water charged ground: Engage a geotechnical specialist to analyse the support and anchorage systems, pipe material and jointing methods.

Above ground crossings

Above ground pipelines: Document the pipeline supports and loading protection including for vandalism, exposure conditions, impact loading from traffic and external corrosion. Conform to WSA 02 SEW-1404, SEW-1405, SEW-1406.

Bulkheads and trenchstops

Design: Document bulkheads and trenchstops in conformance with WSA 02 clause 8.10,Table 8.1 and SEW-1206, SEW-1207.

Drainage: Provide details for trench drainage where required.

Pipeline anchorage for pressure/vacuum sewerage

Design: Document and detail pipeline anchorage required at all changes in direction, tees, valves, tapers and termination points exceptions include restrained joints and welded pipelines. Consider all horizontal and vertical forces arising from maximum allowable operating pressure.

Thrust blocks: Document the design for the thrust blocks including:

- Calculation of unbalanced thrust and resultant thrust.
- Temporary thrust blocks to conform to the permanent thrust blocks requirements.
- Size.
- Location: Must not protrude beyond the space allocation for the main.
- Where required use puddle flanges to transfer thrust.
- Timber and recycled plastics.

Anchor blocks design: Document to resist the unbalanced thrust due to the greater of the design pressure or test pressure to be imposed at the anchorage location and prevent movement of pipe bends in a vertical direction consisting of sufficient mass concrete to prevent pipe movement.

Restrained joint ductile iron water mains: Document the details including locations and any special construction techniques required. Conform to manufacturer's recommendations for restrained jointing systems.

Design restraint requirements for special situations: Document any special requirements such as above ground mains with unrestrained flexible joints, buried steel mains with welded joints, above ground steel mains with welded joints, ductile iron and steel mains with flanged joints, PE mains.

Mechanical protection of pipelines

Requirement: Protect pipeline located under major infrastructure by design and documenting in conformance with WSA 07 clause 3.10, WSA 06 clause 3.10 and the following:

- Concrete encasement: Document encasement and connections. If concrete encasement is proposed, submit for approval and include the following:
  - Design as a beam to withstand external loadings where encased length of pipelines incorporated joints or the AHBP < 50 kPa.
  - Do not encase cast iron, wrought iron, AC pipe, lead joints, flanged joints, riveted pipe, sections of any main containing a service connection or valve (including air valves).
- Bored encasing pipe.
- Service pipe inside a carrier pipe.

3.7 MATERIALS

General

Products and materials: Conform to *Product and material information and guidance for sewerage code of Australia WSA02-2002,* WSAA *Product specifications* and Water Agency product catalogues.

PVC non-pressure

Standard: To AS/NZS 1260 and WSA 02 Table 10.1.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe pressure classification (SN).
- Material classification number (as necessary).
- Length of pipes.
- Types, materials and classes of fittings.
- Internal and external corrosion protection.

Vitrified clay (VC) non-pressure

Standard: To BS EN 295-1 and WSA 02 Table 10.1.

Elastomeric joints: To BS EN 681-1.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Minimum crushing strength.
- Nominal diameter.
- Pipe pressure classification.
- Joint type.
- Length of pipes.
- Types, materials and classes of fittings.
- Internal and external corrosion protection.

Ductile iron gravity or pressure sewers

Standard: To AS/NZS 2280 and WSA 02 Table 10.1.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe series (CIOD or ISO).
- Pipe pressure classification (PN).
- Joint type.

- Length of pipes.
- Types of fittings.
- Internal and external corrosion protection.
- Restrained joint seals.

Sleeving: PE sleeving to bituminous coated DI pipes to AS 3681.

Flange class DI pipes: Fully support flange in the installed condition. Include instructions for preventing loading of the flange during installation.

Flanged joints to AS/NZS 4087: Document the type of flange gasket and the tightening sequence.

Corrosion protection: Document one of the following on the drawings:

- Cement mortar lining: To AS/NZS 2280, or
- Thermal-bonded medium density polyethylene: To AS/NZS 4158.
- Epoxy coating: To AS 3862.

Polyethylene sleeving: To AS 3680.

Joints: Elastomeric seal to AS 1646.

Protection: Provide wrapping for unprotected joints in the trench with an approved petrolatum tape system or approved alternative.

Bolts and nuts: To AS 2129 and galvanized to AS 1214 or stainless steel to ASTM A276.

Glass reinforced plastic (GRP) non-pressure

Standards: To AS 3571.2 and WSA 02 Table 10.1.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe series.
- Pipe pressure classification (PN).
- Pipe stiffness classification (SN).
- Joint type.
- Length of pipes.
- Types of fittings.

Pressure sewers: GRP pipe to ISO 10467.

PVC pressure/vacuum sewer

Standard: Conform to WSA 02 Table 10.3 and the following:

- PVC-U: To AS/NZS 1477.
- PVC-M: To AS/NZS 4765 series 2.
- PVC-O: To AS/NZS 4441 series 2.
- Vacuum pipes and fittings: To WSA 06 clause 9.5.2.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe series (1 or 2).
- Pipe pressure classification (PN).
- Material classification number (as necessary).
- Length of pipes.
- Types, materials and classes of fittings.
- Internal and external corrosion protection.

Steel pipeline systems

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter: To AS 1579 Appendix C.
- Rated pressure.
- Joint type: To AS 1579 Appendix E.
- Length of pipes.
- Types of fittings: To AS 1579 Appendix D.
- Internal and external corrosion protection including cathodic protection if appropriate.

- Flanged joints, class of flange, type of flange gasket and the tightening sequence: To AS/NZS 4087.

Steel water mains: Submit for approval by the Water Agency for use in reticulation systems.

Gasket types: Document full face (FF), inside bolt circle (IBC), tongue and groove (TG), spigot and recess (SR), single flat sheet, laminated ply or moulded.

Insulated flanged joints: Document if steel pipes, fittings and other steel appurtenances are jointed to flanges and/or flange backing plates of dissimilar metals such as copper, copper alloys, galvanized steel and stainless steel. Insulated flanged joints are not required where joining to wrought iron flanges, grey cast iron flanges or ductile cast iron flanges.

Pipe jointing: Document one of the following on the drawings:

- Elastomeric seal jointed with seals conforming to AS 1646.
- Butt welded, welded spigot and socket, or welded using a welding collar and with the application of a polyethylene heat shrunk sleeve over the weld, or wrapped.
- Flanges: To AS/NZS 4087.

Protection: Provide wrapping for unprotected joints in the trench with an approved petrolatum tape system or approved alternative.

Bolts and nuts for flanged joints: To AS 4087 clause 3.2..

PE pipeline systems

PE pipeline: To WSA 01.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe pressure classification (PN).
- Material class (PE80 or PE100).
- Length and form of pipes (straight lengths or coils).
- Types, materials and classes of fittings.
- Internal and external corrosion protection.

Jointing: In conformance with WSA 01.

Mechanical couplings: Self restraining.

Stub flanges and backing rings: Conform to POP 007.

Flanges: Conform to AS 2129, AS/NZS 4331.1 and AS/NZS 4087.

Polyethylene (PE) pipe: To AS/NZS 4130 and WSA 02 Table 10.2.

PE Fittings: To AS/NZS 4129.

Bending: To AS 2033.

Vacuum pipes and fittings: Conform to WSA 06 clause 9.5.3.

Polypropylene (PP) non-pressure

Standard: To AS/NZS 5065 Type B ID series and conform to WSA 02 Table 10.2.

Pipe stiffness class: SN 10.

Elastomeric joint seals: To AS 1646.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Length of pipes.

ABS pipes and fittings

Acrylonitrile butadiene styrene (ABS) pipes and fittings: To AS 3518 and joined in conformance with the manufacturer's recommendations using solvent cement to AS 3879.

Pipe class: Provide for cyclic loading.

Reinforced concrete (PVC lined)

Standard: To AS/NZS 4058 and WSA 113.

Testing: To AS/NZS 4058 Appendix A including crack load, ultimate load, hydrostatic pressure, dimensional accuracy, cover, joint assembly.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe load class.

- Configuration of bends.
- External coatings for aggressive soils.
- Lifting holes if required.
- Any additional cover.
- Length.
- Types, materials and classes of fittings.
- Internal and external corrosion protection.

Protection against degradation

Detail: Document measures to protect all pipeline system items (e.g. pipes, fittings, appurtenances, elastomeric seals) including the following:

- Eliminate contact between dissimilar metals to prevent galvanic corrosion.
- Protective coatings for some metallic components and concrete structures, suitably designed for various corrosivity levels of soil and groundwater.
- Fully sealed conduits for plastic pipes and fittings in contaminated ground.
- Fully sealed conduits for all elastomeric seal jointed pipes and fittings in contaminated ground.
- Control trench fill and pipe embedment materials.
- Mitigate stray current or other effects on buried steel pipelines.
- Cathodic protection for buried steel pipelines to AS 2832.1 and AS 2832.2.

Protection against damage to coatings: Provide for more than one thickness of PE sleeving between coated fittings, valves and other appurtenances and thrust and anchor blocks.

Stainless steel: Grade 316 or 316L, welding requirements to AS/NZS 1554.6 and threaded component details.

Protection against contaminated ground: Fully welded externally coated or wrapped steel pipeline. Submit alternatives for approval by the Water Agency.

Bolted galvanized connections: An encapsulating system using priming paste wrapped with petrolatum tape or PE sleeving.

Valves

Isolation valves: Conform to WSA 07 clause 5.4 and the following:

- Minimum PN 16.
- Clockwise closing.
- Waterway internal diameter > 90%.
- ≥ DN 80: Flange or restrain-joint socketed resilient seated gate valve.
- < DN 80: Resilient seated ball valves.
- Anchor valves ≥ DN 80 if not flanged or restrained-joint socketed.
- Flange gaskets: > 3 mm thick full face NBR or EPDM rubber to WSA 109.
- Capable of being locked in the open and closed positions.

Air release and vacuum break valves: Conform to WSA 07 clause 5.5 and the following:

- Combination air release valves with a large orifice and small orifice in a single unit preferred at the high points.
- Large orifice minimum size: ≥ DN 50 for installation on pressure sewers ≤ DN 280.

Division valves on vacuum sewers: Conform to WSA 06 clause 9.6.

Vacuum interface valves: Conform to WSA 06 clause 10.2.

3.8 VACUUM SEWERAGE ADDITIONAL REQUIREMENTS

Application of vacuum sewerage

Vacuum sewerage design: Consider the application of a vacuum sewerage system in conformance with WSA 06 clause 1.5.3. Address the following in the vacuum system design:

- Vacuum and gravity configuration.
- Locations for vacuum station and discharge point.
- System characteristics including head, vacuum and discharge capacity, generator and pump type, pressure main and pipe work requirements, vacuum interface valve type, vacuum tank, collection chamber and collection sump volumes, operating levels.

- Size(s) and grades of sewers throughout the relevant portion of the proposed vacuum system to meet concept plan requirements.
- Material type(s) and class(es) in conformance with the concept plan.
- Sewer layouts and alignments including route selection, topographical and environmental aspects, easements, foundation and geotechnical aspects, provisions for future extensions, types and locations of maintenance structures, overflows and vents, property service connection locations.
- Document all assumptions and review assumptions during construction.
- Unforeseen ground conditions arising during construction.

Detailed design

Vacuum sewer design flows: Conform to WSA 06 Tables 5.1, 5.2 and 5.3 for PVC-U, PVC-M and PE80.

Air to liquid ratios: Relate to the longest vacuum sewer in conformance with WSA 06 Table 5.4.

Vacuum station design: Conform to *0077 Sewerage systems-pump stations (Design).*

Vacuum sewer design

Sewer layout: Document the sewer layout to conform with WSA 06 clause 9.2 and the following:

- Main routes: Select to minimise lift and length, equalise flows on each vacuum main, provide adequate access for operation and maintenance and efficiently connect to properties.
- Split catchments into appropriate zones.

Headloss: Determine headloss to conform with WSA 06 clause 9.3 including the available vacuum, friction loss and static lift loss.

Sewer profiles: Level grade, upgrade and downgrade profiles to conform with WSA 06 Figures 9.2 and 9.3. Lift pitches and lift heights to conform with WSA 06 Table 9.1. Profile design to conform with WSA 06 clause 9.4.2.

Connections: Conform with the following:

- Connection to vacuum vessel: Conform to WSA 06 Figure 9.4.
- Connecting sewers: Conform to WSA 06 clause 9.4.5.
- Bends: Conform to VAC-1100 and VAC-1102.
- Waterlogging: Conform to clause 9.4.7.

Pumping system and pump discharge pipework: Conform to *0077 Sewerage systems-pump stations (Design)*

4 DOCUMENTATION

4.1 GENERAL

Design

Design review: Demonstrate compliance with the concept plan and WSA 02 clause 9.1.

Project design documentation: Provide project-specific information including the following:

- Detailed drawings including location of all relevant obstructions.
- Specifications for products, materials, site investigation, excavation/trench details, size pressure class, jointing methods, corrosion protection measures and other technical matters.
- Design assumptions and constraints.

Asset categorisation:

- Risk assessment of final design for consistency with asset categorisation of concept plan.
- Surge analysis and design for surges.
- PN of system components.
- Operations and maintenance training manuals.

Specifications

Construction documentation: Provide project specific completed specification *1361 Sewerage systems – reticulation (Construction)*.

Design certification

Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS

General

Design drawings: Provide design drawings to WSA 02 clause 9.2, WSA 04 clause 15.2, WSA 06 clause 19.1 and 19.2 and include the following:

- Pipeline acronyms: Use the WSAA acronym's provided at www.wsaa.asn.au.

Drawing scale, size and format

Drawing scale:

- Detail plans scale: 1:500.
- Longitudinal sections.
- Horizontal scale: 1:1000.
- Vertical scale: 1:100.

Drawing size: Consultation with the relevant Water Agency.

Drawing format: Provide in electronic form after consultation with the relevant Water Agency.

Symbols: Conform to AS 1102.

All wires and terminals: Numbered.

Drawings content

Requirement: Provide design drawings to include the following:

- Plan:
  - Lot boundaries and lot numbers.
  - Location and chainage of all maintenance holes, junctions and dead ends.
  - MH types.
  - Location and size of all gravity and rising mains and pump stations.
  - Location of pipelines, valves and vents.
  - Sewer main number and maintenance hole number.
  - Existing sewer mains, junctions and maintenance holes.
  - For level lots, spot levels at the lot extremities to show that at least 90% of the area of the lot can be connected to the sewer by gravity.
  - Hatching to show the area of any lot not serviced.
  - Site contours.
  - Existing and proposed features and services.
  - North point and scale bar.
  - Easement location.
  - Arrangement of other utilities.
- Longitudinal section:
  - Reduced levels for natural surface and design surfaces at all changes in grade.
  - MH locations and type.
  - MH numbered in conformance with the Sewer Authority's Asset Register.
  - Invert levels for maintenance holes inlet and outlet.
  - Size, type, class and grade of pipe.
  - Location, invert level and size of all drainage lines, water mains, and other utility services crossing the main.
  - Notation regarding all joining lines.
  - Property ownership.
  - Note 'In road' trench conditions.
- Pipe protection: Details of corrosion protection required for pipes and fittings.
- Trenchless installation: Areas designated for trenchless pipe installation.

Asset register

Maintain: Provide asset schedules and drawings in a form consistent with the existing or proposed Asset Register after consultation with the Water Agency.

4.3 WORK-AS-EXECUTED

Work-as-executed drawings

General: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

Requirements for recording: Document the requirements for recording work-as-executed drawings including the GPS coordinate points.

0077 SEWERAGE SYSTEMS – PUMP STATIONS (DESIGN)

1 GENERAL

1.1 RESPONSIBILITIES

Objective

Design requirement: Provide the design and documentation for sewerage system pump stations to transport sewage from proposed development to the treatment plant or to a defined discharge point on an existing sewerage reticulation system in conformance with all current relevant legislation. Provide for pumping plant, sewer mains and allow an appropriate point of connection to the reticulation system. Designer responsibilities include the following:

- Translate the planning output into a detailed pump station design. Prepare design drawings compatible with the Water Agency's concept plan and the design parameters.
- Identify potential problems and provide appropriate solutions.
- Justify any variation from the requirements set out in this worksection or specified by the Water Agency.
- Obtain written approval from the Water Agency for any variation.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *0010 Quality requirements for design*
- *0076 Sewerage systems – reticulation (Design)*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian standards

AS 1102-series	Graphical symbols for electrotechnical documentation (Various)
AS 1210-2010	Pressure vessels
AS 1657-1992	Fixed Platforms, walkways, stairways and ladders—Design, construction and installation
AS 2865-2009	Confined spaces
AS/NZS 3000:2007	Electrical installations (known as the Australian/New Zealand Wiring Rules).
AS 3439	Low voltage switchgear and controlgear assemblies
AS 3439.1-2002	Type-tested and partially type-tested assemblies
AS 3600-2009	Concrete structures
AS 3735	Concrete structures retaining liquids
AS 3735 Supp1-2001	Concrete structures retaining liquids - Commentary (Supplement to AS 3735-2001)
AS 3959-2009	Construction of buildings in bushfire-prone areas
AS 4024.1-2006	Series: Safety of machinery (26 parts)
AS 4100-1998	Steel structures
AS 4198-1994	Precast concrete chambers for sewerage applications
AS 4883–2008	Air valves for sewerage
AS 60947	Low voltage switchgear and controlgear
AS 60947.4.2-2004	Contactors and motor-starters - A.C. semiconductor motor controllers and starters
AS/NZS 61000	Electromagnetic compatibility (EMC)
AS/NZS 61000.4.6:2008	Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
AS/NZS 61000.6.2:2006	Generic standards - Immunity for industrial environments

Water Services Association of Australia (WSAA)

WSA 02-2002	Sewerage Code of Australia, 2nd Edition Ver. 2.3

WSA 03-2011	Water Supply Code of Australia, Version 3.1
WSA 04-2005	Sewerage Pumping Station Code
WSA 06-2008	Vacuum Sewerage Code of Australia Version 1.1 Parts 0-4 and WSA 06 Standard drawings CD
WSA 07-2007	Pressure Sewerage Code of Australia Version 1.1 Parts 0-4 and WSA 07 Standard drawings (CD)
WSA 101-2008	Industry standard for submersible pumps
Other standards	
ASTM A276:2010	Standard Specification for Stainless Steel Bars and Shapes
IEC 61643	Low-voltage surge protective devices
IEC 61643-11	Surge protective devices connected to low-voltage power systems - Requirements and test methods
IEC 61643-12	Surge protective devices connected to low-voltage power distribution systems - Selection and application principles
NSF/ANSI 46-2010	Evaluation of components and devices used in wastewater treatment systems
SAA HB 48:1999	Steel structures design handbook
Other publications	
IPWEA	
IIMM-2011	International Infrastructure Management Manual

1.4 STANDARDS

General

Planning and design of sewage pump stations: To WSA 04 Part 1.

1.5 INTERPRETATIONS

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- EIS: Environmental impact statement.
- ERS: Emergency relief system.
- ISO: International standards organisation.
- MH: Maintenance hole.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Concept plan: A package of information provided to the designer by the Water Agency to allow the appropriate planning/design of major sewerage system components to be performed. It is the critical starting point of the design process as it determines the extent of sewers and the possible need for pressure or vacuum pumping stations.
- Designer: The person(s) responsible for a design output in conformance with the Water Agency's project brief, contract or development agreement.
- Document: Record of information in written or graphical form.
- Water Agency: An Authority, board, business, corporation, Council or local government body with the responsibility for planning or defining, design, construction and maintenance requirements for water supply and/or sewerage systems.
- Septicity: The prolonged retention of sewage under anaerobic conditions, particularly during low flow periods.

2 PRE-DESIGN PLANNING

2.1 SYSTEM PLANNING

General

Reticulation: To *0076 Sewerage systems – reticulation (Design).*

Application: Define the pumping strategy and the application of the complete sewerage system.

Parameters for option analysis: Obtain from the Water Agency.

Assessment of loads: Include future system loads.

Environmental considerations: Consider the environmental impact and conform to the local government environmental and heritage requirements.

Operation and maintenance considerations: Locate the pump stations to provide safe and easy access for maintenance and condition assessment.

Geotechnical investigations: Engage a geotechnical engineer to assess if any special investigation is required for ground instability and ground water infiltration.

2.2 SUBSIDISED SCHEMES

Funding

Government grant funds: If the works form part of a contract attracting Government grant funds, identify the following:

- Items which are not of the least cost option, that:
  - Are intended to have a much longer design life than the normal asset service life detailed in the Asset Management Guidelines of the *International Infrastructure Management Manual*.
  - Do not meet the project objectives and the requirements of the various Authorities for the least Net Present Value (NPV) but may become the preferred option for construction.
- Particular equipment which is procured without relevant competition through tendering.
- Duplication of equipment or unit processes in a system configuration.

2.3 CRITICAL INFRASTRUCTURE PROTECTION

Asset categorisation

Concept plans: Address the asset categorisation and review the final design for consistency with asset categorisation of the concept plan to conform to WSA 03 clause 1.2.4.1.

2.4 CONSULTATION

Council and other authorities

Approval: Obtain approval from the following public authorities:

Consulting Authority: Bellingen Shire Council

3 DESIGN

3.1 GENERAL

General

Design parameters: If conflict between this specification and the Water Agency requirements occurs seek clarification.

Concept design: Provide a concept design for the proposed pumping station in conformance with WSA 04 clause 1.3.

Modelling: Carry out models in conformance with WSA 04 clause 1.4 and in particular pollution.

Commissioning plan

Requirement: Provide a commissioning plan in conformance with WSA 04 clause 2.17, Appendix A and Appendix B including the following:

- Pre-commissioning procedures, including schedules, record sheets for each item of equipment and checklists. For pressure sewerage conform to schedule requirements in WSA 07 clause 2.13.2.3.
- Commissioning procedures, including procedures, schedules, notice periods for independent testing. For pressure sewerage conform to schedule requirements in WSA 07 clause 2.13.3.
- Handover requirements.
- Sign-off requirements.
- Documentation of supply requirements at handover and sign-off.

- Documentation required to operate, maintain and resource the facility including equipment technical specifications, work-as-executed drawings, risk analysis, operation and maintenance manuals, resource requirements for ongoing operation of the facility.
- Following final design, update the commissioning plan in conformance with design documentation.

Location

General: Document the layout of the pump station including consideration of the following:

- Right of occupancy and access requirements including truck turn around access.
- Proximity to residential boundaries: Conform to regulations.
- Precautions for flood prone areas: To WSA 04 clause 5.2.3.
- Environmental impacts: Visual impact and noise and odour impact during operation.
- Site maintenance and restoration requirements.
- Easements.
- Power supply requirements.
- Working area: To AS 2865.

Inlet MH

General: Document the inlet MH to conform with WSA 04 clause 5.3 including the following:

- Minimum clear opening.
- Minimum diameter.
- Type of cover and frame.
- Step irons: If removal is required.
- Invert levels.
- Grit collection if required.

Wet-well design

General: Document the wet-well to conform with WSA 04 clause 5.4 including the following:

- Isolating valve: Knife gate valve or equivalent required where there is only one wet-well to cater for any shut down periods.
- Number, location and size of wet-wells.
- Depth.
- Pumping control volume.
- Maximum number of pump starts per hour.
- Control levels: Default control levels to WSA 04 Table 5.1.
- Detention time.
- Base benching.
- Wet-well washer or submersible mixer if required.
- Natural ventilation.
- Forced ventilation where required.
- Educt vent shaft.
- Falls from heights protection.

Protection of internal surfaces: Document protection requirements for internal surfaces of wet wells. This may include epoxy paint, plastic lining or bare concrete.

Bolted connections within wet wells: Provide for stainless steel to ASTM A276 Grade 316.

Overflow containment: Provide for overflow containment to conform to WSA 04 clause 5.6 including one or more of the following as required:

- Emergency storage: Including the following:
  - . Configurations: No dry weather overflows.
  - . Invert, outlet and obvert levels.

. Filling protocol.
. Configuration of the emergency storage/wet-well relationship.
. Self-cleaning.
. Wall thickness.
. Roof thickness.
. Cover.
. Minimum floor and pipe grades.
. Design against flotation.
. Access openings.
. Minimum head room: 2.2 m.
. Locations of eyebolts for portable ladder tie offs.
. Emergency by-pass pumping to the pressure main if required.
. Covers and frames.
. Construction details.

- Permanent generator.
- Permanent by-pass pumping.

Future storage provisions: Document future storage provisions.

Emergency relief system (ERS): Document the ERS system including the overflow pipe, weir point, baffle arrangement and storage facility to hold gross solids/trash, scum and gas.

Ladders and platforms: If required provide for ladders in conformance with WSA 04 clause 5.7 and AS 1657.

Valves for pressure systems

Valves design and location: Document the location, type, class, end connections and arrangement for all valves in conformance with WSA 07 clause 5.3 and WSA 07 Standard Drawing PSS-1005.

Collection/pump units for pressure sewerage

Design flow: Provide the collection/pump capacity and overflow storage time based on minimum design flow in conformance with WSA 07 clause 7.1.

Collection tanks and pump units: Document the make and model of collection tank and grinder pump unit.

Grinder pumps, collection tanks (pump basins) including check and air or vacuum release valves: Document to WSA 07 clause 10.6 and NSF/ANSI 46 including the following:

- Grinder pump capacity.
- Grinder pump testing.
- Tank dimensions, positions and dimensions of access cover, connector fittings for pipework and electrical/control conduits including any brackets, supports or other elements.
- Tank and cover material.
- Class of access cover.

Collection chambers: Conform to WSA 06 clause 10.1.

Structural design of pump station building

General: To WSA 04 Section 11.

Ground and site conditions: To geotechnical site investigation report, including differential ground support and flotation.

Supports for pumps: To resist loads and hydraulic forces without vibration.

Dimensions: To suit selected equipment, handling, support and access.

Preformed components: Implement preformed components or systems instead of in situ construction in conformance with the following:

- Precast concrete chambers: Manufactured to AS 4198.
- Internal joints: Flush and watertight.

Concrete components: To AS 3600, AS 3735 and AS 3735 Supplement 1.

Structural steelwork: To AS 4100.

3.2 PUMPING SYSTEM

General

Staging proposals: If proposed, submit for approval. Do not use throttled variable flow control. Size access covers to provide for replacement of pumps if required for staging.

Hydraulic design: Conform to WSA 04 clause 6.2 and Appendix D and document the following:

- Design flow and total pump head.
- Invert level of the incoming sewer.
- Pumping station capacity (initial and long term).
- Internal diameter, length, route and materials of the pressure main, including surge and fatigue analysis.
- Levels and profile of the pressure main.
- Levels of the pressure main discharge point.
- High-points.
- Detention times for wet-well and pressure mains.

Pump selection: Select pumps that conform with WSA 04 clause 6.4 and the following:

- Interchangeable with other approved Water Agency makes/models.
- Readily available in the market place.
- Close coupled fully submersible electric centrifugal pumps and ancillary equipment in conformance with WSA 101.
- Submit proposals using triple-pump pumping for approval.
- Select impellors of a non-clog type.
- Select motors in conformance with WSA 101 and WSA 04 clause 6.6.3.
- Detail discharge connection including anchoring.
- Junction boxes: To WSA 04 clause 6.6.5.
- Pumpset lifting equipment in conformance with WSA 101 including guide rails and brackets where required.
- Flushing valves.
- Pump starters: To WSA 04 clause 6.8.
- Variable speed drives: To WSA 04 clause 6.8.

Removal: Provide for fixed guide rails to aid removal of pumps.

Harmonics and radio frequency interface: Document to conform with AS/NZS 61000.4.6, AS/NZS 61000.6.2 and WSA 04 clause 6.9.

Emergency stop: Document in conformance with AS/NZS 3000 and AS 4024.1.

3.3 POWER SYSTEM

Power supply

General: Determine the power supply requirements in conformance with WSA 04 clause 7.2.

Primary supply: Provide for 3 phase, 4 wire, 40 0V, 50 Hz, MEN system with capacity to operate at full pumping load.

Fault level protection: Determine the prospective fault current and design the electrical protection to withstand the prospective fault current level of the incoming supply at the equipment location.

Power supply security

Risk assessment criteria: To WSA 04 clause 2.5 and the following:

- Evaluation of reliability/security of power supply.
- Duplicate power supplies.
- An emergency on-site power generator.
- Provision for the connection of a mobile diesel generator.

- Detail security requirements against theft of on-site generators and connections for mobile generators.

3.4 PRIMARY SUPPLY

General

General: Determine the primary power supply requirements in conformance with WSA 04 clause 7.2.2.

Off-site electrical services: Liaise and provide for all off-site electrical services as required by the local Electricity Distributors.

Site specific substation

Electricity Distributor dedicated substation: Where required for the pumping station, determine the following:

- Location of substation.
- Type of service.
- LV connection point and route of the distribution mains to the point of supply.
- Protection equipment, particularly any LV transformer output protection.
- Easement details.

LV transformer output protection: Provide short circuit and overload protection at the transformer secondary supply using fault current limiting circuit breakers with adjustable overload and short circuit current setting features, where secondary output supplies are required to be installed by the Electricity Distributor.

Cascade protection: Include full discrimination and cascade protection with the Electricity Distributor's incoming supply protection system and the downstream site protection devices.

Customer owned substation

HV customer service: Where a HV supply is provided to the pumping station site, meet the requirements of the Electricity Distributor for the following:

- HV reticulation.
- HV protection.
- Transformer and LV protection: Set out LV facilities and LV transformer protection in Electricity Distributor dedicated substations.

Electrical mains

On-site electrical mains: Run on-site electrical mains underground between electricity supply and the switchboard for the pumping station.

Point of supply for LV sites: Conform to the following types:

- Pole mounted at the site boundary, where from overhead supply.
- A private underground termination enclosure at the site boundary, where from underground supply.
- Direct connected consumers mains run underground from the Electricity Distributor's connection point to the main switchboard.

Consumers Mains: Provide consumers mains, associated services and all necessary fault and overload current protection equipment to AS/NZS 3000 Section 3, the local Electricity Distributor's standards, the local Service and Installation Rules and WSA 04 clause 7.2.3.

Minimum size of the consumer mains: Conform to the following requirements:

- Current carrying capacity to suit the maximum demand with an excess current carrying capacity of 30% minimum.
- A voltage drop less than 1.5% of the maximum demand as calculated.
- Single core PVC/PVC cables or XLPE insulated cable.

Pole termination method: Determine in consultation with the local Electricity Distributor.

Protected consumers mains: Provide short circuit and overload protection, where required by the Electricity Distributor.

Electricity Distributor's service protective devices:

- Low voltage service protective devices: To AS/NZS 3000, the Electricity Distributor's requirements and Service Installation Rules.
- For service protective devices > 100 A: Provide fault current limiting circuit breakers with adjustable overload and short circuit current facilities with full discrimination and cascade protection between the incoming supply protection systems and the downstream protection systems.

3.5 ELECTRICAL DESIGN

Design responsibility: Design the equipment suitable for the purpose in conformance with the requirements of the relevant standard specification.

Automatic operation: Design the pump station for fully automatic operation in the unmanned condition.

Switchboards

General: Document the switchboards in conformance with WSA 04 clause 7.3 and AS 3439.1.

Inter-changeability: If more than one item of equipment is designed to form a particular function, make sure that all such items of equipment are identical and completely interchangeable (e.g. pilot lights, pushbuttons, relays, etc).

Switchboard: Provide for installation in a visible location which is physically accessible above all areas at risk of flooding.

Ambient conditions: Determine the ambient conditions for the local area. Generally, normal accepted limits are 0℃ to 45℃.

Switchboard construction form: Generally Form 2 to AS 3439.1. Segregate telemetry and communications equipment from the power and control sections of the switchboard.

Switchboard location:

- General: Locate switchboard on concrete plinth adjacent to the pump well. Provide plinth details and physical protection.
- Flood prone areas: Locate switchboards above the flood level on suitable support structures. Detail switchboard support structures and location. Provide suitable access facilities and working platform in front of switchboard for safe operation of the equipment.

Selection of equipment and devices: To WSA 04 clause 8.8.

Phase failure protection: Provide electronic phase failure relay to monitor the incoming power supply, incorporating:

- Detection of undervoltage (80% of normal voltage),
- Voltage or phase angle imbalance,
- Reverse phase sequence.
- 10 A fuse protection for connection to the three supply phases.

Surge protection: Provide, where considered necessary, Type I SPD shunt connected metal oxide varistor based SPDs between each phase and neutral at assembly incoming supply terminals.

- Surge protection devices: To IEC 61643-11 and IEC 61643-12.
- Installation: To AS/NZS 3000 Appendix F.

Metering requirements: To WSA 04 clause 7.3.3.

Lighting requirements: To WSA 04 clause 7.3.4.

Power factor correction: Consider power factor correction requirements as set out in WSA 04 clause 7.2.9, the energy cost in running the pumping station and cost savings to justify the installation of power factor correction equipment.

Connection facilities for mobile diesel generators: In addition to the requirements of WSA 04 clause 7.2.7, consider incorporation of safeguards to prevent inadvertent simultaneous connection of mains and generator power. Where necessary, provide mechanical interlocks and an isolation device or changeover switch to switch the mobile generator supply to the switchboard.

Anti-condensation heaters: Provide thermostatically controlled anti-condensation heaters to weatherproof switchboards with an external surface area greater than 4 m^2 based on 40 watts/m^2 of exposed surface area, where environmental conditions may cause condensation to occur within the

switchboard. Provide heaters of the black heater type, mechanically protected and able to be touched without harm.

Protection devices

General: To WSA 04 clause 8.8.8.

Selection: Provide full discrimination and cascade protection for overload and short circuit conditions.

Motor starters

Soft starters: Conform to AS 60947.4.2 using hybrid motor controller Form 1 or 2 as appropriate to the control requirements as defined in AS 60947.4.2 clause 3.1.1.2. Where the soft starter is not intended to continuously control the motor for the full duration of the run cycle, utilise a bypassed hybrid motor controller as defined in clause 3.1.2.

Variable speed drives: Use hybrid motor controllers as defined in AS 60947.4.2 clause 3.1.2.

3.6 CONTROL AND TELEMETRY

General

Control, telemetry and alarms: Document control, telemetry and alarm systems in conformance with WSA 04 clause 8 and the following:

- Compatible with existing systems.
- Record available storage volume in well.

Selection of equipment and devices: To WSA 04 clause 8.8.

3.7 PROTECTION DEVICES

General: To WSA 04 clause 8.8.8.

Selection: Provide full discrimination and cascade protection for overload and short circuit conditions.

Motor protection: Provide motor overload protection in conformance to WSA 04 clauses 8.8.8.5 to 8.8.8.7.

Thermal-overload relays: Conform to WSA 04 clause 8.8.8.5 and the following:

- Incorporate single phase fault protection using differential trip bar mechanisms operating at 60% of motor full load rating under single phasing conditions particularly for delta wound motors.
- Incorporated in motor protection design where thermistor protection is required.
- Manual reset on overload trip unless design conditions dictate automatic reset.

Protection CTs: Provide protection CTs and connect electronic motor protection relays to the secondary side of the CTs where motor currents do not allow for direct connection of the relays into the motor circuit.

Phase failure protection: Provide electronic phase failure relay to monitor the incoming power supply, incorporating:

- Detection of undervoltage (80% of normal voltage),
- Voltage or phase angle imbalance,
- Reverse phase sequence.
- 10 A fuse protection for connection to the three supply phases.

Surge protection: If considered necessary, provide Type I SPD shunt connected metal oxide varistor based SPDs between each phase and neutral at assembly incoming supply terminals.

Surge protection devices:

- General: To IEC 61643-11 and IEC 61643-12.
- Installation: To AS/NZS 3000 Appendix F.

3.8 ELECTRICAL REQUIREMENTS FOR PUMP STATION BUILDINGS

General: If the pumping equipment is installed within a pump station building, provide the following:

- Fluorescent lighting within the building using sealed corrosion resistant lighting fittings with electronic ballasts.

- 10 A, 240 V switched power outlets. Quantity and location to suit pumping station requirements.
- 15 A, 240 V switched power outlet suitable for electric welding requirements.
- RCD protection to AS/NZS 3000 requirements.

Lighting switches and power outlets: Ironclad or high impact polycarbonate industrial type.

Conduits:

- Electrical accessories: Heavy duty UPVC conduit.
- Pumping equipment: Heavy duty conduit, on tray or on cable ladder.

3.9 WET-WELL PIPEWORK

General

Pump discharge pipework: Document the pump discharge pipework in conformance with WSA 02 clause 9.1 and the following:

- Vertical pipework in the wet-well.
- Horizontal pipework up to the pressure main isolating valve.
- Emergency bypass pipework and valves.
- Sizing of pipework.
- Type of pipework.
- Air release valves to AS 4883.
- Valve chambers.
- Dismantling joints.
- Pipework supports.
- Main tappings.
- Access covers.
- Emergency pumping arrangements including condition monitoring and maintenance.
- Drain from valve pit back into wet well.

Pressure main

Site test pressure: Document the allowable site test pressure taking into account all parameters including surge.

Location: Document the location of pressure mains in conformance with WSA 02 clause 10.2.

Hydraulic design: Provide hydraulic design in conformance with WSA 02 clause 10.3 including total mean head, mean static head, friction head loss, fitting head loss. Document the hydraulic design including the following:

- Velocity in pressure mains.
- Sizing of pressure mains.
- Maximum design pressure.
- Surge.
- Pipe and fitting pressure class.
- Pressure main valves.
- Odour and septicity control.
- Receiving system including discharge MHs.

Supporting systems

General: Conform to WSA 04 clause 2.15.

Health and safety

General: Conform to WSA 04 clause 2.16.

4 ADDITIONAL DESIGN REQUIREMENTS FOR VACUUM SEWERAGE

4.1 GENERAL

Detailed design

Reticulation: Conform to *0076 Sewerage systems – reticulation (Design).*

Vacuum generation rate: < 5 starts per hour for the sewage discharge pumps. Equates to approximately 1.33 times design flow.

Vacuum generators and pipework: Determine the following in conformance with WSA 06 clause 6.6:

- Vacuum generator capacity.
- Evacuation time.
- Vacuum generator selection: Liquid ring, sliding vane oil lubricated or rotary lobe vacuum generators.
- Vacuum generator operating vacuum: Determined from the reticulation design.
- Select electric motors.
- Vacuum pipework and valves.
- Make up water tank.

Emergency pumping: Provide facilities for emergency bypass pumping and/or pumpout within the vacuum station or in a separate pit.

Sewage discharge pumps: Determine motors, shaft seals, equalisation lines, total dynamic head (TDH), net positive suction head and delivery pipework in conformance with WSA 06 clause 6.8.

Gauges and recorders: Determine vacuum and pressure gauges and recorders in conformance with WSA 06 clause 6.9.

Skid-mounted packaged stations: Provide an assembly drawing including the dry weight of all packaged stations.

4.2 POWER SYSTEM

Power supply

General: Determine the power supply requirements in conformance with WSA 06 clause 7.2.

Primary supply: Provide for 3 phase, 4 wire, 400 V, 50 Hz, MEN system with capacity to operate at full pumping load.

Fault level protection: Determine the prospective fault current and design the electrical protection to withstand the prospective fault current level of the incoming supply at the equipment location.

Power supply security

Due diligence requirements: To WSA 06 clause 2.3, clause 7.2 and the following:

- Evaluation of reliability/security of power supply.
- Duplicate power supplies.
- An emergency on-site power generator.
- Provision for the connection of a mobile diesel generator.
- Detail security requirements against theft of on-site generators and connections for mobile generators.

4.3 PRIMARY SUPPLY

General

General: Determine the primary power supply requirements in conformance with WSA 06 clause 7.2.3.

Off site electrical services: Liaise and provide all off-site electrical services as required by the local Electricity Distributors.

Switchboards

General: Document the switchboards in conformance with WSA 06 clause 7.3,2, AS 3439.1.

Metering requirements: To WSA 06 clause 7.3.3.

Lighting requirements: To WSA 06 clause 7.3.4.

Power factor correction: Consider power factor correction requirements as set out in WSA 06 clause 7.2.8.

Connection facilities for mobile diesel generators: To WSA 06 clause 7.2.7.

4.4 CONTROL AND TELEMETRY

General

Control, telemetry and alarms: Document control, telemetry and alarm systems in conformance with WSA 06 clause 8 and be compatible with existing systems.

Telephone/telemetry lines: Conform with ACA and AUSTEL standards.

Selection of equipment and devices: To WSA 06 clause 8.2.

4.5 MOTOR STARTERS

General

Standard: To WSA 04 clause 6.8.

4.6 SUPPORTING SYSTEMS

General

Water provision: Provide metered water service to the vacuum station to conform with WSA 06 clause 16.1.2.

Water closet, wash trough and work bench: Conform to WSA 06 clause 16.2.

Materials handling equipment: Conform to WSA 06 clause 16.3.

Security: Document a security plan to conform to WSA 06 clause 16.4.

Lighting: To AS 4282.

Fire control: Document a fire control plan to conform to AS 3959 and WSA 06 clause 16.5.

Detailed design

Structural design for vacuum station: Conform to WSA 06 clause 14.1.

Vacuum station layout: To WSA 06 clause 6.3, VAC-1300, VAC-1301.

Permanent stairways: To AS 1657.

Vacuum vessel: Determine the operating volume and document vacuum and moisture removal vessels in conformance with AS 1210 and WSA 06 clause 6.4.3.

Pumping system

Hydraulic design: Conform to WSA 06 clause 11.2.

Pump selection: Conform to WSA 06 clause 11.4, Include for total dynamic head, net positive suction head, impeller selection, electric motors, shaft seals and equalisation lines.

Pump starters and variable speed drives: Conform to WSA 06 clause 11.5.

Emergency stop: Provide an emergency stop to conform to AS/NZS 3000 for electronic starter/controllers or variable speed drives.

Pump discharge pipe work

Hydraulic design: Determine and document the pump discharge pipe work to conform to WSA 06 clause 12.2 and the following:

- Internal level of the vacuum vessel flanged off takes.
- Internal vacuum within the vessel.
- Vacuum station capacity (initial and long term).
- Internal diameter, length, route and materials of the pressure main, including a surge and fatigue analysis.
- Level and profile of the pressure main.
- Level of the pumping discharge point.
- High-points.

5 DOCUMENTATION

5.1 GENERAL

Approvals
Authorities: Bellingen Shire Council

Design reports
Construction documentation: Prepare site investigation report, excavation/trench details, design assumptions, design constraints and other technical matters.

Specifications
Construction documentation: Prepare a project specific specification to *1361 Sewerage systems – pump stations (Construction)*.

Design certification
Requirement: Provide a signed and dated design certificate.

Structural design: Include certification against flotation.

5.2 DRAWINGS

General
Minimum drawing scale:

- Plans and sections: 1:50.
- Structural concrete details: 1:20.
- Structural steelwork details: 1:10.

Electro technical symbols: To AS 1102.

All wires and terminals: Numbered.

Drawing presentation
Drawing size: Consult with the Water Agency.

Drawing format: Provide in electronic form after consultation with the Water Agency.

Title block: Include Water Agency details and a signature block.

Asset register
Maintain: Provide asset schedules and drawings in a form consistent with the existing or proposed Asset Register after consultation with the Water Agency.

Drawings content
General: To WSA 04 Section 15 and the following:

General arrangement of pump stations with site plan:

- Number, make, model and details of pumps.
- Inlet and outlet pipework details and levels.
- Pump cut in.
- Cut out and alarm levels.
- Switchboard location.
- Pump station access details.
- Design starts per hour.
- Overflow storage details.
- Electrical drawings.
- Switch and Control Gear Assemblies (SCA): Fully dimensioned manufacturing details, general arrangement (showing internal/external details) and foundation/gland plate details.
- Common control: Circuit diagram and description of operation.
- Schedule of equipment.
- Other engineering drawings fully describing the proposed equipment.
- Location of pipelines, valves, pipe materials, size pressure class, jointing methods and corrosion protection measures.

- Location of all obstructions.

5.3 WORK-AS-EXECUTED

Work-as-executed drawings
General: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

Final certification of completed works
Requirement:As per development 011 Development and subdivision of land.

0222 EARTHWORK

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide earthworks to the dimensions and tolerances, as documented.

General: The footing or pier depths shown on the drawings are provisional.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Site management*.

1.3 STANDARDS

General

Earthworks: To AS 3798.

General: Conform to the recommendations of those parts of AS 3798 which are referenced in this worksection.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

GITA: Geotechnical inspection and testing authority.

GTA: Geotechnical testing authority.

Definitions

General: For the purposes of this worksection the definitions given in AS 1348, AS 3798 and the following apply:

- Description and classification of soils: To AS 1726.
- Site classification: To BCA 3.2.4.
- Bad ground: Ground unsuitable for the purposes of the works, including fill liable to subsidence, ground containing cavities, faults or fissures, ground contaminated by harmful substances and ground which is or becomes soft, wet or unstable.
- Base: Layer(s) of material forming the uppermost structural element of a pavement and on which the surfacing may be placed.
- Discrepancy: A difference between contract information about the site and conditions encountered on the site, including but not limited to discrepancies concerning the following:
  - . The nature or quantity of the material to be excavated or placed.
  - . Existing site levels.
  - . Services or other obstructions beneath the site surface.
- Rock: Monolithic material with volume greater than 0.5 m^3 which cannot be removed until broken up by rippers or percussion tools.
- Site topsoil: Soil excavated from the site which contains organic matter, supports plant life, conforms generally to the fine to medium texture classification to AS 4419 (loam, silt, clay loam) and is free from:
  - . Stones > 25 mm diameter.
  - . Clay lumps > 75 mm diameter.
  - . Weeds and tree roots.
  - . Sticks and rubbish.

. Material toxic to plants.

- Subbase: The 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.
- Subgrade: The trimmed or prepared portion of the formation on which the pavement or slab is constructed. Generally taken to relate to the upper line of the formation.
- Zone of influence: A foundation zone bounded by planes extending downward and outward from the bottom edge of a footing, slab or pavement and defining the extent of foundation material having influence on the stability or support of the footings, slab or pavement.

1.5 INSPECTION

Notice

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

- Items to be measured as listed in **Records of measurement**.
- Areas to be cleared and/or stripped of topsoil.
- Areas stripped of topsoil.
- Excavation completed to contract levels or founding material.
- Proof roll subgrade before placing fill.
- Filling completed to contract levels.
- Stockpiled topsoil before spreading.

1.6 TOLERANCES

General

Finish: Finish the surface to the required level, grade and shape within the following tolerances:

- Under building slabs and load bearing elements: + 0, - 25 mm.
- Pavement subgrades: + 0, - 40 mm.
- Batters: No steeper than the slope shown on the drawings. Make sure flatter slopes do not impact on boundaries or required clearances to buildings, pavements or landscaping.
- Other ground surfaces: ± 50 mm, provided the area remains free draining and matches adjacent construction where required. Provide smoothness as normally produced by a scraper blade.

1.7 SUBMISSIONS

Design

Calculations: Submit calculations by a professional engineer to show that proposed excavations and temporary supports, including where applicable supports for adjacent structures, will be stable and safe.

Execution details

Report: Submit a time based schedule noting the methods and equipment proposed for the groundworks, including the following:

- Dewatering and groundwater control and disposal of surface water.
- Excavation methods, stages, clearances, batters and temporary supports.
- Stockpiles and borrow pits.
- Placing and compaction methods and stages.

Geotechnical site investigations: Provide a geotechnical report supporting the procedures proposed for excavation.

Disposal location: Submit the locations and evidence of compliance with the relevant authorities for the disposal of material required to be removed from site.

Temporary shoring: Provide a proposal for any temporary shoring or underpinning required including the progressive removal.

Proof rolling: Submit method and equipment for proof rolling.

Certified records of measurement: Submit a certified copy of the agreed records of measurement.

Construction records: Submit the following to AS 3798 clause 3.4 and Appendix B:

- Geotechnical site visit record; and

- Earthworks summary report or daily geotechnical reports.

Materials

Imported fill: Submit certification or test results by a GTA registered laboratory which establish the compliance of imported fill with the contract including the source.

Tests

Compaction: Submit certification and/or test results in conformance with the specified level of responsibility to AS 3798.

2 PRODUCTS

2.1 FILL MATERIALS

General

Suitable material: To AS 3798 clause 4.4 including inorganic, non-perishable material suitably graded and capable of compaction to the documented density.

Unsuitable materials: Do not use unsuitable material for fill in conformance with AS 3798 clause 4.3.

Sulphur content: Do not provide filling with sulphur content exceeding 0.5 % within 500 mm of cement bound elements (for example concrete structures or masonry) unless such elements are protected by impermeable membranes or equivalent means.

Re-use of excavated material: Only re-use suitable material in conformance with AS 3798 clause 4.4.

Stockpiles: Segregate the earth and rock material and stockpile, for re-use in backfilling operations.

Locations: Do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along gutters where stockpiling is permitted along the line of the trench excavation.

Disposal: If stockpiling is not permitted under the contract, dispose of excavated material off-site to AS 3798 clause 6.1.8.

2.2 BORROW OR IMPORTED FILL

Borrow or imported material: Only when no suitable excavated material is available.

- Suitable material: To AS 3798 clause 4.4.

Borrow pits:

- Location: More than 3 m from any fence line, boundary, edge of excavation or embankment.
- Strip and stockpile topsoil.
- Provide erosion protection during winning operations of material and ensure drainage is maintained.
- On completion of winning operations grade abrupt changes of slope, respread topsoil and apply and maintain hydroseeded grassing.

3 EXECUTION

3.1 SITE PREPARATION

Erosion and sedimentation control

Drainage, erosion and sedimentation control: To the *Site management* worksection.

3.2 GEOTECHNICAL

As found site conditions

General: If the following are encountered, give notice immediately and obtain instructions before carrying out any further work in the affected area:

- Bad ground.
- Discrepancies.
- Rock.
- Springs, seepages.
- Topsoil > 100 mm deep.

Inspection and testing

Inspection and testing: Conform to the following:

- Level 1 GITA required to AS 3798 clause 8.2.

- Level 2 GTA required to AS 3798 clause 8.3.

3.3 RECORDS OF MEASUREMENT

Excavation and backfilling

Agreed quantities: If a schedule of rates applies, provisional quantities are specified, or there are variations to the contract levels or dimensions of excavations, do not commence backfilling or place permanent works in the excavation until the following have been agreed and recorded:

- Depths of excavations related to the datum.
- Final plan dimensions of excavations.
- Quantities of excavations in rock.

Method of measurement: By registered surveyor unless otherwise agreed.

Rock

Level and class: If rock is measured for payment purposes, whether as extra over excavation of material other than rock or for adjustment of provisional measurements, do not remove the rock until the commencing levels and the classes of rock have been determined.

3.4 REMOVAL OF TOPSOIL

General

Extent: Areas of cut or fill and areas occupied by structures, pavements and embankments.

Maximum depth: 200 mm.

Topsoil stockpiles

General: Stockpile site topsoil intended for re-use and imported topsoil where necessary.

Stockpile heights: Establish stockpiles to maximum height of 1.5 m.

Mark: Identify stockpiles of different soil types.

Vegetation: Do not burn off or remove plant growth which may occur during storage.

Protection: Provide the following:

- Drainage and erosion protection.
- Do not allow traffic on stockpiles.
- If a stockpile is to remain for more than four weeks, sow with temporary grass.
- Protect the topsoil stockpiles from contamination by other excavated material, weeds and building debris.

Remove: Remove topsoil that is unsuitable for re-use from the site to AS 3798 clause 6.1.8.

3.5 EXCAVATION

Extent

Site surface: Excavate over the site to give correct levels and profiles as the basis for structures, pavements, filling and landscaping. Make allowance for compaction, settlement or heaving.

Footings: Excavate for footings, pits, wells and shafts, to the required sizes and depths. Confirm that the foundation conditions meet the design bearing capacity.

Rock

General: Do not use explosives.

Existing footings

Requirement: If excavation is required within the zone of influence of an existing footing, use methods including (temporary) shoring or underpinning which maintain the support of the footing and make sure that the structure and finishes supported by the footing are not damaged.

Existing services

Location: Before commencing 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.

Excavation: Do not excavate by machine within 1 m of existing underground services.

Proof rolling

Extent: Proof roll excavations for pavements, filling and non-spanning slabs on ground to determine the presence of any bad ground.

Proof rolling method and equipment: To AS 3798 clause 5.5.

Outcome: If excessive settlement, rebound or heaving is encountered, provide test pits or trenching to determine the extent of bad ground.

Disposal of excess excavated material

General: Remove excess excavated material from site not required or unsuitable for fill.

- Standard: To AS 3798 clause 6.1.8.

3.6 SUBGRADES AFFECTED BY MOISTURE

General

General: If the subgrade is unable to support construction equipment, or it is not possible to compact the overlying pavement only because of a high moisture content, perform one or more of the following:

- Allow the subgrade to dry until it will support equipment and allow compaction.
- Scarify the subgrade to a depth of 150 mm, work as necessary to accelerate drying, and recompact when the moisture content is satisfactory.
- Excavate the wet material and remove to spoil, and backfill excavated areas.

3.7 BEARING SURFACES

General

General: Provide even plane bearing surfaces for loadbearing elements including footings. Step to accommodate level changes. Make the steps to the appropriate courses if supporting masonry.

Deterioration

General: If the bearing surface deteriorates because of water or other cause, excavate further to a sound surface before placing the loadbearing element.

3.8 REINSTATEMENT OF EXCAVATION

General

Fill adjacent structures and trenches: To AS 3798 clause 6.2.6.

Zone of influence: Within the zone of influence of footings, beams, or other structural elements, use concrete of strength equal to the structural element, minimum 15 MPa. Ensure that remedial concrete does not create differential bearing conditions.

Below slabs or pavements: Provide selected fill compacted to the specified density.

Cut subgrades: Where the over excavation is less than 100 mm, do not backfill. Make good by increasing the thickness of the layer above.

Rock depressions and subsoil drains: Backfill rock depressions and over excavation of subsoil drains using coarse subsoil filter.

3.9 SUPPORTING EXCAVATIONS

Removal of supports

General: Remove temporary supports progressively as backfilling proceeds.

Voids

General: Guard against the formation of voids outside sheeting or sheet piling if used. Fill and compact voids to a dry density similar to that of the surrounding material.

3.10 ADJACENT STRUCTURES

Temporary supports

General: Provide supports to adjacent structures where necessary, sufficient to prevent damage arising from the works.

Lateral supports: Provide lateral support using shoring.

Vertical supports: Provide vertical support where necessary using piling or underpinning or both.

Permanent supports

General: If permanent supports for adjacent structures are necessary and are not described, give notice and obtain instructions.

Encroachments

General: If encroachments from adjacent structures are encountered and are not shown on the drawings, give notice and obtain instructions.

Zone of influence
Angle from horizontal: 45 degrees

3.11 ROCK BOLTING

General
General: Provide proprietary high strength steel bars or tubes anchored into holes drilled in the rock and tensioned against plates bearing on the rock face to provide temporary or permanent support for the rock face. Schedule the installation to conform to systematic bolting or calculated relief, as documented.

Standard: To AS 4678.

Protection
General: Protect permanent rock bolts by grouting the drilled hole with cement grout after tensioning the rock bolt. Protect the bearing plate and the exposed portion of rock bolt and anchorage with a protective coating or by embedment in concrete.

3.12 PREPARATION FOR FILLING

Preparation
Stripping: Prepare the ground surface before placing fill (including topsoil fill), ground slabs or load bearing elements to AS 3798 clause 6.1.5. Remove materials which will inhibit or prevent satisfactory placement of fill layers, loose material, debris and organic matter.

Foundation preparation: To AS 3798 clause 6.1.7.

Compaction: Compact the ground exposed after stripping or excavation to the minimum relative compaction in AS 3798 Section 5 and the **Compaction table.**

Scarify method: Loosen exposed excavation by scarifying to a minimum or 150 mm, moisture condition and compact to AS 3798 Section 5 and the **Compaction table**.

Impact roller compaction: Use an approved impact roller or impact completion.

Slope preparation: If fill is placed on a surface which slopes steeper than 4 H:1 V, bench the surface to form a key for the fill. As each layer of fill is placed, cut the existing ground surface progressively to form a series of horizontal steps more than 1 m in width and more than 100 mm deep. Recompact the excavated material as part of the filling. Shape to provide free drainage.

Under earth mounds
General: Cultivate the ground to a depth of 200 mm before mound formation.

Under slabs, paving and embankments
General: Compact the ground to achieve the densities specified in the **Compaction table**. If necessary loosen the ground to a depth of more than 200 mm and adjust the moisture content before compaction to a density consistent with subsequent filling.

Rock ledges
General: Remove overhanging rock ledges.

3.13 GEOTEXTILE

General
Material: UV stabilised polymeric fabric formed from a plastic yarn composed of at least 85% by weight.

Identification and marking: To AS 3705.

Preparation: Trim the ground to a smooth surface free from cavities and projecting rocks.

Placing: Lay the fabric flat, but not stretched tight, and secure it with anchor pins. Overlap joints 300 mm minimum.

3.14 PLACING FILL

General
Layers: Place fill in near-horizontal layers of uniform thickness, deposited systematically across the fill area.

Extent: Place and compact fill to the designated dimensions, levels, grades, and cross sections so that the surface is always self draining.

Edges: At junctions of fill and existing surfaces, do not feather the edges.

Mix: Place fill in a uniform mixture.

Previous fill: Before placing subsequent fill layers, ensure that previously accepted layers still conform to requirements, including moisture content.

Protection: Protect the works from damage due to compaction operations. Where necessary, limit the size of compaction equipment or compact by hand. Commence compacting each layer at the structure and proceed away from it.

Protective covering: Do not disturb or damage the protective covering of membranes during backfilling.

Placing at structures

General: Place and compact fill in layers simultaneously on both sides of structures, culverts and pipelines to avoid differential loading. Carefully place first layers of fill over the top of structures.

Concrete: Do not place fill against concrete retaining walls until the concrete has been in place for 28 days unless the structure is supported by struts.

3.15 PLACING TOPSOIL

Stockpiled topsoil

Cultivation: Rip to a depth of 100 mm or to the depth of rippable subgrade if less. Cultivate around services and tree roots by hand. Trim to allow for the required topsoil depth.

Herbicide: Apply before placing topsoil.

Placing: Spread and grade evenly.

Disposal of excess topsoil

On-site: Dispose of surplus topsoil remaining on site by spreading evenly over the areas already placed.

Off-site: Remove excess topsoil from the site and dispose of legally.

Compaction: Lightly compact topsoil so that the finished surface is smooth, free from lumps of soil, at the required level, ready for cultivation and planting.

Edges: Finish topsoil flush with abutting kerbs, mowing strips and paved surfaces. Feather edges into adjoining undisturbed ground.

3.16 FILL MOISTURE CONTROL

General

Moisture content: Adjust the moisture content of fill during compaction within the range of 85 – 115% of the optimum moisture content determined by AS 1289.5.1.1 or AS 1289.5.2.1 as appropriate to achieve the required density.

3.17 COMPACTION REQUIREMENTS FOR FILL AND SUBGRADE

Density

General: Other than rolled fill, to AS 2870 clause 6.4.2(b). Compact the subgrade and each layer of fill to the required depth and density, as a systematic construction operation and to conform to the **Compaction table**. Shape surfaces to provide drainage and prevent ponding.

Compaction table

Location	**Cohesive soils. Minimum dry density ratio (standard compaction) to AS 1289.5.4.1**	**Cohesionless soils. Minimum density index to AS 1289.5.6.1**
Residential: Lot fill, house sites.	95	70
Commercial: Fills to support minor loadings incl. floor loadings < 20 kPa and isolated pad or strip footings < 100 kPa.	98	75
Pavements: Fill to support pavements	95	70
Subgrade to 300 mm deep	98	75

Excavated and stripped ground surface: After excavation and/or stripping, compact these surfaces in conformance with the **Compaction table** to a minimum depth of 150 mm.

Maximum rock and lump size in layer after compaction: 2/3 compacted layer thickness.

Fill batter faces: Either compact separately, or overfill and cut back. Form roughened surfaces to the faces.

Compaction control tests

Compaction control tests: To AS 1289.5.4.1 or AS 1289.5.7.1.

Compaction control test frequency

Standard: To AS 3798 Table 8.1.

Confined operations: 1 test per 2 layers per 50 m^2.

3.18 COMPLETION

Grading

External areas: Grade to give falls away from buildings, minimum 1:100.

Subfloor areas: Grade the ground surface under suspended floors to drain ground or surface water away from buildings without ponding.

Temporary works

Tree enclosures: Remove temporary tree enclosures at completion.

Tree marking: Remove temporary marks and tags at completion.

Temporary supports: Remove temporary supports to adjacent structures at completion.

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.

0223 SERVICE TRENCHING

1 GENERAL

1.1 RESPONSIBILITIES

General

General: Provide trenching for underground services, as documented.

Design

Steel shoring and trench lining systems: To AS 4744.1.

Hydraulic shoring and trench lining equipment: To AS 5047.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Earthwork.*
- *Pavement base and subbase.*
- *Asphaltic concrete.*
- *Sprayed bituminous surfacing.*
- *Segmental pavers – mortar and adhesive bed.*
- *Segmental pavers – sand bed.*

1.3 STANDARDS

General

Earthworks: To AS 3798.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- CBR value: California Bearing Ratio value.

1.5 INSPECTION

Notice

Inspection: Give notice so that inspection may be made at the following stages:

- Service trenches excavated before laying the service.
- Services laid in trenches and ready for backfilling.

1.6 TOLERANCES

General

Earthworks: To **Tolerances** in the *Earthwork* worksection.

1.7 SUBMISSIONS

General

Extent: Submit a plan of trench works noting the location and type of service.

Notice: Advise proposed duration of open excavation.

Construction: Submit details of proposed equipment and method of excavation.

Stability: If shuttering and/or bracing of the sides of a trench is required for safety and stability, provide proposals.

Geotechnical data: Provide a geotechnical report supporting the procedures proposed for trenching and/or boring.

Hazards: Identify WHS hazards that may be encountered with deep trenches including toxic gases and liquids.

Boring: Submit proposals for the following:

- Limits on length.
- Existence of other services and method of protection.
- Pressure grouting to voids.
- The effect of pressure grouting on other services, ground heave and proposals for minimising such effects.
- Access to properties outside the site.
- Council permits.
- Service interruptions including a plan for minimising unintended interruptions.

Off site disposal
Disposal location: Submit the locations and evidence of compliance with the relevant authorities for the disposal of material required to be removed from the site.

2 PRODUCTS

2.1 FILL MATERIALS

General
Requirement: Provide fill materials including borrow or imported fill to **Fill materials** and **Borrow or imported fill** in the *Earthwork* worksection.

3 EXECUTION

3.1 EXISTING SERVICES

Location
Requirement: Before commencing service trenching, locate and mark existing underground services in the areas which will be affected by the service trenching operations.

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

Excavation
General: Do not excavate by machine within 1 m of existing underground services.

3.2 EXISTING SURFACES

Concrete and asphalt pavements
Method: Sawcut trench set out lines for the full depths of the bound pavement layers except where the set out line is located along expansion joints.

Removal of concrete and asphalt: Break out concrete or asphalt pavement material between the trench set out lines, remove and dispose of off-site.

Segmental paving units
Removal: Take up segmental paving units both full and cut by hand, between the trench set out lines, and neatly stack on wooden pallets.

Concrete edging: Break out, remove and dispose of off-site.

Concrete subbase: If present, sawcut along the trench set out lines.

Grass
Method: Neatly cut grass turf between trench set out lines into 300 mm squares. If the grass is suitable for re-use, take up and store the turf and water during the storage period, otherwise remove and dispose of it off-site.

Small plants, shrubs and trees
Storage: If required for re-planting, take up small plants and store. Wrap the root ball in a hessian or plastic bag with drain holes and water during the storage period.

Unsuitable vegetation: Remove and dispose of off-site.

3.3 EXCAVATING

Site preparation
As found site conditions: To **Geotechnical** in the *Earthwork* worksection.

Records of measurement: If Records of measurement are required, to **Records of measurement** in the *Earthwork* worksection.

Remove topsoil: To **Removal of topsoil** in the *Earthwork* worksection.

Excavation

General: Excavate for underground services in conformance with the following:

- To required lines and levels, with uniform grades.
- Straight between access chambers, inspection points and junctions.
- With stable sides.
- Width tolerance: ± 50 mm, unless constrained by adjacent structures.
- Excavation: To the *Earthwork* worksection **Excavation** and **Adjacent structures**.

Trench widths

General: Keep trench widths to the minimum consistent with the laying and bedding of the relevant service and construction of access chambers and pits.

Trench depths

General: As required by the relevant service and its bedding method.

Adjacent to footings: If excavation is necessary below the zone of influence of the underside of adjacent footings, give notice, and provide support for the footings as instructed.

Obstructions

General: Clear trenches of sharp projections. Cut back roots encountered in trenches to at least 600 mm clear of services. Remove other obstructions including stumps and boulders which may interfere with services or bedding.

Tree protection: To AS 4970.

Dewatering

General: Keep trenches free of water. Place bedding material, services and backfilling on firm ground free of surface water.

Pumping: Provide pump-out from adjacent sumps or install well points.

Adjacent subsidence: Provide recharge points to isolate the dewatering zone.

Excess excavation

General: If trench excavation exceeds the correct depth, reinstate to the correct depth and bearing value using compacted bedding material or sand stabilised with 1 part of cement to 20 parts of sand by volume.

Stockpiles

Excavated material for backfill: If required, segregate the earth and rock material and stockpile, for re-use in backfilling operations.

Locations: Do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along gutters where stockpiling is permitted along the line of the trench excavation.

Disposal: If stockpiling is not permitted, dispose of excavated material off-site.

Unsuitable material

Disposal: Remove unsuitable material from the bottom of the trench or at foundation level and dispose of off-site. Replace with backfill material to **Backfill material.**

Boring

Subcontractor: If under road boring is required in lieu of trenches, engage a suitably qualified subcontractor to do the work.

3.4 TRENCH BACKFILL

General

Timing: Backfill service trenches as soon as possible after laying and bedding the service, if possible on the same working day.

Marking services: Underground marking tape to AS/NZS 2648.1.

Place fill: To **Placing fill** in the *Earthwork* worksection.

Bedding, haunch, side and overlay zones

Installation and material: To the particular utility authority or utility service requirements. Secure pipes against floatation.

Overlay zone thickness: Maximum of 300 mm immediately over the utility service.

Topsoil areas: Complete the backfilling with at least 100 mm of topsoil.

Material in reactive clay areas: In sites classified M, M-D, H1, H1-D, H2, H2-D, E or E-D to AS 2870, re-use excavated site material at a moisture content within ± 1% of that of the adjoining in situ clay.

Selected material zone

Extent: The section of trench within the zone, if applicable.

Backfill material: Selected material free from stones larger than 100 mm maximum dimension and the fraction passing a 19 mm Australian Standard sieve to have a 4 day soaked CBR value, in conformance with AS 1289.6.1.2, and not less than that of the adjacent selected material zone.

Trees

General: Backfill at trees, for a minimum 300 mm thickness, around tree roots with a topsoil mixture, placed and compacted in layers of 150 mm minimum depth to a dry density equal to that of the surrounding soil.

Backfill level: Do not place backfill material above the original ground surface around tree trunks or over the root zone.

Watering: Thoroughly water immediately after backfilling the tree root zone.

Compaction

Control moisture within backfill: To **Fill moisture control** in the *Earthwork* worksection.

Layers: Compact all material in layers not exceeding 150 mm compacted thickness. Compact each layer to the relative compaction specified before the next layer is commenced.

Compaction: To **Compaction requirements for fill and subgrade** in the *Earthwork* worksection and AS 3798 Section 5.

Frequency of testing: To AS 3798 clause 8.7.

Precautions: If compacting adjacent to utility services, use compaction methods which do not cause damage or misalignment.

Density tests

Testing authority: Have density tests of pipe bedding and backfilling carried out by a Registered testing authority.

Test methods:

- Compaction control tests: To AS 1289.5.4.1 or AS 1289.5.7.1.
- Field dry density: AS 1289.5.3.2 or AS 1289.5.3.5.
- Standard maximum dry density: AS 1289.5.1.1.
- Dry density ratio: AS 1289.5.4.1.
- Density index: AS 1289.5.6.1.

3.5 SURFACE RESTORATION

Subbase and base

Material: Provide crushed rock, DGS20 or DGB20 material and configure in layers and depths to match existing and adjacent work.

Supply and installation: To the *Pavement base and subbase* worksection.

Compaction: Uniformly compact each layer of the subbase and base courses over the full area and depth within the trench to a relative compaction of 100 per cent when tested in conformance with AS 1289.5.4.1.

Tests: Test for compaction at a minimum frequency of 1/ every second layer/50 m² of restoration surface area.

Pathways and paved areas generally

Materials: Provide material consistent with the surface existing before commencement of the works.

Subbase: 150 mm crushed stone DGB20 compacted to 100 percent relative compaction in conformance with AS 1289.5.4.1.

Lippage at patches: Match the surface level at any point along the patch's edge with the adjoining footpath surface within ± 5 mm.

Concrete surfaces

Construction: Conform to the following:

- Prime coat the cut edges of the existing surfaces with cement slurry. Lay and compact concrete so that the edges are flush and the centre is cambered 10 mm above the adjoining existing surfaces.
- Material: 25 MPa concrete

- Surface finish and pattern: Match existing adjoining work.
- Minimum thickness: 75 mm or the adjacent pavement thickness, whichever is thicker.
- Reinforcement and dowels: If required, provide steel reinforcement with dowels into the adjacent concrete.
- Expansion joints: 15 mm thick preformed jointing material of bituminous fibreboard placed where new concrete abuts existing concrete and in line with joints in existing concrete.
- Control joints:
  . Form control joints strictly in line with the control joints in existing concrete.
  . Around electricity supply poles: Terminate the concrete paving 200 mm from the pole and fill the resulting space with cold mix asphalt.

Curing: Cure by keeping continuously wet for 7 days.

Asphalt footpaths

Materials and installation: To the *Asphaltic concrete* or *Sprayed bituminous surfacing* worksections as appropriate.

Thickness: Match the adjoining footpath.

Finish: Compact to a smooth even surface.

Segmental paving units

Materials and installation: To *Segmental pavers – sand bed* or *Segmental pavers – mortar and adhesive bed* as appropriate and as follows:

- Laying: Re-lay to match the pattern and surface levels of the existing paving.
- Damaged paving units: Replace paving units which are unsuitable for relaying with new units of the same material, type, size and colour as the existing.

Landscaped areas

In topsoil areas: Complete the backfilling with topsoil for at least the top 100 mm.

Lawn: Re-lay stockpiled turf. If existing turf is no longer viable, re-sow the lawn over the trench and other disturbed areas.

Planted areas: Overfill to allow for settlement.

0224 STORMWATER – SITE

1 GENERAL

1.1 RESPONSIBILITIES

General
General: Provide stormwater drainage, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- *General requirements*.
- *Earthwork*.
- *Hydraulic pumps* for pumped discharge.

1.3 STANDARDS

Stormwater drainage
Standard: To AS/NZS 3500.3.

1.4 INTERPRETATION

Definitions
General: For the purposes of this worksection the following definition applies:
- Pipe surround: Includes pipe overlay, pipe side support, side zone and haunch zone.

1.5 INSPECTION

Notice
Inspection: Give notice so that inspection may be made at the following stages:
- Excavated surfaces prior to placing bedding material.
- Concealed or underground services prior to being covered.
- Pipe joints before covering.
- Placing of cast in situ concrete.
- Upon completion.

1.6 SUBMISSIONS

Products – documentation
Conformance: Produce documentary evidence that the pipes conform to the requirements of this worksection.

Samples
General: Submit samples of the following:
- Each type of imported pipe bedding material.
- Each type of filter material.

Tests
Results: Submit results from pre-completion leak testing.
Certification: Submit certificate stating that network is leak free upon completion.

2 PRODUCTS

2.1 MATERIALS

Concrete and mortar
Concrete: To AS 1379 and the following:
- Grade: N15.
- Cement: To AS 3972.

. Type: GP, GL or GB.

Steel reinforcement:

- Bars and machine welded mesh: To AS/NZS 4671.

Joints

Solvent cement and priming fluid: To AS/NZS 3879.

Type of pipes and fittings

Fibre reinforced cement (FRC): To AS 4139 and the following:

- ≤ 450 mm diameter: Rubber ring joints to AS 4139.
- > 450 mm diameter: With a purpose machined internal spigot and socket system within the pipe wall.

Glass-reinforced polyester (GRP): To AS 3571.1.

Cast iron access chamber covers and frames: To AS 1830 or AS 1831, as appropriate.

Polyvinyl chloride (PVC): To AS/NZS 1254, AS/NZS 1260 or AS 1273, as appropriate.

Polyethylene (PE): To AS/NZS 4129, AS/NZS 4130, ISO 8770 or AS/NZS 2033, as appropriate.

Precast concrete: To AS/NZS 4058.

Rubber ring joints/elastomeric seals: To AS 1646.

Plastic pipe for subsoil drainage: To AS 2439.1.

Vitrified clay or ceramic: To AS 1741.

Bedding material

Bed and haunch zones: Provide granular material graded to AS 1141.

Conformance: Conform to the **Bedding material grading table**.

Bedding material grading table

Sieve size (mm)	**Weight passing %**	
	Bed and haunch	**Side zones**
75.0	-	100
19.0	100	-
9.5	-	50-100
2.36	50-100	30-100
0.60	20-90	15-50
0.30	10-60	-
0.15	0-25	-
0.075	0-10	0-25

Filter material

General: Provide filter materials consisting of natural clean washed sands and gravels and screened crushed rock conforming to AS/NZS 3500.3 clause 2.14.1.

2.2 GEOTEXTILES

General

Requirement: Provide polymeric fabric formed from plastic yarn composed of at least 85% by weight propylene, ethylene amide or vinylidene chloride and containing stabilisers or inhibitors which provide resistance to deterioration due to ultraviolet light.

Subsoil drainage

Filter: Conform to AS/NZS 3500.3 clause 2.14.2.

2.3 PREFABRICATED PITS

General

Requirement: Provide precast or prefabricated pits in conformance with AS/NZS 3500.3 clauses 2.13.8 and 8.6.

Metal access covers and grates

Standard: To AS 3996.

2.4 STORMWATER DRAINAGE PUMPS

General

Standard: To AS/NZS 3500.3 Section 9.

Requirement: Conform to **Pumped discharge system** in the *Hydraulic pumps* worksection.

3 EXECUTION

3.1 PIPING

General

Laying: Lay lengths separately with the barrel bearing evenly on the prepared bedding.

Sockets: Lay with sockets pointing upstream.

Cleaning: Clean pipe interior of dirt, debris, mortar and other foreign matter.

Protection: Provide temporary caps over the ends of incomplete sections to prevent the entry of foreign matter.

3.2 TOLERANCES

General

Requirement: Conform to the **Pipeline tolerances table**. These tolerances are conditional on falls to outlets being maintained and no part of a pipeline having less than the documented gradient.

Pipeline tolerances table

	Permissible angular deviation from the documented alignment	**Permissible displacement from the documented positions**
Horizontal	1:300	15 mm
Vertical	1:500	5 mm

3.3 STORMWATER DRAINS

Location

General: Provide stormwater drains to connect surface drains, subsoil drains and drainage pits to the outlet point or point of connection. Make sure that location of piping will not interfere with other services and building elements not yet installed or built. Subject to the preceding and documented layouts, follow the most direct route with the least number of changes in direction.

Laying

General: Lay in straight lines between changes in direction or grade with socket end placed upstream. If other pipes are adjacent, set each pipe true to line and complete each joint before laying the next pipe. If work is not continuous cap open ends to prevent entry of foreign matter.

Identification

General: Lay a detectable strip or plastic tape in the trench after pipe laying, testing and initial backfilling.

Pipe underlay (bedding)

General: Bed piping on a continuous underlay of bedding material, minimum 75 mm, maximum 150 mm thick after compaction. Grade the underlay evenly to the gradient of the pipeline.

Chases: If necessary, form chases to prevent projections such as sockets and flanges from bearing on the trench bottom or underlay.

Pipe surrounds

General: Place the material in the pipe surround in layers ≤ 200 mm loose thickness, and compact without damaging or displacing the piping.

Trench backfill

General: Backfill the remainder of the trench to the underside of the subgrade with fill material in conformance with the *Earthwork* worksection.

Lifting holes

General: Seal lifting holes in all pipes with plastic preformed plugs or 3:1 sand:cement mortar, before the commencement of backfilling.

Anchor blocks
General: If necessary, to restrain lateral and axial movement of the stormwater pipes, provide anchor blocks at junctions and changes of grade or direction conforming to AS/NZS 3500.3 clause 8.10.

Encasement
General: As documented in the **Stormwater pipeline schedule**.

Location: Encase the pipeline in concrete at least 150 mm above and below the pipe, and 150 mm each side or the width of the trench, whichever is the greater.

3.4 SUBSOIL DRAINS

General
Requirement: Provide subsoil drains to intercept groundwater seepage and prevent water build-up behind walls and under pavements. Connect subsoil drains to surface drains or to the stormwater drainage system as applicable.

Piping: As documented in the **Subsoil pipeline schedule**.

Trench width: ≥ 450 mm.

Trench floor: Grade the trench floor evenly to the gradient of the pipeline. If the trench floor is rock, correct any irregularities with compacted bedding material.

Pipe depth: Provide the following minimum clear depths, measured to the crown of the pipe, where the pipe passes below the following elements:

- 100 mm below subgrade level of the pavement, kerb or channel.
- 100 mm below the average gradient of the bottom of footings.
- 450 mm below the finished surface of unpaved ground.

Jointing
General: At junctions of subsoil pipes, provide tees, couplings or adaptors to AS 2439.1.

Pipe underlay (bedding)
General: Bed piping on a continuous underlay of bedding material, minimum 75 mm, maximum 150 mm thick after compaction. Grade the underlay evenly to the gradient of the pipeline.

Chases: If necessary, form chases to prevent projections such as sockets and flanges from bearing on the trench bottom or underlay.

Pipe surrounds
General: Place the material in the pipe surround in layers ≤ 200 mm loose thickness, and compact without damaging or displacing the piping.

Depth of overlay:

- To the underside of the bases of overlying structures such as pavements and channels.
- To within 150 mm of the finished surface of unpaved or landscaped areas.

Geotextiles
Marking: To AS 3705.

Laying: Place geotextile as documented.

Protection: Provide heavy duty protective covering. Store clear of the ground and out of direct sunlight. During installation do not expose the filter fabric to sunlight for more than 14 days.

Filter socks
General: Provide polyester permeable socks capable of retaining particles 0.25 mm and greater. Securely fit or join the sock at each joint.

3.5 PITS

Installation
General: Prepare foundation, install pit and connect pipes, to manufacturer's recommendations.

Location: At junctions, changes of gradient and changes of direction of stormwater drains, as documented.

Finish to in-situ exposed surfaces
General: Provide a smooth, seamless finish, using steel trowelled render or concrete cast in steel forms.

Corners: Cove or splay internal corners.

Metal access covers and grates
Cover levels: Top of cover or grate, including frame:
- In paved areas: Flush with the paving surface.
- In landscaped areas: 25 mm above finished surface.
- Gratings taking surface water runoff: Locate to receive runoff without ponding.

3.6 TESTING

Pre-completion tests
General: Before backfilling or concealing, carry out the following tests:
- Site stormwater drains and main internal drains: Air or water pressure test to AS/NZS 3500.3 Section 10.

Leaks: If leaks are found, rectify and re-test.

3.7 COMPLETION

Cleaning
General: Clean and flush the whole installation.

0257 LANDSCAPE – ROADWAYS AND STREET TREES

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Provide vegetation as documented to the following areas:

- Cut and fill batters
- Pathway verges
- Median areas and open drains, and
- Street tree planting.

Performance

Erosion control: To *1102 Control of erosion and sedimentation*.

Selections: Conform to the selections in **Annexure A**.

Design

Authority requirements: Conform to the following:

- Statutory requirements for Work Heath and Safety.
- Council planting lists.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksections:

- *0136 General requirements (Construction).*
- *0152 Schedule of rates – supply projects.*
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1102 Control of erosion and sedimentation.*
- *1112 Earthworks (Roadways).*
- *1424 Landscape - maintenance.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents incorporated in this worksection by reference:

AS 1160-1996	Bituminous emulsions for the construction and maintenance of pavements
AS 2507-1998	The storage and handling of agricultural and veterinary chemicals
AS 4419-2003	Soils for landscaping and garden use
AS 4454-2012	Composts, soil conditioners and mulches
AS 4843-2001	Synthetic weed blocking fabric

1.4 STANDARDS

General

Storage and handling of pesticides: To AS 2507.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

NPK ratio: Nitrogen:Phosphorous:Potassium ratio.

Definitions

General: For the purposes of this worksection the following definitions:

Ameliorant: Material used to make or improve soil.

Anionic bitumen: A type of bituminous emulsion where dispersed particles comprise a bituminous binder and are negatively charged.

1.6 SUBMISSIONS

Soil tests for imported topsoil

Report: Submit a certificate noting the:

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

Ameliorants recommendation: If required to include ameliorants, recommend the source of ameliorant material, rates and methods of incorporation.

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 each type specified. Submit bulk material samples, with required test results, at least 10 working days before bulk deliveries.

Seed

Supply: Submit the name/s of the proposed seed supplier/s.

Timing: Within 2 weeks of the acceptance of the tender.

Lead time for native seed: Notify the lead time that may be required to procure native seed species.

Plant provenance

Locality: Provide written certification that all plant material has been grown from locally provenanced stock. If this is not achievable give notice.

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

1.7 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause/subclause	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Transportation	Inspect plants upon delivery to ensure no physical damage or drying out	3 working days prior to transporting	Superintendent

WITNESS POINTS Table

Clause/subclause	Requirement	Notice for inspection by the Superintendent
EXECUTION		
Slopes and drains – Preparation	Maintain sprayed areas undisturbed for 2 weeks	2 weeks
Slopes and drains – Seed mixing	Notice prior to sowing	2 working days
Slopes and drains – Watering	Check for excessive rilling	Progressive
Transplanting street trees – General	Give notice for watering, fertilising root cutting	Progressive
Transplanting street trees – maintenance of on-site plant	Program for regular fertiliser applications	Prior to completing works

material		
Transplanting street trees – Above ground	Approval for pruning of branches	Prior to pruning

2 PRE-CONSTRUCTION PLANNING

2.1 SPECIMEN PLANTS

Properties

Source: From locations where these plant materials are growing in 'natural' ground conditions.

Non-containerised nursery stock: Required.

Presentation: Provide maximum initial impact at the time of project opening.

Properties: To the **Specimen plants schedule**.

Preparation: Program the preparation of specimen plants and preparation works to assure readiness of specimen plants for transplanting to site when required.

Transportation

Responsibility: Ensure plants are transported to the site without physical damage or drying out. This is a **HOLD POINT**.

3 MATERIALS

3.1 SELECTIONS

General

Selections: To **Annexure A**.

3.2 TOPSOIL – MINOR WORKS

General

Source: Imported topsoil and/or topsoil won and stockpiled on site to *1112 Earthworks - Roadways*.

Standard: To AS 4419.

Topsoil description:

- Of a friable, porous nature.
- Free of weeds and weed seeds, bulbs, corms and vegetable propagules.
- Free of refuse or materials toxic to humans, animals or plants.
- Free of stumps, roots, clay lumps or stones larger than 50 mm in size.
- Minimum organic content: 3% by mass.
- pH range: 5.5 to 7.5.
- Maximum soluble salt content: 0.06% by mass.

Health warning: Provide a health warning to conform with AS 4419 on packaging or invoice for bulk supply.

3.3 FERTILISER AND MULCHES

Fertiliser

Type: Organic.

NPK ratio:

- Slopes and open drains: 8:3.6:2 nitrogen: phosphorus: potassium.
- Mass planting: 6.3:1.8:2.8 nitrogen: phosphorus: potassium.

Vegetable mulch

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

Prohibited material: Meadow hay and weeds.

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

Straw mulching

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.

Mulch types

Organic landscape mulch: To AS 4454.

- Composition:
  - . Fines: < 5% by volume.
  - . Woodchip: Maximum size < 50 mm.
  - . Leaf mulch: < 25% by volume.

Quality: Free of weeds and allopathic organisms.

Synthetic weed blocking fabric: To AS 4843.

Hardwood stakes

Material: Sharpened 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.

3.4 PLANT MATERIAL

Seed

Certification: Provide a Certificate of Authenticity for all seed as follows:

- 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, air tight containers and keep away from direct sunlight. Do not expose seed to the elements at any stage during storage.

Seed batch not true to type: Replace.

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.

Species: To **Annexure A**.

Prohibited material: Kikuyu grass.

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

Width of rolls: > 300 mm.

Plant material – minor works

Balance (small plants) assessment requirements:

- Tubes or plant cells: Height above soil level must be between 1.5 and 2.5 times the height of the tube or plant cell.
- Trees and shrubs in containers < 20 L (other than tubes or plant cells) or ex-ground trees of size index < 35 (e.g. 1.4 m high x 25 mm calliper); height must fall within the range indicated for the container size in the Small container-grown plant table.
- Containers/rootballs (other than tubes or plant cells) must remain flat on the ground when the stem, held at 80% of height above ground, is deflected 30º from the vertical, side to side.

Plant stock classification: To the **Small container-grown plant table.**

Plant description:

- Healthy, of good form and not soft or forced.
- Large robust root systems.
- Not rootbound.
- Free from disease and insect pests.

Tree description: Single leading shoot.

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.

Fertilising: Submit details of fertiliser to be used and application rate for approval.

Small container-grown plant table

Minimum rootball diameter or container size	**Height range (m)**	
	Thin-stemmed species	**Thick-stemmed species**
Tubes or plant cells	Height between 1.5 and 2.5 x the height of the container	
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

Plant material – major works

3.5 STREET TREES

General

Labelling: Clearly label individual plants and batches.

- Label type: To withstand transit without erasure or misplacement.

Health

Foliage: Consistent with the size, texture and colour shown in healthy specimens of the nominated species.

Vigour

Extension growth: Consistent with vigorous specimens of the species nominated.

Damage

Supply: Free from damage and from restricted habit due to growth in nursery rows.

Stress

Supply: Free from stress resulting from inadequate watering, excessive shade or excessive sunlight.

Site environment

Grown and hardening off conditions: To suit the conditions that could be reasonably anticipated to exist on site at the time of delivery.

Root development

Final containers: Grow plants in their final containers for the following periods:

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

Pests and disease

Supply: Foliage free from attack by pests or disease.

Native species susceptible to attack by native pests

Evidence of previous attack: To no more than 15% of the foliage. Ensure absence of actively feeding insects.

Large trees (Balance)

Conformance at inspection: To balance (large trees) assessment requirements.

Balance (large trees) assessment requirements:

- For trees grown in containers ≥ 20 L, the size index must lie within the range for the nominal container size shown in the **Common container volumes table.**
- Ex-ground trees with a size index ≥ 35 (e.g. 1.4 m high x 25 mm calliper) must have rootball diameters ≥ the minimum rootball diameters shown in the **Ex-ground trees table**.

Common container volumes table

Size index	Nominal container volume (L)	Size index	Nominal container volume (L)
26-33	20	371-480	450
32-41	25	412-518	500
45-58	35	453-587	550
57-74	45	495-640	600
77-99	60	533-716	700
83-107	75	632-818	800
111-143	100	711-921	900
154-200	150	791-1023	1000
194-251	200	842-1089	1100
227-314	250	918-1188	1200
273-353	300	1148-1485	1500
289-373	350	1530-1980	2000
330-427	400	1913-2475	2500

Ex-ground trees table

Size index	Minimum rootball diameter (mm)	Size index	Minimum rootball diameter (mm)
36–55	350	341–383	850
56–72	400	384–429	900
73–106	450	430–530	1000
107–131	500	531–642	1100
132–156	550	643–732	1200
157–173	600	733–859	1300
174–228	650	860–1144	1500
229–249	700	1145–1507	1750
250–299	750	1508–1968	2000
300–340	800	1969–3075	2500

Photographs: Provide current colour copies with date verification.

3.6 ABOVE-GROUND QUALITIES

Supply

General: Supply only trees that:

- Are free from injury.
- Are self-supporting.
- Have the calliper at any given point on the stem greater than the calliper at any higher point on the stem.

Pruning

Clean stem height: less than 40% of total tree height.

Pruning wounds

Extent: Restrict fresh (i.e. recent, non-calloused pruning wounds) to < 20% of total tree height.

Type: Ensure a clean-cut at the branch collar.

Diameter of wound: less than 50% of the calliper immediately above the point of pruning.

Apical dominance

Species with an excurrent form: Defined central leader and intact apical bud.

Crown symmetry

Crown distribution: Difference on opposite sides of the stem axis < 20%.

Stem structure
Species with excurrent form: Single stem roughly in the centre of the tree with any deviation from vertical less than 15º.

Species with decurrent form: Central stem undivided below the clean stem height nominated with sound stem junction at the point of division.

All species: Branch diameter less than or equal to one-half of the calliper immediately above the branch junction.

Included bark
General: Convex branch/stem bark ridges at junctions between stems and branches and between co-dominant stems.

Trunk position
Variation in distance from the centre of the trunk to the extremity of the rootball: no more than 10%.

Compatibility of graft unions
Union between the scion and rootstock: Sound for the perimeter of the graft.

Diameter of the scion immediately above the graft: Equal to the diameter of the rootstock immediately below the graft (± 20%).

Indication of north
Trees in containers greater than 100 L or of size index greater than 140: Indicate the northerly aspect during growth in the nursery.

General: Indicator to withstand transit without erasure or misplacement.

3.7 STREET TREES – BELOW-GROUND QUALITIES

Root division
Trees in containers less than or equal to 45 L or ex-ground trees with a size index less than or equal to 70: Primary division of roots at less than 100 mm intervals.

Trees in containers greater than 45 L or ex-ground trees with a size index greater than 70: Primary division of roots within the outer 50% of the rootball at less than 100 mm intervals.

Root direction
General: Ensure that roots generally grow in an outwards (radial) or downwards direction from the point of initiation and that any deviation from the established direction is less than 45º.

Trees with a calliper at ground level less than 40 mm: Ensure the diameter of any nonconforming roots at the extremity of the rootball is less than 25% of the calliper.

Trees with a calliper at ground level of 40 mm or larger: Ensure the diameter of any nonconforming roots at the extremity of the rootball is less than 10 mm.

Rootball occupancy
Soil retention: On shaking or handling the unsupported rootball, at least 90% of the soil volume to remain intact.

Rootball depth
Rootball depth assessment for containers/rootballs 45 L or larger:

- Depth: no greater than maximum depth documented.
- Maximum depth (regardless of size): 550 mm.
- Diameter: Greater than or equal to depth.

Height of root crown
General: Ensure that root crown is at the surface of the rootball.

Non-suckering rootstock
Grafted cultivars/varieties: Supply trees grafted onto non-suckering rootstock.

4 EXECUTION

4.1 SLOPES AND DRAINS

Program
Between September and May: Vegetate exposed surfaces before the area exceeds 1 ha.

Between June and August: Do not carry out landscape work to exposed surfaces without approval.

Preparation

Herbicide treatment:

- Spray application
- Rate: To **Annexure A.**
- Program: Maintain sprayed areas undisturbed for 2 weeks. This is a **WITNESS POINT**.

Soil conditioning:

- Material and rate: To **Annexure A.**
- Gypsum application: Acceptable methods:

Spread evenly over the subsoil by a mechanical spreader and topsoil on the same day.

Thoroughly mixed into the topsoil whilst the topsoil is being removed from stockpiles.

- Apply conditioners other than gypsum to the supplier's recommendations and as approved by the Superintendent.

Seed mixing:

- Notice prior to sowing: 2 days. This is a **WITNESS POINT**.
- 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

Application:

- Initial watering: To a uniform moisture condition without run-off.
- After turfing: Re-water to a uniform moisture condition without run-off.
- After sowing: Re-water to a uniform moisture condition without causing rills in the surface, daily for 15 days or as directed.

Excessive rilling: If excessive rilling has occurred, as determined by the Superintendent, re-prepare and re-sow the affected area. This is a **WITNESS POINT**.

4.2 SLOPES 3H TO 1V OR FLATTER

Preparation of the surface

Cultivation: Before topsoiling, tyne to a depth of 200 mm to produce a loose surface and remove all large stones, rubbish and other materials that may hinder germination.

Topsoil

Approval from the Superintendent: Required.

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

Cultivation depth: 50 mm, to provide a roughened surface with soil lumps not exceeding 50 mm.

Incorporation of pesticide

Timing: Immediately before sowing.

Pesticide type: Powder form.

Application: Mix thoroughly with the seed at the rate specified in **Annexure A**, to the equivalent mass of seed to be spread on 1 hectare of the surface in accordance with **Annexure A**.

Grassing

Sowing:

- 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 to **Annexure A**.

Turfing:

- Laying: On the prepared topsoiled surface.
- Runs of turf: Butt hard against each other and be place perpendicular to the direction of water flow.
- Slopes 5:1 to 3:1: Peg turfs and remove pegs when established.

Seams: Topdress with topsoil.

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.

4.3 SLOPES STEEPER THAN 3H TO 1V

Methods

Vegetate slopes by one of the following methods:

- Topsoiling and hydromulching.
- Topsoiling, hydroseeding and straw mulching.
- Hydroseeding.

Determination of method: If not shown on drawings, by the Superintendent.

Preparation of the surface

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

Timing: No more than seven days before seeding.

Method:

- If batters are not stepped: By dragging a steel chain of 30 kg/m minimum weight.
- Elsewhere: As approved by the Superintendent.

Topsoil

Application:

- Stepped batters: Loosely fill with topsoil.
- Elsewhere: Apply uniformly to provide an average thickness of 50 mm with a minimum compacted thickness of 30 mm.

Hydromulching or hydroseeding

Application rate: To the **Hydromulching or hydroseeding table.**

Watering: Water dry surfaces by a fine spray before the application of the hydromulch.

Pesticide:

- Timing: Apply during preparation of the hydromulch or hydroseed slurry.
- Pesticide type: Liquid, added to the slurry storage tank.
- Rate: 5 litres of pesticide to the equivalent volume of hydromulch or hydroseed slurry to be spread on 1 hectare of surface.

Equipment: Clean and free of contamination from previous operations.

Mix: The addition of the specified materials in the 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:

- When temperature is higher than 35°C.
- When winds exceed 15 km/hr.
- Where, in the opinion of the Superintendent, the surface is too wet.
- During rain periods or when rain appears imminent.

Hydromulching or hydroseeding table

Material	**Application rate per hectare**	
	Hydromulching	**Hydroseeding**
Vegetable mulch (kg)	1500	Nil
Water (L)	35,000	20,000
Binder (L)	1200	Nil
Fertiliser	**See Annexure A**	
Seed	**See Annexure A**	
Wetting agent (L)	35	20
Pesticide (L)	5	5

Straw mulching

Application: Apply uniformly by 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 at ≥ 2500 litres per hectare of surface.

Straw mat thickness: ≥ 20 mm at any location.

4.4 OPEN DRAINS

Preparation of the surface

Topsoil: Spread to provide 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.

Sowing

Rate: To **Annexure A**.

Application: Apply uniformly by one of the following procedures as directed by the Superintendent:

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

Surface protection

Provide protection to all or part of the sown surface by one of the following methods:

- 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 listed in **Annexure A**. Lay the runs of matting along the direction of water flow loosely on the soil surface and not stretched. Slot the upstream end of the 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. Provide 'U' shaped pins of 4 mm gauge wire, 50 mm wide and 150 mm long legs. Overlap adjacent runs of matting 100 mm with the higher run lapped over the lower run. Pin the matting along the sides of each run at 500 mm centres and along the middle of each run at 1000 mm centres. Provide end overlaps 150 mm wide with the higher run end lapped over the start of the lower run and pinned at 200 mm centres.
- Turfing: Butt runs of turf hard against each other and placed perpendicular to the direction of water flow in the drain. Pin into position at 500 mm centres. Topdress seams of turf with topsoil.

Determination of method: If not shown on drawings, by the Superintendent.

4.5 LANDSCAPE PLANTING

Conditions

Timing: Give minimum 2 days notice of commencement of planting.

Conditions: Do not carry out landscape planting in extreme weather conditions (above 35°C or below 10°C), unless otherwise approved by the Superintendent.

Preparation generally

Weed management by herbicide spray:

- Rate: To **Annexure A.**
- Program: Maintain sprayed areas undisturbed for 2 weeks.
- Spray drift: Ensure there is no contact with planted material.

Alternative weed management by synthetic weed blocking fabric:

- Extent: 800 mm surrounding each proposed planting.
- Approval: Required.

Soil conditioning:

- Material and rate: To **Annexure A.**
- Gypsum application: Acceptable methods:

Spread evenly over the subsoil by a mechanical spreader and topsoiled on the same day.

Thoroughly mixed into the topsoil whilst the topsoil is being removed from stockpiles.

- Other conditioners: Apply to the supplier's recommendations and as approved.

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 – minor works

This clause is for minor works such as mass planted areas associated with cut and fill batters, pathway verges, median areas and open drains.

Method: Remove the localised mulch. Root prune to ensure 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.

Landscape planting - major works

If the project is of a major scope the following procedure should be followed:

Care of landscape planting – minor works

This clause is for minor works such as mass planted areas associated with cut and fill batters, pathway verges, median areas and open drains.

Watering: Water all plants, from the time of planting, at the rate of 10 litres per plant every third day for the first twelve weeks.

Replacement: Replace missing plants, dead plants and plants nominated by the Superintendent as unhealthy 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 accordance with the manufacturer's instructions at monthly intervals during the construction period and contract maintenance period. Replace plants damaged by herbicide application.

Landscape planting – major works

If the project is of a major scope the following procedure should be followed:

4.6 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.

Planting: 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 prior to 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.

Paved areas

Select a cubic capacity to suit the size and species of the tree. A potentially large tree may need 12 m^3.

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

Backfill: Provide structural soil to the **Structural soil table.**

Type	Description	Fertiliser	Depth
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
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

Mulch: 10 mm screenings 75 mm thick.

Initial watering: 50 litres per tree applied gradually.

Porous bonded gravel

Backfill: Allow for base aggregate and gravel.

Filter fabric: Lay over growing medium 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 manufacturers published directions.

4.7 TRANSPLANTING STREET TREES

General

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

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

Preparation

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

Fertilising: Apply one application of liquid fertiliser mix to the foliage and root 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.

Initial cut:

- Manually or by chain trenching machine. Trees whose rootballs have been excavated by backhoe or excavator are not acceptable.
- Located 250 mm beyond the required finished rootball dimensions of each side to allow any damaged roots to be trimmed back to final dimensions and sealed.

Hand trimming:

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

Outcome: Cut rootball to be:

- Symmetrical about the trunk and in proportion to the overall size of the tree except where the limitations of individual tree planter openings requires specific tailoring of the rootball dimension.

- Cut to a size designed to maximise the rootball in the best interests of each specimen.

Trench: 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.

Fertilising: Submit a program for regular fertiliser applications continued over this period. This is a **WITNESS POINT**.

Responsibility: Take precautions to safeguard the health and well being of all on site plant material prior to the lifting and transplanting.

Above ground

Pruning: If selected pruning of branches appears necessary to balance root loss obtain prior approval. This is a **WITNESS POINT**.

Lifting: Thoroughly irrigate to the full depth of the rootball two days prior to transplanting of 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.

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

4.8 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Limits and tolerances table

Activity	**Limits/tolerances**	**Worksection reference Clause/subclause**
Topsoil - Organic content - pH - Soluble Salt	 > 3% by mass > 5.5 < 7.5 < 0.06% by mass	MATERIALS/Topsoil – minor works
Turf - Width of rolls	 > 300 mm	MATERIALS/Plant material (Turf)
Vegetable Mulch - Hydromulch - Paper pulp	 Maximum size < 10 mm < 50% by mass of total mulch	MATERIALS/Fertiliser and mulches
Straw mulching - Straw mat	 Finished thickness > 20 mm	MATERIALS
Mulch composition - Fines - Woodchip - Leaf mulch	 < 5% by volume Maximum size < 50 mm < 25% by volume	MATERIALS/Fertiliser and mulches (Mulch types)
Plant material - Container soil mix	Contain 20% to 25% by volume of clay	Plant materials
Topsoil (Execution)	Minimum compacted thickness at any location of 30 mm	EXECUTION/Slopes 3:1 or flatter, Slopes steeper than 3:1
Landscape planting	Planting not to be undertaken when	EXECUTION/Landscape

Activity	Limits/tolerances	Worksection reference Clause/subclause
- Temperature	temperatures > 35℃ or < 10℃.	planting (Conditions)

Location of planting

General: 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:

- Mature canopy clearance: Locate trees to achieve 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: 750 mm to 1000 mm measured to the back of the kerb.

Driveways: > 3 m.

Intersections: > 10 m measured from the face of the kerb of the adjoining street.

Existing trees: The combined mature canopy width.

Roundabouts

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

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

Median Islands

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

0 m – 0.3 m: Appropriate pavement material.

0.3 m – 1 m: Appropriate groundcovers, 200 mm high with minimal pruning requirements.

5 ANNEXURE A

5.1 LANDSCAPING MATERIALS

Edit with additions or deletions to suit the project.

Landscaping materials

	Material	Type	Minimum application rate
1.	Herbicide*	Glyphosate e.g. Roundup	9 litres/200 litres water/ha
2.	Seed		
	- Grass	Rye Corn (April-August) or	60 kg/ha
		Japanese Millet (September-March)	60 kg/ha
		Hulled Couch	5 kg/ha
		Red Clover (Inoculated)	5 kg/ha
		White Clover (Inoculated)	5 kg/ha
		'Elka' Perennial Rye	5 kg/ha
	- Native	Acacia dealbata	4 kg/ha
		Acacia buxifolia	1 kg/ha

	Material	Type	Minimum application rate
		Acacia decurrens	1 kg/ha
		Acacia pravissima	1 kg/ha
		Leptospermum lanigerum	1 kg/ha
		Hardenbergia violacea	500 g/ha
		Kennedia prostrata	500 g/ha
		Acacia implexa	200 g/ha
		Banksia marginata	200 g/ha
		Bursaria spinosa	200 g/ha
		Callistemon pallidus	200 g/ha
		Dodonaea viscoca	200 g/ha
3.	Turf grass		
	- Medians - Verges/Footpaths - Other Areas	Couch Buffalo Couch	Refer to Drawings ‘ ‘
4.	Fertiliser *		
	Vegetation of Slopes/Drains	Dynamic Lifter ‘Nitro’	1000 kg/ha
5.	WETTING AGENT *	‘Aquasoil’	1 litre/1000 litres of mix water
6.	PESTICIDE *		
	Liquid Powder	‘Lorsban 500 EC’ ‘Lorsban 250 W’	5 litres 10 kg
7.	SOIL CONDITIONER*		
	Vegetation of Slopes/Drains Landscape Planting	Gypsum N:P:K ratio 6.3:1.8:2.8	400 g/m^2 5k g/m^2
8.	ORGANIC FIBRE MAT*	‘Sta-firma’ (light grade)	—
9.	MULCH	Composted/Pasteurized	75 mm thick

* Provide the material as listed or as approved by the local authority.

5.2 PLANT MATERIAL

Plant material supply schedule

Botanical name	Common name	Size	Quantity (+10%)

Plant selection: Consult the Local Authority for the list of recommended (or proscribed) species.

Transplanting schedule

Species	Description

Specimen plants schedule

Species	Description

0271 PAVEMENT BASE AND SUBBASE

1 GENERAL

1.1 RESPONSIBILITIES

General
General: Provide base and subbase courses as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- *General requirements*.
- *Earthwork*.

1.3 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
- CBR: California bearing ratio.
- CRB: Crushed rock base.
- CRS: Crushed rock subbase.
- NGB: Natural gravel base.
- NGS: Natural gravel subbase.
- RCCB: Recycled crushed concrete base.
- RCCS: Recycled crushed concrete subbase.

Definitions
General: For the purposes of this worksection the definitions given in AS 1348 and the following apply:
- Absolute level tolerance: Maximum deviation from design levels.
- Base: Layer(s) of material forming the uppermost structural element of a pavement and on which the surfacing may be placed.
- Flexible pavement: A pavement which obtains its load-spreading properties from intergranular pressure, mechanical interlock and cohesion between the particles of the pavement material.
- Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.
- Subbase: Material laid on the subgrade (or selected material), below the base, either for the purpose of making up additional pavement thickness, to prevent intrusion of the subgrade into the base, or to provide a working platform.

1.4 INSPECTION

Notice
Inspection: Give notice so that inspection may be made of the following:
- Prepared subgrade.
- Proof rolling of subbase before spreading of base.
- Proof rolling of base before sealing.

1.5 SUBMISSIONS

Execution
General: Submit details of the proposed work methods and equipment for each pathway and roadworks operation, including the following:
- Staging of the work, access and traffic control methods.
- Disposal of surface water, control of erosion, contamination and sedimentation of the site, surrounding areas and drainage systems.
- Sources of materials.

Compaction: If a layer is proposed to exceed 200 mm in thickness, submit evidence that the proposed compaction equipment can achieve the required density throughout the layer.

Materials

Source of material: Submit the supplier name, material type (crushed rock, natural gravel, recycled concrete aggregate) and source quarry or recycling site.

Compliance of material: Provide certification and test results from a NATA registered laboratory confirming that the material conforms to the documented requirements.

Tests

Material property testing: Conform to the **Base material properties table** and the **Subbase material properties table** test methods.

Frequency of material property tests: Not less than the following:

- Particle size distribution: 1 per 1000 t (or part of).
- Liquid limit: 1 per 1000 t (or part of).
- Plasticity index: 1 per 1000 t (or part of).
- Linear shrinkage: 1 per 1000 t (or part of).
- Maximum dry compressive strength: 1 per 5000 t (or part of).
- Particle shape: 1 per 1000 t (or part of).
- Los Angeles value: 1 per 1000 t (or part of).
- Aggregate wet strength: 1 per 5000 t (or part of).
- Wet/dry strength variation: 1 per 5000 t (or part of).

2 PRODUCTS

2.1 BASE AND SUBBASE MATERIAL

Granular material

Requirement: Provide unbound granular materials, including blends of two or more different materials, which when compacted develop structural stability and are uniform in grading and physical characteristics.

Crushed rock and recycled material class

Requirement: Provide crushed rock and recycled material as documented, 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 require a very high standard of surface preparation.
- Class 3: Not applicable.
- Class 4: Subbase material for unbound flexible pavements.

Crushed rock

Designation: Unbound crushed rock materials are designated as follows:

- CRB20-1: 20 mm nominal sized class 1 crushed rock base.
- CRB20-2: 20 mm nominal sized class 2 crushed rock base.
- CRS20: 20 mm nominal sized crushed rock subbase.
- CRS40: 40 mm nominal sized crushed rock subbase.

Recycled crushed concrete

Designation: Recycled crushed concrete materials are designated as follows:

- RCCB20-1: 20 mm nominal sized class 1 recycled crushed concrete base.
- RCCB20-2: 20 mm nominal sized class 2 recycled crushed concrete base.
- RCCS20: 20 mm nominal sized recycled crushed concrete subbase.

Natural gravel

Designation: Unbound natural gravel materials are designated as follows:

- NGB20: 20 mm nominal sized natural gravel base.
- NGS20: 20 mm nominal sized natural gravel subbase.
- NGS40: 40 mm nominal sized natural gravel subbase.

Base material properties

Base materials: Conform to the **Base material properties table**.

Base material properties table

Test method	Description	CRB20-1	CRB20-2	RCCB20-1	RCCB20-2	NGB20
AS 1289.3.6.1	Particle size distribution					
AS 1289.3.6.1	% passing 26.5 mm sieve	100	100	100	100	100
AS 1289.3.6.1	% passing 19.0 mm sieve	95-100	95-100	95-100	95-100	93-100
AS 1289.3.6.1	% passing 13.2 mm sieve	77-93	77-93	78-92	78-92	-
AS 1289.3.6.1	% passing 9.5 mm sieve	63-83	63-83	63-83	63-83	71-87
AS 1289.3.6.1	% passing 4.75 mm sieve	44-64	44-64	44-64	44-64	47-70
AS 1289.3.6.1	% passing 2.36 mm sieve	29-49	29-49	30-48	30-48	35-56
AS 1289.3.6.1	% passing 0.425 mm sieve	13-23	13-23	13-21	13-21	14-32
AS 1289.3.6.1	% passing 0.075 mm sieve	5-11	5-11	5-9	5-9	6-20
AS 1289.3.1.1	Liquid limit	max 30	max 30	max 35	max 35	max 25
AS 1289.3.3.1	Plasticity index:					
	All areas	min 2	-	min 2	-	-
	Areas with annual rainfall > 500 mm	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
AS 1289.3.4.1	Linear shrinkage:					
	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
	Areas with annual rainfall < 500 mm	max 4.0	max 4.0	max 4.0	max 4.0	max 4.0
Direct measurement	Foreign materials in that fraction					

Test method	Description	CRB20-1	CRB20-2	RCCB20-1	RCCB20-2	NGB20
	of RCCB retained on 4.75 mm sieve - % by mass:					
	High density (brick, etc.)	—	—	max 2.0	max 2.0	—
	Low density (plaster, etc.)	—	—	max 0.5	max 0.5	—
	Organic matter (wood, etc.)	—	—	max 0.1	max 0.1	—
	Asbestos and hazardous	—	—	0	0	—
AS 1141.52	Maximum dry compressive strength on fraction passing 19 mm sieve (only applies if plasticity index is less than 1)	min 1.7 MPa	min 1.7 MPa	min 1.7 MPa	min 1.7 MPa	min 1.7 MPa
AS 1141.14	Particle shape by proportional calliper - % misshapen (2:1)	max 35%	max 35%	max 35%	max 35%	—
AS 1141.22	Aggregate wet strength*	min 100 kN	min 80 kN	min 100 kN	min 80 kN	—
AS 1141.22	Wet/dry strength variation* (dry - wet)/dry	max 35%	max 35%	max 35%	max 35%	—
AS 1141.23	Los Angeles value	max 35%	max 35%	max 40%	max 40%	—
AS 1289.6.1.1	4 day soaked CBR (98% modified compaction)	min 80%	min 80%	min 80%	min 80%	min 80%
NOTES: * All fractions of the proposed mix must satisfy this requirement. Use the fraction with the highest wet/dry strength variation as the value for determining conformance. Test the fraction 19.0 mm to 9.5 mm. In the case of blended materials, also test the fraction 9.5 mm to 4.75 mm. Test any other fraction which is at risk of failing in the opinion of the Engineer.						

Subbase material properties

Subbase materials: Conform to the **Subbase material properties table**.

Subbase material properties table

Test method	Description	CRS20	CRS40	RCCS20	NGS20	NGS40

Test method	Description	CRS20	CRS40	RCCS20	NGS20	NGS40
AS 1289.3.6.1	Particle size distribution					
AS 1289.3.6.1	% passing 53.0 mm sieve	-	100	-	-	100
AS 1289.3.6.1	% passing 37.5 mm sieve	-	90-100	-	-	95-100
AS 1289.3.6.1	% passing 26.5 mm sieve	100	74-97	100	100	80-97
AS 1289.3.6.1	% passing 19.0 mm sieve	90-100	62-86	95-100	96-100	-
AS 1289.3.6.1	% passing 13.2 mm sieve	74-96	-	74-95	-	-
AS 1289.3.6.1	% passing 9.5 mm sieve	61-85	42-66	60-90	65-90	48-85
AS 1289.3.6.1	% passing 4.75 mm sieve	42-66	28-50	42-76	47-80	35-73
AS 1289.3.6.1	% passing 2.36 mm sieve	28-50	20-39	28-60	32-67	25-58
AS 1289.3.6.1	% passing 0.425 mm sieve	11-27	8-21	10-28	14-42	10-33
AS 1289.3.6.1	% passing 0.075 mm sieve	4-14	3-11	2-10	6-26	3-21
AS 1289.3.1.1	Liquid limit	max 35	max 35	max 40	max 35	max 35
AS 1289.3.3.1	Plasticity index:					
	Areas with annual rainfall > 500 mm	max 12	max 12	max 12	max 12	max 12
	Areas with annual rainfall < 500 mm	max 15	max 15	max 15	max 15	max 15
AS 1289.3.4.1	Linear shrinkage:					
	Areas with annual rainfall > 500 mm	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
Direct measurement	Foreign materials in					

Test method	Description	CRS20	CRS40	RCCS20	NGS20	NGS40
	that fraction of RCCB retained on 4.75 mm sieve - % by mass:					
	High density (brick, etc)	—	—	max 3.0	—	—
	Low density (plaster, etc)	—	—	max 1.0	—	—
	Organic matter (wood, etc)	—	—	max 0.2	—	—
	Asbestos and hazardous	—	—	0	0	—
AS 1141.52	Maximum dry compressive strength on fraction passing 19 mm sieve (only applies if plasticity index is less than 1)	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa
AS 1141.14	Particle shape by proportional calliper - % misshape n (2:1)	max 35%	max 35%	max 35%	—	—
AS 1141.22	Aggregate wet strength*	min 50 kN	min 50 kN	min 50 kN	—	—
AS 1141.22	Wet/dry strength variation* (dry - wet)/dry	max 40%	max 40%	max 40%	—	—
AS 1141.23	Los Angeles value	max 40%	max 40%	max 40%	—	—
AS 1289.6.1.1	4 day soaked CBR (94% modifie d compaction)	min 30%	min 30%	min 30%	min 30%	min 30%

NOTES:
* All fractions of the proposed mix must satisfy this requirement. Use the fraction with the highest wet/dry strength variation as the value for determining conformance. Test the fraction 19.0 mm to 9.5 mm. In the case of blended materials, also test the fraction 9.5 mm to 4.75 mm. Test any other fraction which is at risk of failing in the opinion of the Engineer.

3 EXECUTION

3.1 SUBGRADE PREPARATION

General

Requirement: Prepare the subgrade in conformance with the *Earthwork* worksection.

3.2 PLACING BASE AND SUBBASE

General

Weak surfaces: Do not place material on a surface that is weakened by moisture and is unable to support, without damage, the construction plant required to perform the works.

Spreading: Spread material in uniform layers without segregation.

Moisture content: Maintain wet mixed materials at the required moisture content before and during spreading. Add water to dry mixed materials through fine sprays to the entire surface of the layer after spreading, to bring the material to the required moisture content.

Compacted layer thickness: 200 mm maximum and 100 mm minimum. Provide layers of equal thickness in multilayer courses.

Joints

General: Plan spreading and delivery to minimise the number of joints. Offset joints in successive layers by a minimum of 300 mm.

Start of shift: Remix last 2 m of previous days work for continuity of compaction.

Final trimming

General: Trim and grade the base course to produce a tight even surface with no loose stones or slurry of fines.

3.3 TOLERANCES

Surface level

General: Provide a finished surface which is free draining and evenly graded between level points.

Base abutting gutters: ± 5 mm from the level of the lip of the gutter, minus the design thickness of the wearing course.

Tolerances: Conform to the **Surface level tolerances table**. The tolerances apply to the finished level of each layer, unless overridden by the requirements (including tolerances) for the finished level and thickness of the wearing course.

Surface level tolerances table

Item	Level tolerance	
	Absolute	**Relative**
Subbase surface	+ 10 mm, - 25 mm	10 mm
Base surface	+ 10 mm, - 5 mm	5 mm

3.4 SUBBASE AND BASE COMPACTION

General

Construction operation: Compact each layer of fill to the required depth and density, as a systematic construction operation and to conform to the **Minimum relative compaction table**.

Minimum relative compaction table

Item description	Minimum dry density ratio (modified compaction) to AS 1289.5.2.1
Subbase	95
Base	98

Unstable areas: If unstable areas develop during rolling or are identified by proof rolling, open up, dry back and recompact, to the requirements of this worksection. If dry back is not possible, remove for the full depth of layer, dispose of and replace with fresh material.

Compaction requirements

General: Apply uniform compactive effort, over the whole area to be compacted, until the required density is achieved or until failure is acknowledged. If failure acknowledged, the subclause **Rectification** applies.

Equipment: Use rollers appropriate to the materials and compaction requirements documented.

Moisture content

General: During spreading and compaction, maintain material moisture content within the range of -2% to +1% from the optimum moisture content (modified compaction).

Spraying: Use water spraying equipment to distribute water uniformly in controlled quantities over uniform lane widths.

Dry back: Allow material to dry back to 60% to 80% of the optimum moisture content prior to application of seal or wearing course.

Rectification

General: If a section of pavement material fails to meet the required density or moisture content after compaction, remove the non-conforming material, dispose of off-site or rectify for re-use, replace with fresh material, and recompact.

Level corrections

General: Rectify incorrect levels as follows:

- High areas: Grade off.
- Low areas: Remove layers to a minimum depth of 75 mm, lightly tyne and replace with new material and recompact.

3.5 TESTING

Compaction control tests

Standard: To AS 1289.5.4.1 and AS 1289.5.4.2.

Frequency of compaction control tests

General: Not less than the following (whichever requires the most tests):

- 1 test per layer per 100 lineal metres for 2-lane roads.
- 1 test per layer per 2000 m^2 for carparks.
- 3 tests per layer.
- 3 tests per visit.

0272 ASPHALTIC CONCRETE

1 GENERAL

1.1 RESPONSIBILITIES

General

General: Provide a finished asphaltic concrete surface as documented and as follows:

- Free draining and evenly graded between level points.
- Even and smooth riding.

1.2 STANDARDS

General

Hot mix asphalt: To AS 2150.

1.3 INTERPRETATION

Definitions

General: For the purposes of this worksection the definitions given below apply:

- Absolute level tolerance: Maximum deviation from design levels.
- Lot: A lot consists of any part of the works which has been constructed/manufactured under a continuous operation of uniform conditions and is essentially homogeneous with respect to material and general appearance. The whole of the work included in a lot is of a uniform quality without obvious changes in attribute values.
- Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.
- Relative compaction: The ratio between the field bulk density and the bulk density of the job mix when compacted in the laboratory.

1.4 INSPECTION

Notice

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

- Surface prepared for priming, sealing or asphalt surfacing.
- Commencement of asphalt surfacing.
- Completion of asphalt surfacing.

1.5 TOLERANCES

General: To the **Tolerances table** which applies to the finished level of each layer, unless overridden by the requirements (including tolerances) for the finished level and thickness of the surface course.

Tolerances table

Item	Level tolerance	
Level (Longitudinal)	± 10 mm Absolute	5 mm Relative
Level (Transverse)	± 10 mm Absolute	10 mm Relative
Compacted layer thickness (Any one sample)	+ 10 mm, - 5 mm.	
Edges abutting gutters	± 5 mm from the level of the lip of the gutter.	
Shape	Conform to AS 2150 Table 15.	
Roughness	Conform to AS 2150 Table 16.	

1.6 SUBMISSIONS

Execution details

General: Submit proposals for work methods and equipment including the following:

- Survey control.

- Staging of the work, access and traffic control methods.
- Disposal of surface water, control of erosion, contamination and sedimentation of the site, surrounding areas and drainage systems.
- Methods and equipment for each operation.
- Material stockpiles.

Trial: Submit trial paving using the proposed job mix and all equipment as proposed. Trial may be incorporated into the final works, if satisfactory.

Trial length: 10m

Products

Certificate of compliance: As an alternative to testing a product, submit the manufacturer's certificate together with the results of recent tests undertaken by the manufacturer, showing conformance with test criteria.

Proposals: Submit the following details before commencing production:

- Combined aggregate particle size distribution.
- Binder content expressed as a percentage of the total mix.
- The filler content expressed as a percentage by mass of the combined aggregates.
- The asphalt mix properties.
- The proposed mixing temperature.
- Sources of materials.
- Reclaimed asphalt pavement stockpile and proportion.

Samples

Samples: Submit samples to AS 1141.3.1 at least one month before use:

- Granular materials: Submit samples of each proposed type and size of asphalt and cover aggregate.

Identification: Attach a tag to each sample showing relevant information including description, source and nominal size of material.

2 PRODUCTS

2.1 AGGREGATE

Properties

Description: Clean, sound, hard, angular, of uniform quality, free from deleterious matter in conformance with the **Aggregate properties table**.

Standard: To AS 2758.5.

Mineral filler: To AS 2150 clause 4.2.

Combined aggregate grading: To AS 2150 clause 5.2.

Crushed slag: Air-cooled blast furnace slag of uniform quality, generally free from vesicular, glassy or other brittle pieces.

Fine aggregate: Clean, sound, hard, durable particles of natural sand or particles derived from crushed stone, gravel or slag, free from injurious coating or particles of clay, silt, loam or other deleterious matter.

Aggregate properties table

Property	Test method	Value
Particle shape	AS 1141.14	≤ 25 for wearing course ≤ 30 for binder course and corrective course
Wet strength	AS 1141.22	≥ 100 kN
Wet/dry strength variation	-	≤ 35%

2.2 TACK COATING

Properties
Bitumen emulsion: Rapid setting to AS 1160.

2.3 ASPHALT

General
Hot mix asphalt: To AS 2150.

Medium cut back bitumen: To AS 2157.

Bitumen emulsion: To AS 1160.

Bitumen binder: Class 170.

Mix design
Design: To AS 2891.5 and AS 2150 and the Marshall method:

- Marshall stability: > 4.5 kN.
- Marshall flow: 2 - 4 mm.
- Voids in total mix (maximum theoretical density based on apparent specific gravity of aggregates):
  . Wearing courses: 3% – 5%.
  . Binder courses and 7 mm mixes: 4% – 6%.
- Voids in aggregate filled with bitumen:
  . Wearing courses: 75% – 85%.
  . Binder courses and 7 mm mixes: 70% – 80%.

Reclaimed asphalt pavement: To AS 2150 clause 4.6.

Warm mix asphalt additive
General: If required, include warm mix asphalt additive to asphalt to reduce the asphalt manufacturing temperature and/or to improve workability during the paving and compaction operations.

Product tests
General: Take samples from trucks at the mixing plant and test for mix properties using one of the following methods as applicable:

Standard: To AS 2150 Table 9 and AS 2891.5.

- Marshall stability of compacted mix:
  . Compactive effort:
    * 35 blows for light traffic,
    * 50 blows for general conditions
    * 75 blows for heavy traffic or deep lifts.

Variations in mix properties
General: Ensure that the maximum variation between the mix property of each sample and the job mix value conforms to the **Mix property table**.

Mix property table

Mix property	Maximum variation from job mix value
Aggregate passing 4.75 mm sieve or larger	± 7% by mass
Aggregate passing 2.36 mm to 300 µm sieves	± 5% by mass
Aggregate passing 150 µm sieve	± 2.5% by mass
Aggregate passing 75 µm sieve	± 1.5% by mass
Bitumen content	± 0.3% by mass
Added filler content	± 0.3% by mass
Mixing temperature	± 10°C

2.4 OTHER MATERIALS

Tactile ground surface indicators
Standard: To AS/NZS 1428.4.1.

3 EXECUTION

3.1 PREPARATION

Cleaning

Remove: Immediately before priming or tack coating remove loose stones, dust and foreign material from the base surface using a power broom or blower. Keep traffic off the cleaned surface.

Priming

Protection: Prime the base surface as soon as possible after compaction and finishing.

Potholes

Patching: Trim to a regular shape and a uniform depth of at least 75 mm, tack coat the edges and patch with asphaltic concrete.

Level anomalies

Final levels: Flush kerbing, gutter or other concrete or metal components may require level modification to achieve safe foot surfaces or drainage. Prepare adjacent asphaltic areas as for potholes to achieve uniform or tapered depth to match final levels.

Pre-treatment: Regulate to AS 2150 clause 14.3.2.

Protection

Adjacent surfaces: Protect adjacent surfaces during spraying. Protect freshly sprayed surfaces from contamination.

Tack coating

Application rate: Apply tack coat 30 – 120 minutes before asphalt surfacing is placed. Cover the surface uniformly at an application rate of 0.20 – 0.40 L/m^2 of residual bitumen.

3.2 SURFACING

Spreading

Conditions: Place asphalt surfacing in dry weather on a dry pavement surface at a pavement temperature of at least 10˚C.

Operations: Spread the mix in layers covering the full width of the pavement, or, in the case of carriageways and wide pavements, in lanes of minimum width 3 m. Place layers in adjoining lanes to the same compacted thickness.

Method: Spreading by self propelled paving machine to AS 2150 clause 12.2.

Hand spreading: To AS 2150 clause 12.3.

Average thickness tolerance:

- Thickness > 50 mm: ± 10% of total thickness up to a maximum of ± 15 mm.

Frequently check thickness: Measure uncompacted and compacted layer to conform with AS 2150.

Abutting structures

Level: Place asphalt surfacing to match the level of abutting surfaces such as kerbs, gutters, edge strips, access chamber covers, or adjoining pavement in the same manner as for longitudinal and transverse joints.

Fill: Fill spaces left unfilled between the spreader run and abutting edges with sufficient material to the proper height before compaction.

Assess: On site level anomalies to determine the need to raise the surface level of a structure where the use of infill or tapered asphalt would create a local pedestrian trip hazard or effect the durability.

Matched junctions

Smooth joints: If asphalt surfacing is to match an existing pavement, bridge deck, rail or other fixture, place the material to provide a smooth riding surface across the junction.

As required: Remove existing pavement or taper the thickness of layers.

Junction: Terminate layers at a 20 mm deep and 400 mm wide chase cut into the existing pavement.

Remove: Coarse particles from a layer of tapering thickness using hand raking.

Tack coat: Where the thickness of the layer tapers to less than twice the nominal size of the mix, tack coat the area upon which material of such thickness is to be placed uniformly at an application rate 0.50 - 0.75 L/m^2.

Joints

Standard: To AS 2150 clause 12.6.

Minimise the number of joints: Make joints that are well bonded and sealed and provide a smooth riding surface across the joint.

Transverse joints: Construct a transverse joint if the operation is stopped for more than 20 minutes or the pavement temperature falls below 90 °C. Construct to a straight vertical face for the full depth of the layer, and offset in adjoining spreader runs and layer to layer by at least 1 m.

Longitudinal joints: Offset joints from layer to layer by at least 150 mm. Position longitudinal joints in the wearing course to coincide with the lane line.

Edges: Form exposed edges of each spreader run while hot to a straight line with a dense face inclined between vertical and 45°.

Cold joints: Tack coat the surface of cold longitudinal and transverse joint before placing the adjoining asphalt.

Compaction

Trimming: Before commencing compaction, correct any irregularities in line or level. Trim lane edges to a straight line.

Rolling: Compact asphalt surfacing uniformly as soon as it will support rollers without undue displacement, and complete rolling while the mix temperature is above 90 °C.

Density tests: Perform a field bulk density test for each test site from either of the following:

- On a core sample taken from the asphalt surfacing layer.
- If the nominal layer thickness is 50 mm or greater, measured in situ using a nuclear gauge.

Sample preparation: To AS 2891.2.1 and AS 2891.2.2, as applicable.

Number of tests per lot: To AS 2150, generally 6 tests per lot for simple/small works.

Nuclear gauge tests: To AS/NZS 2891.14.2.

Density criteria: [complete/delete]

3.3 COMPLETION

Rejection

Extent: Remove areas of rejected asphalt surfacing, including defective joints and finish, to the full depth of the layer, and replace with complying pavement.

Joints: Treat edges of remedial work as specified for cold joints.

Reinstating adjacent surfaces

General: Reinstate surfaces next to new pavements and associated elements. Where an existing flexible road pavement has been disturbed, trim it back to a straight and undisturbed edge 250 – 300 mm from and parallel to the new concrete for the full depth of the slab. Backfill with asphalt rammed solid, using suitable rammers.

Removal: Disposal of any residual or rejected material to a location off site.

Traffic on pavement

General: Give notice before opening the pavement to traffic before the work is completed. Provide protection.

Junctions with existing pavements

Trimming: Where the pavement is to be joined to an existing pavement remove a strip of the existing pavement at least 300 mm wide for its full depth and trim the edge to an angle of approximately 45 in steps of maximum height 150 mm before placing new pavement material.

Existing sealed pavement: Trim the seal to a neat edge.

Finished pavement properties

Tolerances: Check finished pavement levels, thickness and shape with the **Tolerances table**.

Reject surfaces: Where tolerances are exceeded reject surface.

3.4 TESTING

General

Tests: Perform tests of the type and frequency necessary to control the materials and processes used in the construction of the works and as documented in the **Tests schedule**.

Process control tests

Records: Show the results of process control tests on control charts or graphs displayed on site in a readily accessible location and updated daily.

Methods: Use wet preparation methods where applicable.

Sampling: Timing and location to AS 2891.1.1.

Compliance assessment tests

Timing: Obtain materials samples at the time of delivery to the site.

Location: Sample from selected sample sites within designated uniform test lots, consisting of an area placed, or compacted or both in one day. Test lots must be uniform in terms of material properties and density.

0273 SPRAYED BITUMINOUS SURFACING

1 GENERAL

1.1 RESPONSIBILITIES

General

General: Provide a sprayed bituminous surfacing as documented and as follows:

- Free draining and uniformly graded.
- Even and smooth riding.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.

1.3 INTERPRETATION

Definitions

General: For the purposes of this worksection the glossary of terms in AS 1348 applies.

1.4 INSPECTION

Notice

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

- Surfaces prepared for priming, sealing or surfacing.
- Commencement of bituminous spraying.

1.5 SUBMISSIONS

Execution

General: Submit proposals for the methods and equipment used, including the following:

- Staging of the work, access and internal traffic control methods.
- Disposal of surface water, control of erosion, removal of contaminated material and sedimentation control on the site, surrounding areas and drainage systems.
- Methods and equipment for each operation.
- Sources of materials.
- Material stockpiles.

Spraying equipment: Submit a current certificate and calibration chart issued by the State Road Authority.

Hand spraying: If intended, submit proposals.

Spraying operations: Submit proposals for start, finish and width of each spray run.

Bituminous surfacing records: Submit certified records of the works completed.

Records of measurement: Submit certified records of work performed.

Materials

General: Submit information including the following:

- Cutback bitumen field mix/proprietary mix.
- Binder proposal.
- Adhesion agent: Proof of previous conformance with test criteria.
- Aggregates: Source.

Tests

Compliance assessment: Compliance assessment tests are to be carried out by an independent testing authority. Submit 3 copies of each test result.

Certificate of compliance: A certificate of compliance is acceptable as an alternative to testing a manufactured material. Submit the manufacturer's certificate together with the results of recent tests undertaken by the manufacturer, showing compliance with test criteria.

2 PRODUCTS

2.1 BITUMINOUS MATERIALS

Material grades

Bitumen: To AS 2008 Class 170.

Bitumen emulsion: To AS 1160.

Cut back bitumen classification and grading: To AS 2157 and as documented in the **Bituminous materials schedule**.

Proprietary grades of cutback bitumen: To the manufacturer's specification.

Cutter oil and flux oil: To AS 3568.

Aggregate precoating materials

Precoating agent: Provide precoating agents capable of satisfying plate stripping tests.

Allowable percentage of stripping: Less than 10% in accordance with AS 1141.50.

Measuring bitumen and cutter

General: Measure by volume at 15ºC.

Volume correction factors: Conform to the following for converting volume of bituminous binders

- From 15ºC to elevated temperature to AAPA National sprayed sealing specification Table D8, or
- From elevated temperature back to 15ºC to AAPA National sprayed sealing specification Table D9.

2.2 AGGREGATE

Standard: To AS 2758.2.

2.3 OTHER MATERIALS

Protective paper

Start, finish and taper operations: Apply heavy duty protective paper of minimum weight 120g/m^2, and wide enough to prevent over spray.

Geotextile

Type: Non woven, needle punched fabric with minimum melting point 190°C and minimum mass 130g/m^2.

Application: To AUSTROADS AP-T37.

Tactile ground surface indicators

Standard: To AS/NZS 1428.4.1.

3 EXECUTION

3.1 APPLICATION

Precoating

Supply: Precoat aggregates immediately before the aggregate is loaded into the spreader trucks.

7 mm cover aggregate: Precoat at least 48 hours in advance of spreading.

Target application: Apply precoating agent thinly and evenly using a fine pressure spray to a moving stream of aggregate, or by other approved means, so that particles are fully coated but without excess material.

Wet aggregate: If the aggregate is too wet to precoat, or contains enough moisture to cause uneven distribution of the precoating agent, dry the aggregate by turning the stockpile over. Do not precoat aggregate until the moisture has evaporated sufficiently for the precoating agent to adhere evenly.

Target application rate: In the range 4 – 14 L/m^3 of aggregate.

Cutting bitumen

Temperature: Heat sufficient bitumen for immediate needs only. Do not keep the material at spraying temperature for longer than 10 hours. Do not reheat.

Mixing and heating (on site): Heat the bitumen at a rate not exceeding 40ºC/h, and circulate cutback bitumen for 20 minutes to ensure thorough mixing.

Heating devices: Use devices capable of uniform heating without damaging bituminous materials.

Spraying equipment

Areas not accessible to the mechanical sprayer: Spray using hand spray equipment attached to the mechanical sprayer.

3.2 PREPARATION FOR SPRAYING

Cleaning

General: Immediately before spraying, remove loose and foreign material on the finished base surface, including dust, debris and sand spread on primed surfaces, until a mosaic of well embedded aggregate shows on the surface. Keep traffic off the cleaned surface.

Method: Use suitable power blowers or power brooms (or using hand methods where inaccessible to the power equipment).

Preconditions: Prime and seal in dry and reasonably calm weather, on a dry pavement surface at a temperature of at least 10°C in conformance with Table D1 AAPA.

Potholes

General: Trim to a regular shape and a uniform depth of at least 75 mm. Tack coat the sides, and patch with bituminous premix, sanded after completion. Allow sufficient time for the premix to cure before spraying the surface, in conformance with Table DB1 AAPA.

3.3 SPRAYING OPERATIONS

Protection

General: Protect adjacent surfaces during spraying. Place drip trays under spray bars when the sprayer is stationary. Clean bituminous materials from adjacent surfaces or, if this is not possible, replace and make good the surface. Protect freshly sprayed surfaces from contamination.

Primed surface: Keep traffic off the primed surface for at least 3 days after spraying. If required commence sanding 4 – 24 hours after spraying.

Priming

General: Prime the granular pavement to achieve and maintain a strong bond between granular surface and pavement treatment seal.

Edges: At underbed edges, extend the primer 150 mm beyond the edge of the seal.

Junctions with existing pavements

Pavement base: Protect using a suitable temporary seal or primerseal.

Spraying

General: Completely and uniformly cover the surface to be treated. Prevent the spray overlapping previously treated areas, except that where part-width spraying is used, lap the longitudinal joint between adjacent runs by at least 50 mm.

Primersealing and sealing

Process: Allow at least 3 days between priming and sealing and between first and second binder application in double seals. Incorporate the first course of aggregate thoroughly into the binder before a second course is applied.

Spraying temperature ranges:

- Bitumen without cutter: 160°C – 190°C.
- Priming Grade AMC1: 60 °C - 80°C.
- Primerbinder Grade AMC3: 95°C – 115°C.
- Bitumen emulsion binder: Ambient temperature.

Application rates

General: As documented in the **Bituminous materials schedule.**

Grade or class: To AS 2157 and AS 1160.

3.4 PLACING COVER AGGREGATE

Placing cover aggregate

Spreading: Immediately after the binder or primerbinder has been sprayed, cover with a uniform layer of dry aggregate.

Rolling: Immediately after spreading roll and drag broom the area until it is uniformly covered with aggregate thoroughly embedded in the binder. Roll uniformly over the whole area. Complete rolling as soon as possible but not later than 3 days after spraying.

Steel rolling

General: Roll using a maximum of two coverages of a steel-wheeled roller of maximum axle load 5 tonne. Discontinue steel rolling if aggregate shows signs of breaking down.

Pneumatic tyred rolling

Roller: After steel rolling, roll the area using a pneumatic-tyred roller of minimum mass 10 t and with tyre pressures adjustable in the range 550 – 700 kPa.

Rolling:

- Minimum rate: 4 roller hours per 4500 L of binder or primerbinder sprayed.
- Timing: At least one roller pass within 2 minutes of covering, over the whole of the area. After an initial slow pass increase the speed of rolling to the maximum practicable for the area being sealed. Complete at least 25% of the rolling within 2 hours of covering, and 50% within 24 hours of covering.

Loose aggregate

General: When the aggregate has been evenly spread and embedded, remove loose particles remaining on the pavement by sweeping lightly, without disturbing embedded aggregate. Apply additional aggregate to achieve the required surface finish.

Surface finish

General: Provide an even, smooth riding and free draining surface to the grades and levels, as documented.

3.5 DEFECTIVE SURFACING

Primer

Actual rate of application less than 90% of that ordered: Make up the deficiency with a second spray run.

Actual rate of application more than 110% of that ordered: Cover the surface with sand which is chemically inert and free of salts.

Binder and primerbinder

Actual rate of application less than 90% or more than 110% of that ordered: Reseal the surface.

Minimum criteria for retention

Actual rate of application: Between 95 and 105% of the target application rate.

3.6 COMPLETION

Traffic on pavement

Removal: Dispose of any residual or rejected material off-site.

Notice: Give notice before opening the pavement to traffic before the work is completed. Provide protection.

0274 CONCRETE PAVEMENT

1 GENERAL

1.1 RESPONSIBILITIES

General

General: Provide finished surfaces as documented and as follows:

- Free draining and evenly graded between level points.
- Even and smooth riding.

Performance

Conformance: Comply with the local authority in respect of the levels, grades and the minimum details of thickness, reinforcement and concrete strength for pavements within the kerb-and-gutter property boundaries.

Design

Coordination: Determine the local authority requirements initially as they may affect grades, transition, zones for the works. Considerations include:

- Drainage.
- Tree's (due to settlement).
- Adjacent structures.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Earthwork*.
- *Concrete – combined*.

1.3 STANDARDS

Concrete

Specification and supply: To AS 1379.

Materials and construction: To AS 3600.

1.4 INTERPRETATION

Definitions

General: For the purposes of this worksection the definitions given in AS 1348 and the following apply.

- Absolute level tolerance: Maximum deviation from design levels.
- Ambient temperature: The air temperature at the time of mixing and placing of concrete.
- Average ambient temperature: Average value of the maximum and minimum ambient temperatures over the relevant period at a site.
- Concrete class:
  - Normal: Concrete which is specified primarily by a standard compressive strength grade and otherwise in conformance with AS 1379 clause 1.5.3.
  - Special: Concrete which is specified to have certain properties or characteristics different from, or additional to, those of normal-class concrete and otherwise in conformance with AS 1379 clause 1.5.4.
- Early age: A mean compressive strength at 7 days exceeding the values shown in AS 1379 Table 1.2.
- Green concrete: Concrete which has set but not appreciably hardened.
- Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.
- Weather:
- Cold: Ambient shade temperature < 10°C.

- Hot: Ambient shade temperature > 32°C.

1.5 INSPECTION

Notice

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

- Base or subgrade before covering.
- Membrane or film underlay installed on the base or subgrade.
- Concrete formwork, reinforcement and dowels in position.
- Commencement of concrete placing.
- Completion of concrete placing.
- Evaluation of surface finish.

1.6 TOLERANCES

General

Edges abutting gutters: Within ± 5 mm of the level of the actual gutter edge.

Rigid pavement surface:

- Absolute tolerance: + 10 mm, - 0 mm.
- Relative tolerance: ± 5 mm.

Joint locations in plan (rigid pavement): ± 15 mm.

1.7 SUBMISSIONS

Products

Compliance certificate: As an alternative to testing a product, submit the manufacturer's certificate together with the results of recent tests undertaken by the manufacturer, showing compliance with test criteria.

Aggregates: Nominate the source for all aggregates proposed.

Reinforcement: Submit the manufacturer's certificate of compliance with AS/NZS 4671, or submit test certificates from an independent testing authority.

Liquid curing compounds: Submit certified test results, including the application rate and the efficiency index to AS 3799 Appendix B.

Curing by covering: Submit details of the proposed covering material.

Repair materials: Submit proposals for epoxy resin/grout and elastomeric sealant.

Concrete: Submit the concrete supply delivery dockets.

Subcontractors: Submit 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.

Trial mix design report: Six weeks before commencing production, submit a report for each mix design containing the information required in AS 1012.2, the individual and combined aggregate particle size distribution, and the records and reports for the tests.

Execution

Work method statements: Submit proposals for the methods and equipment to be used for the pavement works, including the following:

- Staging of the work, access and traffic control methods.
- Disposal of surface water, control of erosion, contamination and sedimentation of the site, surrounding areas and drainage systems.
- Methods and equipment for each operation.
- Sources of materials.
- Material stockpiles.
- Methods of concrete manufacture.
- Temperature control, curing and protection methods for concrete.

Mix design variation: If a variation is proposed, submit a further mix design report.

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

- Addition of water at the site.

- Changes to the plastic concrete mix.
- Curing and protection methods.
- Cutting or displacing reinforcement, or cutting hardened concrete.
- Handling, placing, compaction and finishing methods and equipment, including pumping.
- Sequence and times for concrete pours, and construction joint locations and relocations.

Cores, fixings and embedded items: If required, submit shop drawings showing the proposed locations, clearances and cover, and indicate any proposed repositioning of reinforcement.

Cutting or coring: If cutting or coring of hardened concrete is proposed, provide details.

Sawn joints: Submit proposed methods, timing and sequence of sawing joints.

Damaged galvanizing: If repair is required, submit proposals to AS/NZS 4680 Section 8.

Splicing: If splicing not documented is proposed, submit details.

Welding: If welding of reinforcement is proposed, provide details and give notice before welding reinforcement.

Joint sealants: Submit proposals for installation methods and sealant performance.

Concrete placing: Submit proposals for size of the area to be placed and the spacing of planned construction joints before placement commences.

Crack assessment: If unplanned cracks occur in the finished pavement, submit proposals for investigation.

Surface repair method: If required, submit details of the proposed method before commencing repairs.
Trial section: Submit trial pavement.

Testing

Test certificates and records: Submit test certificates, and also retain results on site.

2 PRODUCTS

2.1 REINFORCEMENT

General

- Steel reinforcement: Steel bars or mesh to AS/NZS 4671.
- Ductility class: L or N.

Identification: Supply reinforcement which is readily identifiable as to grade and origin.

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

Protective coatings

Protective coating: Coatings to reinforcement must not reduce the performance of the reinforcement. Do not galvanize reinforcement steel. For pavements containing protective coated reinforcement, provide the same coating type to all reinforcement and embedded ferrous metal items, including tie wires, stools, spacers, stirrups, plates and ferrules.

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

- Thickness: 200 µm minimum.

Steel fibres

Fibre reinforcement: To CIA CPN35.

Steel fibre content: 75 kg/m^3.

Accessories

Bar chairs: Use plastic tipped wire bar chairs.

Tie wire: Galvanized annealed steel 1.25 mm diameter (minimum).

Dowels

General: Provide each dowel in one piece, straight, cut accurately to length with ends square and free from burrs.

Standard: To AS/NZS 4671.

Grade: 250R steel bars 450 mm long.

Tie bars

Type: Deformed bar, 12 mm diameter, grade 500N, 1 m long.

2.2 AGGREGATE

Characteristics

Standards: AS 2758.1.

Quality: Provide at least 40% by mass of the total aggregates in the concrete mix of quartz sand aggregate having a nominal size of less than 5 mm and containing at least 70% quartz by mass.

Durability: All constituent, fraction of constituent or aggregates to conform to AS 1141.22 and the following:

- Wet strength not less than 80 kN.
- 10% Fines Wet/Dry Variation not to exceed 35%.

Recycled concrete aggregate (RCA): Use coarse aggregates from demolition concrete or RCA.

Blending: If blending coarse RCA with natural aggregates ensure substitution rates are below 30%.

Slipform grading requirements: For concrete mixes proposed for slipforming, conform to the Combined aggregate grading table for the combined total aggregates proportion by mass passing the Australian Standard sieves.

Combined aggregate grading table

Australian Standard sieve	**% passing by mass of sample**
19.00 mm	95–100
9.50 mm	55–75
4.75 mm	36–48
2.36 mm	30–42
1.18 mm	22–34
600 µm	16–27
300 µm	5–12
150 µm	0–3
75 µm	0–2

2.3 CEMENT

General

Standard: To AS 3972.

Transport: Cement in watertight packaging and protect from moisture until used. Do not use caked or lumpy cement.

- Age: Less than 6 months old.
- Storage: Store cement bags under cover and above ground.

2.4 FLY ASH

General

Standard: Fine grade fly ash to AS 3582.1.

Fly ash quantity: Nil to 70 kg/m^3.

Minimum binder content (fly ash plus cement): 300 to 330 kg/m^3.

2.5 WATER

General

Standard: Chloride ion to AS 3583.13 and sulphate ion to AS 1289.4.2.1.

Quality: Water used in the production of concrete to be potable, free from materials harmful to concrete or reinforcement, and be neither salty nor brackish.

Limits: Not containing more than:

- 600 parts per million of chloride ion, as determined to AS 3583.13.
- 400 parts per million of sulphate ion, as determined to AS 1289.4.2.1.

2.6 ADMIXTURES

General

Standard: Chemical admixtures to AS 1478.1.

Quality: Provide admixtures free from calcium chloride, calcium formate, or triethanolamine or any other accelerator. Do not use admixtures or combinations of admixtures without prior written approval.

Dosage: Vary the dosage of chemical admixture to account for air temperature and setting time in conformance with the manufacturer's recommendations.

Types of admixtures

Air entraining agent: Adjust mix for workability allowing up to 5% air entrainment.

Warm season retarder: During the warm season, (October to March inclusive), use a lignin or lignin-based (ligpol) set-retarding admixture (Type Re or Type WRRe) as approved to control slump within the limits stated in Concrete mix, properties.

Cool season retarder: During the cool season, (April to September inclusive), use only a lignin or lignin based set-retarding admixture containing not more than 6% reducing sugars (Type WRRe complying with AS 1478.1).

2.7 CURING COMPOUNDS

General

Curing compounds: To AS 3799 and AS 1160, Type 2, white pigmented or containing aluminium reflective pigments.

Covering with sheet materials: To ASTM C171, white opaque or clear polyethylene film, or white burlap-polyethylene sheet, or equivalent material.

2.8 OTHER MATERIALS

Tactile ground surface indicators

Standard: To AS/NZS 1428.4.1.

3 EXECUTION

3.1 SUBGRADE

Preparation

Conformance: Prepare subgrade in conformance with the *Earthwork* worksection.

Extent: Prepare a uniform subgrade for the full pavement formation, extending at least to the back of kerbs.

Reinstatement: Ensure uniformity for backfilling of any utility trenches.

3.2 SUBBASE

Thickness

Thickness to be as per the approved pavement design

Width

Subbase width: Extend the subbase at its full depth to at least the back of kerbs or other edge stops before their installation.

No integral kerbs: Extend granular unbound subbase at least 300 mm beyond each side of the carriageway.

Unbound subbase materials and installation: Conform to *Pavement base and subbase* worksection.

Bound subbase materials and installation: Conform to the *Pavement base and subbase* worksection.

Tolerance and friction reduction

Tolerance: Subbase finished surface level, + 0 mm to – 10 mm.

Friction reduction: Provide 200 µm thick polyethylene sheeting with 200 mm taped minimum laps and/or a 20 mm thick layer of sand (silt and clay material less than 5%) directly beneath the concrete pavement.

3.3 TRIAL PAVEMENT

Trial pavement: Demonstrate by placing a test section that the proposed method of placement will produce a conforming pavement. Remove test sections which do not comply with requirements and dispose of as directed.

3.4 CONCRETE MIX

Standard

Concrete mix and supply: To AS 3600 Section 17 and AS 1379.

Properties

Workability: Slump values to conform with the following:

- Fixed form paving with manual operated vibration: 50 – 60 mm.
- For slip form with no side forms: 30 – 50 mm.
- Drying shrinkage: Maximum 450 με after 21 days of air drying.

Elapsed delivery time

General: Ensure that the elapsed time between the wetting of the mix and the discharge of the mix at the site is in conformance with the Elapsed delivery time table. Do not discharge at ambient temperature below 10°C or above 30°C.

Elapsed delivery time table

Concrete temperature at time of discharge (°C)	Maximum elapsed time (hours)
10 – 24	2.00
24 – 27	1.50
27 – 30	1.00
30 – 32	0.75

Site mixed supply

Emergencies: If mixing by hand is carried out, provide details.

Plant: Mix concrete in a plant located on the construction site.

Pre-mixed supply

Addition of water: Do not add water.

Transport: Make sure that the mode of transport prevents segregation, loss of material and contamination of the environment, and does not adversely affect placing or compaction.

Concrete delivery docket: For each batch, submit a docket listing the information required by AS 1379 clause 1.7.3, and the following information:

- Any binders or additives.
- Method of placement and climate conditions during pour.
- Name of concrete delivery supervisor.
- The concrete element or part of the works for which the concrete was ordered, and where it was placed.

3.5 TESTING

Standards

Sampling, identification, testing and recording: To AS 1012.

Specimens: Sample the concrete on site, at the point of discharge from the agitator.

Type and frequency: Conform to AS 1379.

Sampling frequency: To the **Project assessment sampling table**.

Test authority: Concrete supplier or NATA registered laboratory.

Concrete testing methods

Slump: Test at least one sample from each batch before placing concrete from that batch in the work.

- Standard: To AS 1012.3.1.
- Maximum slump variation: ± 10 mm.

Compressive strength: Test to AS 1012.8.1.

Drying shrinkage: Test to AS 1012.13.

Flexural strength: To AS 1012.8.2 and AS 1012.11.

Project assessment sampling table

Number of batches for each type and grade of concrete per day	Minimum number of samples
1	1
2-5	2
6-10	3
11-20	4
each additional 10	1 additional

Acceptance criterion: The average strength of any set of 3 consecutive project samples must be equal to or greater than the specified minimum value.

3.6 INSTALLATION

Junctions with existing pavements

Trimming: Where the pavement is to be joined to an existing pavement remove a strip of the existing pavement at least 300 mm wide for its full depth and trim the edge vertically before placing new pavement material.

Existing sealed pavement: Trim the seal to a neat edge.

Fixed formwork

Description:

- Steel forms.
- Seasoned, dressed timber planks, free of warps, bends or kinks, with the full width of their top edges covered with steel angle sections finishing flush with the form face.

Depth: Equal to the edge thickness of the slab and in one piece.

Tolerances on position:

- Absolute level tolerance: ± 5 mm.
- Relative level tolerance: ± 5 mm.
- Horizontal tolerance: ± 10 mm (maximum departure of face from a plane surface).
- Verticality: 3 mm departure from vertical.

Staking: Stake forms in position using at least 3 steel stakes per form, not more than 1.5 m apart. Lock joints between form sections to prevent movement.

Release agent: Before placing reinforcement, apply a release agent compatible with the contact surfaces, to the interior of the formwork, except where the concrete is to receive an applied finish for which there is no compatible release agent. Clean the reinforcement to remove all traces of release agent.

Re-use: Clean and recoat the forms each time before placing concrete.

Keyways: Form the keyways of keyed construction joints using steel form strips accurately located at the mid-depth of the slab and securely fastened flush against the formwork face.

Reinforcement

Tolerances in fabrication and fixing: To AS 3600.

Locate reinforcement: Place reinforcement in the top half of the pavement.

Minimum cover to reinforcement: 30 mm.

Splicing mesh: Overlap a minimum of 2 crosswires.

Supports: Provide proprietary concrete, metal or plastic supports to reinforcement in the form of chairs, spacers, stools, hangers and ties, as follows:

- 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, or are used with galvanized or zinc-coated reinforcement.
- Minimum spacing:
  - Bars: ≤ 60 diameters.
  - Fabric: ≤ 800 mm.

- Supports over membranes: Prevent damage to waterproofing membranes or vapour barriers. If appropriate, place a metal or plastic plate under each support.
- Projecting reinforcement: If starter or other bars project beyond reinforcement mats or cages, through formwork or from cast concrete, provide a plastic protective cap to each bar until it is incorporated into subsequent work.
- Tying: Secure the reinforcement against displacement by tying at intersections with either wire ties, or clips. Bend the ends of wire ties away from nearby faces of forms so that the ties do not project into the concrete cover.
- Mats: For bar reinforcement in the form of a mat, secure each bar at alternate intersections.

Cores, fixings and embedded items

Position: Fix cores and embedded items to prevent movement during concrete placing. In locating cores, fixings and embedded items, reposition but do not cut reinforcement, and maintain cover to reinforcement.

Isolation: Isolate embedded items so that water cannot track to concrete providing minimum cover to reinforcement.

3.7 CONCRETE PLACING AND COMPACTION

Concrete placing

General: Place concrete uniformly over the width of the slab or lane and so that the face is generally vertical and normal to the direction of placing. Hand spread concrete using shovels, not rakes.

Remove: Any water ponding on the ground.

Placing sequence: Commence from one corner (usually the lowest point) and proceed continuously out from that point.

Weather: Do not place concrete in temperatures above 30°C or below 10°C without adequate precautions.

Compaction

Thickness 100 mm or less: Compaction through placing screeding and finishing processes. If required use a hand-held vibrating screed at the surface. Do not use immersion vibrators.

Thickness more than 100 mm and downturns: Use an immersion vibrator.

Placing records

General: Keep on site and make available for inspection a log book recording each placement of concrete, including the following:

- Date of concrete placement.
- Delivery dockets noting the specified grade and source of concrete.
- Slump measurements to AS 1012.3.1.
- The portion of work.
- Volume placed.

Rain

General: During placement and before setting, do not expose concrete to rain.

Protection: Protect surface from damage by covering until hardened.

Concrete placing in cold weather

Cement: Do not use high alumina cement.

Placing concrete: Maintain the temperature of the freshly mixed concrete at 5°C.

Formwork and reinforcement: Before and during placing maintain temperature at 5°C.

Severe weather: If severe weather conditions are predicted, use high early strength cement.

Temperature control: Heat the concrete materials, other than cement, to the minimum temperature necessary to ensure that the temperature of the placed concrete is within the limits specified.

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 forms, materials, and equipment coming in contact with the concrete.

Maximum temperature of water: 60°C when it is placed in the mixer.

Plastic concrete: Prevent plastic concrete from freezing, without using salts or chemicals.

Concrete placing in hot weather

Handling: Prevent premature stiffening of the fresh mix and reduce water absorption and evaporation losses. Mix, transport, place and compact the concrete in conformance with the **Elapsed delivery time table**.

Placing concrete: Maintain the temperature of the freshly mixed concrete in conformance with the **Hot weather placing table**.

Formwork and reinforcement: Before and during placing maintain temperature at 35°C.

Severe weather: If ambient shade temperature more than 38°C, do not mix concrete.

Temperature control: Select one or more of the following methods of maintaining the specified temperature of the placed concrete:

- Cool the concrete using liquid nitrogen injection before placing.
- Cover the container in which the concrete is transported to the forms.
- Spray the coarse aggregate using cold water before mixing.
- Use chilled mixing water.

Hot weather placing table

Concrete element	Temperature limit
Normal concrete in footings, beams, columns, walls and slabs	35°C
Concrete in sections ≥ 1 m in all dimensions except for concrete of strength 40 MPa or greater, in sections exceeding 600 mm in thickness	27°C

Evaporation control barriers: Erect barriers to protect freshly placed concrete from drying winds.

3.8 CONCRETE PRIMARY FINISH

General

Finishing: Do not commence finishing until all bleed water has evaporated from the surface.

Commence: Immediately after placement and spreading and compaction of the plastic concrete, start finishing operations to achieve the documented finish.

Unformed surfaces

General: Strike off, screed and level slab surfaces to finished levels, to the tolerance class and finish documented in the **Unformed surface finishes schedule**.

Formed surfaces

Damage: Do not damage concrete works through premature removal of formwork.

Curing: If forms are stripped when concrete is at an age less than the minimum curing period, commence curing exposed faces as soon as the stripping is completed.

3.9 CONCRETE CURING

General

Curing: Commence curing as soon as possible after finishing and extend for a minimum period of 3 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.

Cold weather curing

General: Maintain concrete temperature between 10 – 20°C for curing period.

Hot weather curing

Curing compounds: If it is proposed to use curing compounds, provide details.

Protection: Select a protection method as applicable.

- If the concrete temperature exceeds 25°C or if not protected against drying winds, protect the concrete using a fog spray application of aliphatic alcohol evaporation retardant.
- If ambient shade temperature is more than 35°C, protect from wind and sun using an evaporative retarder until curing is commenced.

- Immediately after finishing, either cover exposed surfaces using an impervious membrane or hessian kept wet until curing begins, or apply a curing compound.

Curing methods

Covering sheet method: Immediately after finishing operations cover concrete using damp hessian or cotton mats overlapped at least 150 mm and anchored against displacement by wind or other interference. Keep the mats continuously damp until covered by the covering sheet material. Repair tears immediately.

Moist curing method: Immediately after finishing operations and once concrete has set sufficiently to be not damaged by the curing process keep the concrete surface continuously damp by ponding or spraying constantly with water, fog, or mist, using suitable spraying equipment. Continue wetting for the curing period.

Self levelling toppings: To AS 3799, if also used for curing.

Coloured concrete: Do not cure with plastic sheeting, damp sand or wet hessian. Use only chemical curing compounds compatible with the sealer or simply use a sealer (It must then comply with the requirements of a chemical compound sealer).

Curing compound

Application: Provide a uniform continuous flexible coating to AS 3799 without visible breaks or pinholes. Ensure coating remains unbroken at least for the required curing period after application. Respray defective areas within 30 minutes. Respray within 3 hours after heavy rain.

3.10 JOINTS

General

General: Construct expansion, contraction and construction joints straight and plumb. Make transverse joints normal to longitudinal joints. Extend transverse expansion and contraction joints continuously from edge to edge of the pavement through interconnected slabs.

Joint layout: Install joints as documented.

Contraction joints

Installation: Construct transverse and longitudinal contraction joints by early age power sawing or by placing an insert in the fresh concrete.

Dowelled joints

Dowelled contraction joint: Place dowels at 300 mm centres orthogonal to the joint direction and parallel to the pavement surface, accurate alignment is critical, ensure proper field supervision.

Dowel assembly: Use a dowel-assembly support frame firmly secured to the subbase during concrete placement. Prevent the dowel assembly support frame from passing through the joint. Do not insert dowels during the placement of concrete.

Debond dowel: Coat with a debonding coating to 0.5 length + 25 mm. Embed the unpainted half of the dowels in the slab placed first.

Movement: Do not distort or displace beyond the alignment tolerances under testing or during construction. Do not remove and replace dowels in pre-formed holes.

Tie bar joints

Longitudinal contraction joints: Place tie bars at 800 mm centres. Alignment accuracy of tie bars is not critical.

Construction joints

Installation: Place header board on the subbase or subgrade at right angles to the pavement centre line.

- Planned location: Terminate each day's placing operation at a transverse construction joint located to coincide with a planned contraction or expansion joint.
- Unplanned joints: If placement is interrupted for 30 minutes or longer, form a tied transverse construction joint within the middle third of the distance between planned joints but no closer than 1.5 m to the nearest planned joint. If necessary remove placed concrete back to the required location.

Expansion joints

Expansion joints: Provide formed full depth joints around structures and features which project through, into or against the pavement, and elsewhere as required.

Doweled expansion joints: Cap dowels at one end with a compressible material.

Formed joints

Full depth joints: Form the edge of the concrete placed first to provide a smooth, vertical face. After stripping and cleaning fix the joint filler with a suitable waterproof adhesive to the face of the slab, and place the adjoining concrete after the adhesive has set.

Weakened plane joint: Cut a crack-inducing groove by using a suitable tool into the plastic concrete during finishing of the concrete surface. Compact and refinish the plastic concrete around the groove after forming the joint.

Rebated groove joints: Form the rebate by securely fixing removable steel or timber form strips to the form or forms on the slab which is placed first, so that the top of the steel strip is flush with the top of the form. After stripping and cleaning, fix the joint filler in the rebate after placing the adjoining concrete.

Sawn joints

Weakened plane joint: Saw the hardened concrete to depth at least ¼ to ⅓ of the pavement thickness and to a uniform width in the range of 3 – 5 mm as follows:

- Timing: Commence sawing, regardless of time or weather conditions, as soon as the concrete has hardened sufficiently to permit cutting with only minor ravelling of the edges of the saw cut. Complete sawing no later than 24 hours after concrete placement.
- Sequence: If possible, saw every third transverse joint initially, then saw the intermediate joints. Start where concrete placement has commenced.
- Cracking: If the concrete has already cracked near the location chosen for a joint, do not saw a joint in that location. If a crack develops ahead of the saw cut, discontinue sawing and submit proposals for extra sawn joints. If uncontrolled cracking occurs, suspend concrete placing.
- Stand-by machines: Provide one stand-by sawing machine for each machine planned to be used.
- Cleaning and protection: Immediately after each joint is sawn, flush the saw cut and adjacent concrete surface using water, until the waste from sawing is removed from the joint. Temporarily caulk the joint using plastic or rubber tubing, or a suitable Tee shaped extrusion. Leave the caulking in place until grooving and sealing.

Rebated groove joints: Saw straight, parallel sided grooves for joint seals on top of and centred on the sawn weakened plane joints.

- Timing: Commence sawing after the curing period has ended, immediately before joint sealing. Saw during daylight hours.

Protection: Where there is a time elapse after sawing and before joint sealing, install a thin-splined rubber strip with a free width slightly larger than the saw cut at the bottom of the saw cut after washing slurry from sawn groove to temporarily prevent ingress of solid material.

Preparing joints

Stripping time: At least 12 hours.

Clean: Immediately before installation of the sealer ensure that the joint space is dry, clean and free from loose material. Remove laitance, curing compound and protrusions of hardened concrete from the sides and upper edges of the joint.

Joint sealing

Sealant type: Provide silicone sealant in conformance with manufacturer's recommendations.

Backing rod: Compressible closed cell polyethylene foam with a bond breaking surface.

3.11 SURFACE SEALERS

Slip resistance

Sealer: Apply surface sealer after the curing period and when concrete has dried to allow the sealer to penetrate into the concrete surface.

Curing sealer compound: If using the sealer as a curing compound, apply directly after finishing.

Concrete finishes

Conform to: Finishes in the *Concrete-combined* worksection.

Surface repairs

Surface repair method: If surface repairs are required, submit proposals.

3.12 COMPLETION

Protection

General: Keep traffic, including construction plant, off the pavement entirely during curing, and thereafter permit access only to necessary construction plant vehicles that conform to the predetermined load limits appropriate to the use of the concrete.

Reinstating adjacent surfaces

General: Reinstate surfaces next to new pavements and associated elements. Where an existing flexible road pavement has been disturbed, trim it back to a straight and undisturbed edge 250 – 300 mm from and parallel to the new concrete for the full depth of the slab. Backfill with asphalt rammed solid, using suitable rammers.

Traffic on pavement

General: Give notice before opening the pavement to traffic before the work is completed. Provide protection.

Testing

Concrete pavement: Check tolerances. Where pavement does not conform submit rectification proposal.

Unplanned cracking:

- 0.3 mm wide crack is acceptable.
- > 1 mm must be assessed, submit a proposal for possible cause and rectification processes.

0275 SEGMENTAL PAVERS – MORTAR AND ADHESIVE BED

1 GENERAL

1.1 RESPONSIBILITIES

General

General: Provide external paving, as documented and as follows:

- Consistent in colour and finish.
- Firmly bonded to substrates for the expected life of the installation.
- Resistant to expected impacts in use.
- Set out with joints accurately aligned in both directions.
- To direct all water flowing from supply points to drainage outlets without leakage to the substrate or adjacent areas.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.

1.3 STANDARDS

Slip resistance

Classification: To AS/NZS 4586 for the documented classifications.

Slip resistance measurement of completed installations: To AS/NZS 4663.

1.4 INTERPRETATION

Definitions

General: For the purposes of this worksection the definitions given below apply.

- Absolute level tolerance: Maximum deviation from design levels.
- Bedding: Mixtures of materials which are applied to substrates in a plastic state and dry and cure to adhere pavers to substrates.
  - . Adhesive bedding: Paving adhered by a cementitious adhesives bed.
  - . Mortar bedding: Paving adhered in a cementitious mortar bed.
- Cementitious adhesives (C): Adhesives in which the binders are hydraulic, e.g. Portland cement, with aggregates and organic additives.
- Lippage: Height deviation between adjacent pavers or other surface features.
- Pavers: Units made from clays, stone, precast concrete and/or other inorganic raw materials generally over 20 mm thick used as coverings for floors and supported over continuous substrates.
- Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.
- Substrates: The surface to which a material or product is applied.
- Soldier course: A course of whole or trimmed rectangular pavers at the pavement restraint edge.
- Terrazzo tiles – cementitious: Manufactured cementitious terrazzo tiles formed in a suitable machine to give sufficient compaction and density to the finished surface, and moisture cured before grinding and honed at the place of manufacture. Thickness usually 35 mm.

1.5 INSPECTION

Notice

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

- Substrate immediately before paving.
- Trial set-outs before execution.
- Control joints before sealing and grouting.

1.6 TOLERANCES

Completed paving
General: Conform to the **Surface level tolerances table**.

Surface level tolerances table

Item	Level tolerance	
	Absolute	**Relative**
Vehicular pavements	± 5 mm	5 mm
Pedestrian pavements	± 10 mm	10 mm

Lippage:
- Unpolished pavers: < 2 mm.
- Polished pavers 300 x 300 mm or less: 1 mm, with 5% not exceeding 1.5 mm.
- Polished pavers over 300 x 300 mm: 1.5 mm, with 5% not exceeding 2 mm.

1.7 SUBMISSIONS

Execution
Grouting: Submit proposals for grouting methods and materials.
Margins: If it appears that minor variations in joint widths or overall dimensions will avoid cut pavers, submit a proposal.

Materials
Product conformity: Submit current assessments of conformity as follows:
- Marking and classification of adhesive to AS 4992.1.

Samples
General: Submit labelled samples of pavers, grout and sealants, illustrating the range of variation in colour and finish.

Sample panels
General: Prepare a sample panel of each type of finish as follows:
- Size: ≥ 2 m $^{2.}$
- Include samples of junction details and trim.
- Preserve each panel until related work is complete.

Tests
Type tests: Submit results, as follows:
- Type test slip resistance of pavers to AS/NZS 4586.

Site tests: Submit results, as follows:
- Site slip resistance test of completed installation to AS/NZS 4663.
- Salt efflorescence of paver prototype testing.

2 PRODUCTS

2.1 MARKING

Identification
General: Deliver materials to the site in the manufacturer's original sealed containers or 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. Provide technical data sheets if not shown on labels.

- Handling and installation instructions.
- Material safety data sheets.

2.2 ADHESIVES

General
Standard: To AS 2358 or AS 4992.1.

Type
General: Provide adhesives compatible with the materials and surfaces to be adhered.

Prohibited uses: Do not provide the following combinations:

- Organic PVC-based adhesives and organic natural rubber latex adhesives in damp or wet conditions.
- PVA (polyvinyl acetate) based adhesives in wet areas or externally.

2.3 MORTAR

Materials
Cement: To AS 3972.

- Type: GP.
- White cement: Iron salts content ≤ 1%.
- Off-white cement: Iron salts content ≤ 2.5%.

Lime: To AS 1672.1.

Sand: Fine aggregate with a low clay content selected for grading, sharp and free from efflorescing salts.

Water: Clean and free from any deleterious matter.

Measurement of volume: Measure binders and sand by volume using buckets or boxes. Do not allow sand to bulk by absorption of water.

Bedding mortar
Proportioning: Select proportions from the range 1 cement:3 sand – 1 cement:4 sand to obtain satisfactory adhesion. Provide minimum water.

Mixing: To AS 3958.1 clause 2.15.

Gauging: Site gauged by volume.

2.4 GROUT

Type
Portland cement based grout: Mix with fine sand. Provide minimum water to achieve workability.

- Proportion: 1 cement:3 sand.

Pigments
Pigments for coloured grout: Provide colourfast pigments compatible with the grout material. For cement-based grouts, provide inorganic mineral pigments or lime-proof synthetic metallic oxides compatible with cement.

Water
General: Clean and free from any deleterious matter.

2.5 PAVERS

Standard
Masonry units, pavers and flags: To AS/NZS 4455.2.

Sandstone flagging
Description: Provide sound stone flags of uniform quality. Reject flags with any of the following defects liable to affect strength and durability: Vents, cracks, fissures, seams, porous inclusions, foreign material, loose surface material or discolouration.

Matching: Select for optimum matching of colour and pattern.

Split flagging thickness: Minimum 50 mm, maximum 75 mm.

Face size: Utilise smaller sizes for pathways and larger sizes for open areas and maintain traditional stone flagging appearance.

Stone setts
Description: Igneous stone cubed cobble style setts.

2.6 OTHER MATERIALS

Tactile ground surface indicators
Standard: To AS/NZS 1428.4.1.

Control joint types
General: As documented in the **Control joints schedule**.

Divider strip: A proprietary expansion joint consisting of a neoprene filler sandwiched between plates with lugs or ribs for mechanical keying. Set flush with the finished surface.

Proprietary slide plate divider strip: An arrangement of interlocking metal plates grouted into pockets formed in the concrete joint edges.

Sealant: Two-pack self-levelling flexible mould resistant, one-part silicone or polyurethane sealant applied over a backing rod. Finish flush with the paver surface.

- Floors: Trafficable, shore hardness more than 35.

Backing rod: Compressible closed cell polyethylene foam with a bond-breaking surface.

3 EXECUTION

3.1 SUBSTRATES

Drying and shrinkage
General: Before paving, allow at least the following times to elapse (for curing and initial shrinkage) for these substrates:

- Concrete slabs: 28 days.
- Toppings on slabs: A further 21 days.

3.2 PREPARATION

Trial set-out
General: Prepare a trial paving set-out to each area as follows to:

- Maximise the size of equal margins of cut pavers.
- Locate control joints.
- Note minor variations in joint widths to eliminate cut pavers at margins.

Ambient temperature
General: If the ambient temperature is less than 5 or more than 35°C, do not lay pavers.

Substrates
General: Make sure substrates are as follows:

- Clean and free of any deposit or finish which may impair adhesion or location of pavers.
- Projections are hacked off and voids and hollows are filled with a cement:sand mix not stronger than the substrate nor weaker than the bedding.

Absorbent substrates: If suction is excessive, control it by dampening but avoid over-wetting and do not apply mortar bedding to substrates showing surface moisture.

Dense concrete: If not sufficiently rough to provide a mechanical key, roughen by scabbling or the like to remove 3 mm of the surface and expose the aggregate then apply a bonding treatment.

Fixtures
General: Before paving make sure that fixtures interrupting the surface are accurately positioned in their designed or optimum locations relative to the paving layout.

3.3 PAVING GENERALLY

Variations
General: If necessary, distribute variations in hue, colour, or pattern uniformly, by mixing pavers or paving batches before laying.

Paving joints
Joint widths: Set out pavers to give uniform joint widths of 6 to 12 mm.

Margins
General: Provide whole or purpose-made pavers at margins where practicable, otherwise set out to give equal margins of cut pavers. If margins less than half paver width are unavoidable, locate the cut pavers where they are least conspicuous.

Protection
Traffic: Keep pedestrian and vehicular traffic off paving until the bedding has set and attained its working strength.

Cleaning: Keep the work clean as it proceeds and protect finished work from damage.

3.4 MORTAR BEDDING

Preparation of pavers
Suction: Soak porous pavers in water for half an hour and then drain until the surface water has disappeared.

Bedding
General: Use bedding methods and materials which are appropriate to the paver, the substrate, the conditions of service, and which leave the paver firmly and solidly bedded in the bedding material and adhered to the substrate. Form falls integral with the substrate.

Mortar beds
Substrate preparation: Either lightly dust the screeded bed surface with dry cement and trowel level until the cement is damp, or spread a thin slurry of neat cement, on to the paver back. Do not provide mortar after initial set has occurred.

Sandstone flagging
Mortar bed thickness: Minimum 50 mm to maximum 60 mm.

Laying pattern: Random, with smaller stones filling the gaps to produce roughly uniform joint widths.

Lay flags and fill joints in one operation.

Stone setts dry bed
Description: Lay and tamp setts on to a dry sand and cement mix, compact and moisten as follows:

- Bed: 1 cement:3 sand, screeded to the level required to allow setts to be firmly tamped.
- Select the top side of the sett for surface uniformity and tap into the mix to the pre-compaction position.
- Compact with a hand ram or mechanical compactor.
- Water spray the surface and allow the bedding to harden.
- Grout joints.

3.5 ADHESIVE BEDDING

Preparation of pavers
Adhesive bedding: Fix pavers dry.

Bedding
General: Use bedding methods and materials which are appropriate to the paver, the substrate, the conditions of service, and which leave the paver firmly and solidly bedded in the bedding material and adhered to the substrate. Form falls integral with the substrate.

Thick adhesive beds
General: Provide on substrates with deviations up to 6 mm when tested with a 2 m straight edge, and with pavers having deep keys or frogs.

Nominal thickness: 6 mm.

Adhesive bedding application
General: Apply adhesive by notched trowel to substrates and direct to pavers if required, to provide evenly distributed coverage of more than 90% after laying.

Pattern of distribution of adhesive: Conform to AS 3958.1. Verify by examining one paver in ten as work proceeds.

Grouting: Allow the adhesive to cure for the period recommended by the manufacturer before grouting.

3.6 MOVEMENT JOINTS

General

General: Provide control joints as follows:

- Location:
  - . Over structural control joints.
  - . At internal corners.
  - . Close to external corners in large paved areas.
  - . Around the perimeter at abutments.
  - . At junctions between different substrates.
  - . To divide large paved areas into bays, maximum 5 m wide, maximum area 16 m $^{2.}$
  - . At abutments with the building structural frame and over supporting walls or beams where flexing of the substrate is anticipated.
- Depth of joint: Right through to the substrate.
- Sealant width: 6 to 25 mm.
- Depth of elastomeric sealant: One half the joint width, or 6 mm, whichever is the greater.

3.7 GROUTED JOINTS

Grouted joints

General: Commence grouting as soon as practicable after bedding has set and hardened sufficiently. Clean out joints as necessary before grouting.

Face grouting: Fill the joints solid and tool flush. Clean off surplus grout and wash down as the grouting proceeds.

3.8 COMPLETION

Spare pavers

General: Supply spare matching pavers of each type for future replacement purposes. Store the spare materials on site.

Quantity: At least 1% of the quantity installed.

Cleaning

Completion: Clean progressively and leave pavements clean on completion.

Operation and maintenance manuals

General: Submit a manual describing care and maintenance of the paving, including procedures for maintaining the slip-resistance grading stating the expected life of the slip-resistance grade.

0276 SEGMENTAL PAVERS – SAND BED

1 GENERAL

1.1 RESPONSIBILITIES

General

General: Provide segmental paving surfaces for pavement, footpath and landscape works, as documented and as follows:

- In conformance with the level tolerances specified.
- Consistent in colour and finish.
- To direct all water flowing from supply points to drainage outlets without leakage to the substrate or adjacent areas.

Performance

General: Coordinate with drainage, adjacent structures and trees.

Conformance: Conform to local authority requirements for levels, grades and paving details (including shape, colour and laying pattern) for paving to footpaths and driveways.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *General requirements*.
- *Earthwork*.
- *Stormwater – site*.
- *Pavement base and subbase*.

1.3 STANDARDS

General

Concrete and clay segmental pavers: To AS/NZS 4455.2.

Slip resistance

Classification: To AS/NZS 4586 for the documented classifications.

Slip resistance measurement of completed installations: To AS/NZS 4663.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AGPT: Austroads Guide to Pavement Technology.
- CBR: California Bearing Ratio.
- CCAA: Cement and Concrete Association of Australia.
- CMAA: Concrete Masonry Association of Australia.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Absolute level tolerance: Maximum deviation from design levels.
- Base: One or more layers of material usually constituting the uppermost structural element of a pavement on which the surfacing may be placed and which may be composed of fine crushed rock, natural gravel, broken stone, stabilised material, asphalt or concrete.
- Clay segmental pavers: Manufactured from clay, shale or argillaceous materials and which may be mixed with additives. Clay pavers may have square, bevelled (chamfered), rounded or rumbled edges. The pavers 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 and rely on dimensional accuracy and accuracy of laying to develop interlock.
- Density ratio: Percentage of the maximum density at optimum moisture content as determined by AS 1289.5.2.1.
- Lippage: Height deviation between adjacent pavers or other surface features.
- Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.
- Soldier course: A course of whole or trimmed rectangular pavers at the pavement restraint edge.
- Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.

1.5 INSPECTION

Notice

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

- Completed base preparation.
- Completed trial set-out for segmental paving.
- Completed paving.

1.6 TOLERANCES

Tolerances

General: Conform to the following:

- Absolute level tolerance: ± 8 mm.
- Relative level tolerance: 8 mm.
- Lippage: < 2 mm.

1.7 SUBMISSIONS

Authority approvals

Local authority: Submit authority approvals for paving products, laying patterns, alignment and drainage for footpaths or crossovers.

Execution

Base material: Submit test results on quality, grading and compaction.

Segmental pattern: If it appears that minor variations to joint widths will minimise cutting, submit proposals.

Products

Compliance certificate: Submit compliance certificates for the pavers, as documented.

Tests

Type tests: Submit results, as follows:

- Type test slip resistance of tiles to AS/NZS 4586.

Site tests: Submit results, as follows:

- Site slip resistance test of completed installations to AS/NZS 4663.
- Accelerated wear test.

2 PRODUCTS

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. Provide technical data sheets if not shown on labels.
- Handling and installation instructions.
- Material safety data sheets.

2.2 SAND

Bedding sand

Quality: Free of deleterious material, such as soluble salts which may cause efflorescence.

Grading: To the **Bedding sand grading table** when tested to AS 1141.11.1.

Fines: Do not use single-sized, gap-graded or excessive fine material.

Cement: Do not use cement bound material.

Moisture content: Make sure uniform moisture content between 4 – 8 %.

Bedding sand grading table

Sieve aperture	Percentage passing (by mass)
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

General: Well-graded sand and free of deleterious material such as soluble salts which may cause efflorescence.

Grading: To the **Joint filling sand grading table** when tested to AS 1141.11.1.

Joint filling sand grading table

Sieve aperture	Percentage 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

Moisture content: Use dry sand.

Cement: Do not use cement.

2.3 GEOTEXTILE MATERIALS

General

Standard: To AS 3705.

Quality: Free of flaws, stabilised against UV radiation, rot proof, chemically stable and with low water absorbency. Filaments resistant to delamination and dimensionally stable.

2.4 CONCRETE SEGMENTAL PAVERS

Properties

Requirements: To AS/NZS 4455.2 Table 2.8 when tested as follows:

- Characteristic breaking load and flexural strength: To AS/NZS 4456.5.
- Dimensional deviations: To AS/NZS 4456.3.
- Abrasion resistance: To AS/NZS 4456.9.

Permeable interlocking concrete pavers: To CMAA MA56.

Proprietary product: As documented.

2.5 CLAY SEGMENTAL PAVERS

Properties

Requirements: To AS/NZS 4455.2 Table 2.8 when tested as follows:

- Characteristic breaking load and flexural strength: To AS/NZS 4456.5.
- Dimensional deviation category: To AS/NZS 4456.3.
- Abrasion resistance: To AS/NZS 4456.9.

Proprietary product: As documented.

2.6 OTHER MATERIALS

Tactile ground surface indicators

Standard: To AS/NZS 1428.4.1.

2.7 EDGE RESTRAINT

Concrete

Concrete: To AS 1379.

Compressive strength: 32 MPa.

Sleepers

Hardwood: Sound hardwood railway sleepers to AS 3818.2.

Softwood: Sound preservative-treated softwood sleepers.

Preservative treatment

General: Hazard class H4 to AS 1604.1.

3 EXECUTION

3.1 SUBGRADE

Preparation

Extent: Prepare the subgrade to the required profile and extend to the rear face of the proposed edge restraints or to the face of existing abutting structures.

Subgrade preparation: To the *Earthwork* worksection.

Drainage of subgrade

Subgrade drainage: Prepare piped or channelled stormwater and subsoil drainage to the *Stormwater – site* worksection.

Service trenches: Backfill all drainage trenches to perform similar to the undisturbed ground.

3.2 BASE COURSE

Preparation

Base course extent: Extend base course below the edge restraint for its full width except at walls or pits.

Base course: Conform to the *Pavement base and subbase* worksection.

3.3 EDGE RESTRAINT

Lateral restraint to segmental paving

Perimeter: If not provided by other structures, provide edge restraints to bedding and units.

Drainage: Position edge restraint and pavers so that the top of the pavers are slightly above the front edge of the edge restraint.

Edge restraint shape: Make sure the edge restraint has a vertical or near vertical side abutting the pavers.

Type: [complete/delete]

Sleeper edging

General: Fix sleepers in position by spiking with two 13 mm diameter galvanized mild steel rods per sleeper, penetrating at least 400 mm into the subgrade. Drive the rods flush with the upper surface of the sleeper. Arris the upper exposed sleeper edges to produce a 15 mm wide face at 45 to the edges.

Concrete edging or kerb

Construction: Fixed form, extrusion or slip forms to AS 2876.

Edging or kerb: Place in a shallow trench between timber forms. Wood float finish flush with the adjacent finished grass level.

Joints: Provide contraction joints 20 mm deep every 5 m.

Timing: Carry out concrete edge restraints before bedding course. Allow concrete edge restraints to harden before vibration of the surface course.

Brick

Setting: On a 1:1:6 (cement:lime:sand) mortar haunch.

Laying: [complete/delete]

Joints: 3 mm struck flush.

Alignment: Even and free from dips, humps and bends.

Cleaning: Wash off mortar progressively.

3.4 BEDDING COURSE

General

Preparation: Remove all loose material from the prepared base.

Geotextile

Position: Place fabric between the base course and the bedding sand.

Bedding sand

Spreading: Screed uncompacted sand over prepared base uniformly to achieve a 30 mm thick layer. Maintain sand at a uniform loose density and moisture content.

Bedding course drainage: If water ponding occurs at edge restraint, drain bedding course to existing subsurface drain or drainage pit using geotextile and 20 mm diameter PVC pipe.

Trial section

Moisture content: Prepare a trial section to establish the moisture content limits which will allow paver system compaction to be achieved.

3.5 LAYING PAVING

General

Segmental paving pattern: Prepare a trial set-out for each area.

Pattern: Lay paving units on the screeded sand bedding to the documented pattern.

Joints: 2 – 5 mm gap.

Cut courses: 50 mm minimum plan dimension. On footpaths and other linear elements, use at least two cut courses and maintain symmetry.

Control: Control alignment and laying pattern by stringlines or chalked stringlines every 5 m intervals.

Variable width areas: Include in situ concrete infill strips to make a straight area for paving and take up the variable width.

If there is a concrete base, provide paving control joints:

- Located over base control joints.
- 10 mm wide and filled with bitumen impregnated fibreboard.

Laying around obstacles

Public utility access pits and penetrations: Adjust access covers as required before commencing paving. Make sure water drains away from pits with lids and into surface inlet drainage structures.

Concrete surrounds:

- Plan shape: Square or rectangular with a smooth connection with the laying pattern of the pavers.

- Pit position: Centring not required.
- Minimum thickness between the pit and paving: 100 mm.
- Strength grade: N32.
- Colour: grey.

Precast access chamber: Lay pavers to suit specific dimensions of authority access chambers.

Patterns around obstacles: Lay up both sides of the feature from the main or original laying face.

Compaction of bedding

Compaction: Compact the sand bedding after laying paving units with a vibrating plate compactor and appropriate hand methods.

Sequence: Compact paving as follows:

- Progressively behind the laying face.
- Complete compaction of laid paving at end of each day.
- Do not compact within 1 m of the laying face except where adjacent to an edge restraint.

Joint filling: Compact all paving units to design levels before starting of joint filling.

Joint filling

Filling: Spread dry sand over the paving units and fill the joints by brooming. Carry out one or more passes with the vibrating plate compactor and refill the joints with sand. Repeat the process until the joints are completely filled.

Timing: Start joint filling immediately after compaction.

3.6 COMPLETION

Protection of the work

Protection: Prevent all vehicular and pedestrian traffic from using the pavement until all compaction and joint filling is completed and all edge restraints are in place.

Spare pavers

General: Supply spare matching pavers of each type for future replacement purposes. Store the spare materials on site.

Quantity: At least 1% of the quantity installed.

Cleaning

General: Leave pavements clean on completion.

Final inspection

General: Before the date for practical completion carry out the following inspections:

- Cracking in bound pavements: Width 1.5 mm.
- Subsidence: Offset less than 1.5 m length of the design profile, not more than 5 mm.
- Stepping: Between adjacent elements within the pavement area, not more than 5 mm.
- Chipping and spalling to pavement units: Maximum 10 per 100 units with chipped or spalled arrises.
- Ponding: Maximum 10 mm deep 15 minutes after rain ceases.
- Paving joints: Refill joints as required.

0277 PAVEMENT ANCILLARIES

1 GENERAL

1.1 RESPONSIBILITIES

General
General: Provide channels, kerbs and linemarking, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- *General requirements*.
- *Site management*.
- *Earthwork*.
- *Pavement base and subbase*.

1.3 INTERPRETATION

Definitions
General: For the purposes of this worksection the definitions of AS 1348 and those given below apply.
- Absolute level tolerance: Maximum deviation from design levels.
- Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface
- Channels and kerbs: Includes all forms of concrete gutters, dish drains, grated drains and mountable median and barrier kerbing.

1.4 SUBMISSIONS

Linemarking materials
General: Submit NATA Registered Laboratory Test Reports, at least seven days before work is scheduled to commence, on the properties of the materials, including paint.

2 PRODUCTS

2.1 MATERIALS

Concrete
Standard: To AS 1379 – Grade N20.

Pavement marking paint
Standard: To AS 4049.1, AS 4049.3 and AS 4049.4.

2.2 VEHICLE BARRIERS

Log barriers
General: Hazard class 4 to AS 1604.1.

Size: Diameter range 125 – 150 mm.

Precast concrete wheel stops
Material: Precast concrete units with predrilled holes located 300 mm from each end for fixing to ground surface.

Size: 2000 x 150 x 100 mm high.

Steel tube bollards
Type: Bollards fabricated from heavy steel tube, to minimum nominal size DN 100, to AS 1074. Seal free ends with fabricated end caps, spot welded and ground smooth.

Finish: Galvanize after fabrication.

2.3 BICYCLE RACKS

General
Standards: Layout and location to AS 2890.3.

3 EXECUTION

3.1 LINEMARKING

Setting out

General: Set out the work to ensure that all markings are placed as documented.

Surface preparation

Surface: Clean, dry and free of any deposit which may impair adhesion of the paint finish.

Wet weather: Do not apply pavement marking during wet weather or if rain is likely to fall during the process or paint drying time.

Scabbling: Scabble the full area of concrete wearing surfaces to raised pavement markers and remove fine mortar material.

Provision for traffic: Allow for traffic during application and protect pavement markings until the material has hardened sufficiently to carry traffic without damage.

Mixing of paint: Mix all paint in its original container before use and produce a smooth uniform product consistent with the freshly manufactured product.

Application of paint

Longitudinal lines: Spray all longitudinal lines with a self propelled machine. Spray concurrently the two sets of lines forming a one-way or two-way barrier line pattern.

Hand spraying: Hand spray transverse lines, symbols, legends, arrows and chevrons with templates.

Paint thickness: Uniform wet film thickness: ≥ 0.35 mm to ≤ 0.40 mm.

Pavement markings: Straight or with smooth, even curves where intended.

Edges: Clean with a, sharp cut off. Remove any marking material applied beyond the defined edge of the marking and leave a neat and smooth marking on the wearing surface of the pavement.

Tolerances

Longitudinal line lengths: ± 20 mm from the lengths shown in AS 1742.2.

Longitudinal line widths: ± 10 mm from the widths shown in AS 1742.2.

Transverse line lengths and widths: ± 10 mm from the lengths and widths shown in AS 1742.2.

Other markings: ± 50 mm from the dimensions shown on the drawings or in AS 1742.2 for arrows, chevrons, painted medians, painted left tern islands and speed markings. Place arrows and speed markings square with the centreline of the traffic lane.

Removal of pavement markings

General: Remove pavement markings, no longer required, from the wearing surface of pavements without significant damage to the surface.

3.2 CHANNELS AND KERBS

Foundation preparation

Foundation material: Shape and compact to form a firm base before placing any kerb and/or gutter.
Construction not on a pavement course: Relative compaction To AS 2876.

Construction on a pavement course: To the requirements of the *Pavement base and subbase* worksection.

Standard: Construct kerb and/or gutters in fixed forms, by extrusion or by slip forming to AS 2876.

Foundation, concrete quality, curing and testing details: To AS 2876.

Tolerances

Absolute level tolerance: ± 10 mm at any point on the surface of gutters.

Relative level tolerance: 5 mm to top or face of kerbs, and to the surface of gutters.

Plan position deviation: 25 mm.

Exception: Kerb laybacks, grade changes or curves, or at gully pits requiring gutter depression.

Joints

Standard: To AS 2876.

Concrete pavement: Where kerbs and/or gutters are cast adjacent with a concrete pavement, continue the same type of expansion, contraction and construction joints documented for the concrete pavement across the kerb and/or gutter.

Backfill

Timing: Not earlier than three days after placing kerb and gutter concrete, backfill and reinstate the spaces on both sides of the kerb and/or gutters.

Material: Granular material, free of organic material, clay and rock in excess of 50 mm diameter.

Compaction: Compact backfilling in layers not greater than 150 mm thick, to a relative compaction of 95% when tested in conformance with AS 1289.5.4.1, for standard compactive effort.

Pavement: Backfill pavement material adjacent to new gutter in conformance with the drawings and the *Pavement base and subbase* worksection.

3.3 VEHICLE BARRIERS

Log barriers

Installation: Check out the posts to receive the rails. Set each post 600 mm into the ground and surround with compacted fine crushed rock, gravel or cement stabilised rammed earth. Bolt rails to posts with M12 diameter galvanized bolts and washers, with bolt heads and nuts recessed.

Precast concrete wheel stops

Installation: Drive 12 mm diameter galvanized steel rods 600 mm into the ground to finish 25 mm below the top of the wheel stop, or bolt the stop to masonry anchors in concrete slabs. Grout the holes flush to match the concrete finish.

Steel tube bollards

Footing: Encase in a concrete footing at least 600 mm deep x 250 mm diameter.

On slabs: Weld on a 10 mm thick baseplate drilled for 4 bolts, and bolt to masonry anchors.

Filling: Fill the tube with 15 MPa concrete.

Timber bollards

Material: Sawn recycled Turpentine.

Installation: Mass concrete footing.

Finish: Untreated.

0278 GRANULAR SURFACES

1 GENERAL

1.1 RESPONSIBILITIES

General

General: Provide base and granular surfacing as documented and as follows:

- To the level tolerances.
- To the compaction requirements.

2 PRODUCTS

2.1 MATERIALS

Base

Description: Fine crushed rock, free of sand and coatings of clay or organic material, and containing not more than 1% disintegrated, weathered, soft fractured, friable or poorly indurated fragments.

Granular surface material

Gravel: Unscreeded natural stone as follows:

- Grade: Up to 10 mm maximum with 30% to 40% less than 5 mm including fines.

Crushed granite:

- Particle size: ≤ 4 mm with 40% 0.5 mm to 2 m , and 60% 2 mm to 4 mm.

Crushed brick:

- Grade: 10 mm to 20 mm. Remove particles under 10 mm by sieving before laying.

Decomposed granite:

- Particle size: 5 mm to 20 mm with 40% 5 mm to 10 mm, and 60% 10 mm to 20 mm.

Stabilising: Screed out the fines and replace with 1 part off-white cement to 35 parts decomposed granite to slopes less than 1:30, and with 1 part off-white cement to 20 parts decomposed granite to slopes more than 1:30.

Stabilised sand surface

Sand: Bricklayer's bush sand (fatty sand) with a high percentage of fines less than 75 microns as a plasticising agent.

3 EXECUTION

3.1 SUBGRADE

Preparation

Excavation: Cut and trim the subgrade to enable the finished compacted thickness to finish flush with adjacent surfaces.

3.2 BASE

Gravel surfaces

Method: Mechanically spread material to the loose thickness required to produce the documented finished compacted thickness. Do not transport new material over uncompacted material. If the subgrade is disturbed during placing or becomes mixed with new material, remove all contaminated material and replace, regrade and compact.

Moisture: Bring base material to the optimum moisture content before and during placing. Do not add water during compaction except as required to replace evaporation.

3.3 COMPACTION

Subgrade and base

Hand compaction: Condition the material by moisture adjustment before compaction. Compact to 95% of the maximum dry density.

Sampling: To AS 1289.1.2.1.

Testing: To AS 1289.5.1.1, AS 1289.5.3.1 or AS 1289.5.8.1.

3.4 SURFACING

Finished levels

Absolute level tolerance: ± 10 mm from the documented profile.

Gravel

Thickness: Spread loose material screeded to 25 mm minimum over the compacted base.

Decomposed granite

Thickness: Spread blended dry mix screeded to 100 mm minimum over the compacted subgrade.

Compaction: To 90% of the maximum dry density when tested to AS 1289. Discard stones more than 25 mm.

Moisture: Do not water in the surface material. Allow the natural ground water to rise and stabilise the mixture.

Stabilised sand surface

Thickness: Spread loose material screeded to 100 mm minimum over the compacted subgrade and consolidate by rolling and watering.

Stabilising: General purpose cement at the rate of 5% of the sand spread over the prepared sand surface. Rotary hoe the cement throughout the entire mix and re roll.

Existing sand/earth

Stabilising: 1 part Portland cement to 6 of the sand/earth spread over the prepared surface. Rotary hoe the cement to a depth of 130 mm and consolidate by rolling.

0281 BUSHFIRE PERIMETER TRACKS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

Bushfire protection: Construct bushfire perimeter tracks as documented and make sure that the work is undertaken to minimise the disturbance of the natural surroundings and the need for future maintenance.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152 Schedule of rates – supply projects.*
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0257 Landscape - roadways and street trees.*
- *1351 Stormwater drainage (Construction).*
- *1352 Pipe drainage.*
- *1353 Precast box culverts.*
- *1354 Drainage structures.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following document is incorporated into this worksection by reference:

NSW Soil Conservation Act, 1938.

1.4 INTERPRETATION

Definitions

General: For the purposes of this worksection the definitions given below 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.
- Perimeter access tracks: Provide maintained access for fire fighting beyond private lots.
- Cross bank: A hump of earth constructed across a track so that runoff is effectively diverted from it. Cross banks are designed to handle larger flows than cross drains.
- 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. Where the water flows into the hillside, it is termed 'infall'. Where flow is away from the hillside, it is termed 'outfall'.
- Culvert: A pipe or similar structure used to direct water under the track.
- 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. As a general rule, tracks should not be built on Class D soils.

2 PRE-CONSTRUCTION PLANNING

2.1 GENERAL

Quality

Requirements: Conform to *0161 Quality (Construction)* for quality control and testing, including maximum lot sizes and minimum test frequencies.

Connection to existing tracks

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

Reducing erosion and maintenance

Erosion: Construct the track surface with outfall drainage and trafficable cross banks, so as to reduce erosion damage and maintenance needs.

Maintenance: Further reduce the risk of erosion by establishing and maintaining vegetation on the tracks in designated areas. The vegetation on fire access tracks should be suitable low grasses and ground covers, less than 0.3 m high.

3 EXECUTION

3.1 EARTHWORKS

Minimum disturbance

General: Construct tracks with as little disturbance as possible to the soil and vegetation both on and adjacent to the track. Follow the contour of the land as much as possible to reduce the amount of cut and fill.

Safety: Provide maximum crossfall < 1:10 (horizontal:vertical).

Cut batters

General: Construct cut batters as follows:

- Vertically to 1.5 m: Minimise the area of disturbed soil exposed.
- Higher than 1.5 m: Provide special stabilisation measures including laying back, revegetation and drainage.
- Dispersive soils: If encountered give notice.

Fill batters

General: Construct fill batters as follows:

- As flat as possible to encourage natural revegetation and to effectively accept seed and fertiliser.
- On all soil classes not be steeper than 2:1 (horizontal:vertical).

Batters higher than 1.5 m on Class B, C and D soils: Provide special stabilisation works, such as drop down drains or hay mulching.

- Give notice if dispersive soils are encountered.

Fill batters: Do not use vegetation debris or erosive materials.

Borrow areas

Location: Do not locate borrow areas near drainage lines or streams in order to avoid sediment polluting the stream. Limit ‘borrow’ areas in size and work in such a way as to reduce the amount of sediment leaving the borrow pit, and revegetate progressively as the pit is worked out.

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

Timber clearing
Clearing: Limit to 0.5 m on either side of the track, and include overhanging branches to 4 m clear height.

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

Waste: Dispose of all vegetation matter off site.

3.2 CROSS BANKS

Cross bank outlet points
Blockage: Do not block the outlet points for cross banks with stumps or rocks.

Runoff: Site the outlets such that the runoff spills into undisturbed vegetation and cannot flow back onto the track.

Construction
Method: Rip the roadway area to a depth of 200 to 300 mm for a distance of one or two tractor lengths back from the chosen outlet point. Push the loose earth down the roadline into a bank, commencing at the uphill side of the road and working across the outlet side. Provide a long, shallow excavation for the cross bank.

Cross bank length: 6 m.

Shaping and compaction
Dimension: Use sufficient loose earth to give the required dimensions after shaping and compaction. Size the crest width to ensure comfortable vehicle access over the cross bank, and the channel depth to prevent runoff from overtopping the bank.

Compaction: Track or wheel roll the entire length of the bank to obtain maximum compaction and a smooth, even bank with batters no steeper than 1:5 (horizontal:vertical) in relation to the track surface.

3.3 DRAINAGE

Crossings
General: Construct fords, culverts or bridges across drainage lines and streams, as documented.

Prohibition: Do not use log dam crossings as they obstruct flood flows and can create turbulent flow and erosion.

Fords
General: Construct fords as documented or as directed by the Superintendent.

Culverts
Construction: Construct culverts and headwalls as documented or as directed by the Superintendent in accordance with *1351 Stormwater drainage (Construction), 1352 Pipe drainage*, *1353 Precast box culverts* and *1354 Drainage structures.*

Alignment: Construct culverts as close as possible to the natural alignment of the drainage line to avoid diverting the flow into the stream banks or creating scour along the drainage line.

Prohibition: Do not use culverts where debris or blockages are likely.

Disturbance
General: Keep soil and vegetation disturbance to a minimum. Seed disturbed areas in accordance with *0257 Landscape – roadways and street trees* to protect them from erosion.

Dumping: Do not dump timber, scrub, soil or debris in drainage lines. Stack well above flood levels.

Trees in prescribed streams
Requirement: Where trees must be removed or may be injured in the bed or within 20 m of the banks of prescribed streams, as defined in the NSW Soil Conservation Act, 1938, an authority from the Catchment Areas Protection Board is required.

3.4 REVEGETATION

Built up areas
General: Provide revegetation in accordance with requirements of *0257 Landscape – roadways and street trees* indicated on the development/subdivision plan.

Immediate application

Application: Apply revegetation immediately following the disturbance while the soil is still loose, irrespective of the growing season. Also apply a maintenance dressing of appropriate fertiliser and seed.

4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

General

Payment to the schedule of rates: To *0152 Schedule of rates – Supply projects*, *0281 – Bushfire protection* and **Pay item 0281.1**.

Lump sum prices: Not acceptable.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology

Methodology for measurement and payment:

- Culverts and headwalls: To *1351 Stormwater drainage (Construction),* 1352 *Pipe drainage*, *1353 Precast box culverts* and *1354 Drainage structures*, as appropriate.
- Seeding and vegetation: To *0257 Landscape – roadways and street trees*.

0282 PATHWAYS AND CYCLEWAYS (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide pavements for pathways and/or cycleways, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksections:
- *0136 General requirements (Construction).*
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0257 Landscape - roadways and street trees.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1102 Control of erosion and sedimentation (Construction).*
- *1111 Clearing and grubbing.*
- *1112 Earthworks (Roadways).*
- *1151 Road openings and restoration.*
- *1152 Road openings and restoration (Utilities).*
- *1196 Street lighting*.

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

Australian Standards

AS 1012	Methods of testing concrete
AS 1012.3.1-1998	Determination of properties related to the consistency of concrete – Slump test
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 1141.52-2008	Unconfined cohesion of compacted pavement materials
AS 1160-1996	Bitumen emulsions for construction and maintenance of pavements
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 1289.6.1.1-1998	Soil strength and consolidation tests – Determination of the California Bearing Ratio of a soil – Standard laboratory method for a remoulded specimen
AS 1348-2002	Glossary of terms – Roads and traffic engineering
AS 1379-2007	Specification and supply of concrete
AS 1428	Design for access and mobility

AS 1428.4.1-2009	Means to assist the orientation of people with vision impairment - Tactile ground surface indicators
AS 1478	Chemical admixtures for concrete, mortar and grout
AS 1478.1-2000	Chemical admixtures for concrete
AS 2150-2005	Hot mix asphalt – a guide to good practice
AS 2157-1997	Cutback bitumen
AS 2758	Aggregates and rock for engineering purposes
AS 2758.1-1998	Concrete aggregates
AS 2758.5-2009	Coarse asphalt aggregates
AS 2876	Concrete kerbs and channels (gutters) - Manually or machine placed
AS 2891	Methods of sampling and testing asphalt
AS 2891.5-2004	Determination of stability and flow – Marshal procedure
AS 3582	Supplementary cementation materials for use with portland and blended cement
AS 3582.1-1998	Fly ash
AS 3600-2009	Concrete structures
AS 3798-2007	Guidelines on earthworks for commercial and residential developments
AS 3799-1998	Liquid membrane-forming curing components for concrete
AS 3972-2010	General purpose and blended cements
AS/NZS 4455	Masonry units, pavers, flags and segmental retaining wall units
AS/NZS 4455.2:2010	Pavers and flags
AS/NZS 4586:2004	Slip resistance classification of new pedestrian surface materials
AS/NZS 4671:2001	Steel reinforcing materials
AS/NZS 4680:2006	Hot-dipped galvanized (zinc) coatings on fabricated ferrous articles
Austroads	
AGPT04A-2008	Guide to pavement technology Part 4A: Granular base and subbase materials
Concrete Institute of Australia	
CIA CPN35-2003	Fibres in concrete

1.4 INTERPRETATIONS

Abbreviations

- General: For the purposes of this worksection the following abbreviations apply:
- CBR: California Bearing Ratio.
- CCRB: Crushed Concrete Base.
- CCRS: Crushed Concrete Subbase.
- CRB: Crushed Rock Base.
- CRS: Crushed Rock Subbase.
- NGB: Natural Gravel Base.
- NGS: Natural Gravel Subbase.

Definitions

General: For the purposes of this worksection the definitions given in AS 1348 and the following apply:

- Absolute level tolerance: Maximum deviation from design levels.
- Base: Layer(s) of material forming the uppermost structural element of a pavement and on which the surfacing may be placed.
- Elapsed delivery time: Time between the wetting of the concrete mix and the discharge of the concrete mix at the site.
- Flexible pavement: A pavement which obtains its load-spreading properties from intergranular pressure, mechanical interlock and cohesion between the particles of the pavement material.
- Lippage: Height deviation between adjacent pavers.
- Relative level tolerance: Maximum deviation from a 3 m straight edge laid on the surface.
- Rigid pavement: A pavement composed of concrete or having a concrete base course.
- Subbase: Material laid on the subgrade, below the base, either for the purpose of making up additional pavement thickness, to prevent intrusion of the subgrade into the base, or to provide a working platform.

1.5 SUBMISSIONS

Approvals
Submissions: To the Superintendent's approval.

Drawings
Drawings: Submit drawings showing the following:

- Plan dimensions, levels, cross falls and gradients.
- Material and thickness of subbase, base and wearing surface.
- Details and locations of joints, reinforcement and kerbs.
- Details of the junctions to any existing paving, existing structures or new structures.
- Support details/footings for street furniture, light poles, signs, drainage pits, grates and any other elements associated with the pavements.

Execution
Submit the following:

- Proposed construction method.
- Proposed equipment including slip forms and compaction equipment.
- Activity plan: Submit 4 weeks before commencement of construction works.

Materials
Source and type of construction materials: Submit 2 weeks before ordering.

Reports
Site investigations: Submit a geotechnical report and survey report relating to the site of proposed pathways/cycleways.

Variations
Changes to approved drawings, materials or execution: Submit any proposed changes 5 days before the related construction activity.

1.6 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/ Item	Requirement	Notice for inspection	Release by
PRE-CONSTRCUTION PLANNING			
GENERAL, Provision for traffic	Traffic guidance scheme		Superintendent
EXECUTION			
PREPARATION OF SUBGRADE, Compaction	Prepared subgrade	24 hours	Superintendent
PREPARATION OF BASE AND SUBBASE, Compaction	Compacted subbase and base	24 hours	Superintendent
PREPARATION OF BASE AND SUBBASE, No subbase requirement	Compacted subgrade before installation of polyethylene sheeting and/or a blinding layer or sand	24 hours	Superintendent
CONCRETE BASE, Installation of reinforcement	Installation of reinforcement	48 hours	Superintendent
CONCRETE BASE, Installation of cores fixings and embedment	Installation of embedded items	48 hours	Superintendent
CONCRETE BASE,	Curing of concrete	24 hours	Superintendent

Clause title/ Item	Requirement	Notice for inspection	Release by
Concrete curing			
CONCRETE BASE, Installation of joints	Installation of joints	48 hours	Superintendent
CONCRETE BASE, Completion	Finished concrete pavement surface and reinstated adjacent surfaces.	48 hours	Superintendent
ASPHALT WEARING SURFACE, Completion	Finished asphalt pavement surface and reinstated adjacent surfaces	48 hours	Superintendent
SEGMENTAL PAVERS, Completion	Finished segmental pavement surface and reinstated adjacent surfaces	48 hours	Superintendent

WITNESS POINT table

Clause title/ Item	Requirement	Notice for inspection	Off-site/Onsite
PRE-CONSTRCUTION PLANNING			
Activity plan	Storage of materials	Progressive	Off-site and onsite

2 PRE-CONSTRUCTION PLANNING

2.1 GENERAL

Activity Plan

General: Prepare an activity plan for the contract period. Include the following:

- Plant and personnel.
- Work sequence to meet the Contract constraints, including the HOLD and WITNESS POINTS.
- List of activities requiring approval of local authorities and notification to local residents.
- On-site and off-site storage of materials.

Inspection type: **WITNESS POINT**.

Provision for traffic

Documentation: Submit a Traffic Guidance Scheme for control of vehicular and pedestrian traffic to conform to *1101 Control of traffic*. Construct the works with the least possible obstruction to vehicular and pedestrian traffic.

Inspection type: **HOLD POINT**.

3 MATERIALS

3.1 SUBGRADE

Fill materials

Standard: To AS 3798 Section 4.

Quality: Clean, stable, free of perishable material and capable of compaction to the documented density.

Re-use of excavated material: Only re-use suitable material in conformance with AS 3798 clause 4.4.

3.2 SUBBASE

General

Quality: Provide unbound granular materials, including blends of two or more different materials, which when compacted develop structural stability and are uniform in grading and physical characteristics.

Subbase for rigid pavement (placed under a concrete base)

Maximum particle size: Not more than one third of the subbase thickness.

Maximum amount passing 75 µm sieve: 15%.

Maximum plasticity index: 6%.

Maximum liquid limit: 25%.

Subbase for flexible pavement (placed under a granular base)

Crushed rock or recycled material class: Class 3 to AGPT04A.

Subbase material properties: To the **Subbase material properties table**.

Designations for subbase materials:

- CRS20: 20 mm nominal sized crushed rock subbase.
- CRS40: 40 mm nominal sized crushed rock subbase.
- CCRS20: 20 mm nominal sized recycled crushed concrete subbase.
- NGS20: 20 mm nominal sized natural gravel subbase.
- NGS40: 40 mm nominal sized natural gravel subbase.

Subbase material properties table

Test method	Description	Subbase material requirements				
		CRS20	CRS40	CCRS20	NGS20	NGS40
AS 1289.3.6.1	Particle Size Distribution					
	% passing 53.0 mm sieve	-	100	-	-	100
	% passing 37.5 mm sieve	-	90-100	-	-	95-100
	% passing 26.5 mm sieve	100	74-97	100	100	80-97
	% passing 19.0 mm sieve	90-100	62-86	95-100	96-100	-
	% passing 13.2 mm sieve	74-96	-	74-95	-	-
	% passing 9.5 mm sieve	61-85	42-66	60-90	65-90	48-85
	% passing 4.75 mm sieve	42-66	28-50	42-76	47-80	35-73
	% passing 2.36 mm sieve	28-50	20-39	28-60	32-67	25-58
	% passing 0.425 mm sieve	11-27	8-21	10-28	14-42	10-33
	% passing 0.075 mm sieve	4-14	3-11	2-10	6-26	3-21
AS 1289.3.1.1	Liquid limit	max 35	max 35	max 40	max 35	max 35
AS 1289.3.3.1	Plasticity index: Annual rainfall > 500 mm Annual rainfall < 500 mm	 max 12 max 20	 max 12 max 20	 max 12 max 20	 max 12 max 20	 max 12 max 20
AS 1289.3.4.1	Linear shrinkage: Annual rainfall > 500 mm Annual rainfall < 500 mm	 max 5.5 max 8.5	 max 5.5 max 8.5	 max 5.5 max 8.5	 max 5.5 max 8.5	 max 5.5 max 8.5
AS 1141.52	Maximum dry compressive strength on fraction passing 19 mm sieve (only applies if plasticity index is less than 2)	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa
AS 1141.14	Particle shape by proportional calliper - % misshapen (2:1)	max 35%	max 35%	max 35%	—	—
AS 1141.22	Aggregate wet strength*	min 50 kN	min 50 kN	min 50 kN	—	—
AS 1141.22	Wet/dry strength variation* (dry - wet)/dry	max 45%	max 45%	max 45%	—	—
AS 1141.23	Los Angeles value	max 40%	max 40%	max 45%	—	—

Test method	Description	Subbase material requirements				
		CRS20	**CRS40**	**CCRS20**	**NGS20**	**NGS40**
AS 1289.6.1.1	4 day soaked CBR (94% modified compaction)	min 30%	min 30%	min 30%	min 30%	min 30%
NOTES: * All fractions of the proposed mix must satisfy this requirement. Use the fraction with the highest wet/dry strength variation as the value for determining conformance. Test the fraction 19.0 mm to 9.5 mm. In the case of blended materials, also test the fraction 9.5 mm to 4.75 mm. The other fractions do not need testing unless there is a risk, in the opinion of the Engineer, that such fraction may fail. Test any fraction at risk of failing.						

3.3 GRANULAR BASE

General

Quality: For flexible pavements, provide unbound granular base materials, including blends of two or more different materials which when compacted develop structural stability and are uniform in grading and physical characteristics.

Crushed rock and recycled material class

General: Provide materials from the following classes:

- Flexible pavements with sprayed sealed or thin asphalt surfacing: Class 1 to AGRD04A.
- Flexible pavements generally: Class 2 to AGRD04A.

Base material properties

General: Conform to the **Base material properties table**.

Designation

Unbound crushed rock materials:

- CRB20-1: 20 mm nominal sized class 1 crushed rock base.
- CRB20-2: 20 mm nominal sized class 2 crushed rock base.

Recycled crushed concrete materials:

- CCRB20-1: 20 mm nominal sized class 1 recycled crushed concrete base.
- CCRB20-2: 20 mm nominal sized class 2 recycled crushed concrete base.

Unbound natural gravel materials:

- NGB20: 20 mm nominal sized natural gravel base.

Base material properties table

Test method	Description	Base material requirements				
		CRB20-1	**CRB20-2**	**CCRB20-1**	**CCRB20-2**	**NGB20**
AS 1289.3.6.1	Particle size distribution					
	% passing 26.5 mm sieve	100	100	100	100	100
	% passing 19.0 mm sieve	95-100	95-100	95-100	95-100	93-100
	% passing 13.2 mm sieve	77-93	77-93	78-92	78-92	-
	% passing 9.5 mm sieve	63-83	63-83	63-83	63-83	71-87
	% passing 4.75 mm sieve	44-64	44-64	44-64	44-64	47-70
	% passing 2.36 mm sieve	29-49	29-49	30-48	30-48	35-56
	% passing 0.425 mm sieve	13-23	13-23	13-21	13-21	14-32
	% passing 0.075 mm sieve	5-11	5-11	5-9	5-9	6-20
AS 1289.3.1.1	Liquid limit	max 30	max 30	max 35	max 35	max 25
AS 1289.3.3.1	Plasticity index: Annual rainfall > 500 mm Annual rainfall < 500 mm	min 2 max 6 max 10	 max 6 max 10	min 2 max 6 max 10	 max 6 max 10	 max 6 max 10
AS 1289.3.4.1	Linear shrinkage: Annual rainfall > 500 mm	min 0.8 max 2.5	 max 2.5	min 0.8 max 2.5	 max 2.5	 max 2.5

Test method	Description	Base material requirements				
		CRB20-1	**CRB20-2**	**CCRB20-1**	**CCRB20-2**	**NGB20**
	Annual rainfall < 500 mm	max 4.5	max 4.5	max 4.5	max 4.5	max 4.5
AS 1141.52	Maximum dry compressive strength on fraction passing 19 mm sieve (only applies if plasticity index is less than 2)	—	min 1.7 MPa	—	min 1.7 MPa	min 1.7 MPa
AS 1141.14	Particle shape by proportional calliper - % misshapen (2:1)	max 35%	max 35%	max 35%	max 35%	—
AS 1141.22	Aggregate wet strength*	min 100 kN	min 80 kN	min 100 kN	min 80 kN	—
AS 1141.22	Wet/dry strength variation* (dry - wet)/dry	max 35%	max 35%	max 35%	max 35%	—
AS 1141.23	Los Angeles value	max 35%	max 35%	max 40%	max 40%	—
AS 1289.6.1.1	4 day soaked CBR (98% modified compaction)	min 100%	min 100%	min 100%	min 100%	min 80%
NOTES: * All fractions of the proposed mix must satisfy this requirement. Use the fraction with the highest wet/dry strength variation as the value for determining conformance. Test the fraction 19.0 mm to 9.5 mm. In the case of blended materials, also test the fraction 9.5 mm to 4.75 mm. The other fractions do not need testing unless there is a risk, in the opinion of the Engineer, that such fraction may fail. Test any fraction at risk of failing.						

3.4 CONCRETE BASE

General

Requirement: Provide concrete base materials for the rigid pavements.

Concrete mix and assessment of concrete test results: To AS 1379.

Assessment method of test results: Production assessment to AS 1379.

Design properties: To AS 3600.

Concrete properties

Concrete strength: To the **Concrete strength requirements table** or as documented on the drawings.

Concrete strength requirements table

Use	**MPa**	**Minimum Portland cement GP (GB)**	**Coarse aggregate nominal size**	**Cylinder strength required**	
				7 days	**28 days**
		Kg/m³	**mm**	**MPa**	**MPa**
Drainage structures, driveways, footpaths, miscellaneous minor concrete work	20	270 (330)	20	15	20

Concrete constituents

Aggregates: To AS 2758.1.

Cement: To AS 3972.

Water: To AS 1379.

Fly ash: To AS 3582.1.

Chemical admixtures: To AS 1478.1.

Curing compounds: To AS 3799.

Reinforcement

Steel reinforcement: Steel bars or mesh to AS/NZS 4671.

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

Fibre reinforcement: To CIA CPN35.

Dowels:

- To AS/NZS 4671.
- Galvanised to AS/NZS 4680 or epoxy coated.

Bar chairs: Proprietary concrete or plastic bar chairs:

- To withstand construction loads and maintain the concrete cover.
- With a protective coating if they are used with galvanized reinforcement.

Tie wire: Annealed steel, minimum 1.25 mm diameter.

Side forms

Depth: Equal to the edge thickness of the slab.

Timber forms: Seasoned and dressed timber planks, free of warps, bends or kinks.

Slip forms: Conform to the manufacturer's recommendations for minimum side clearance requirements.

Polyethylene sheeting

Thickness: Minimum 200 µm.

Blinding layer of sand

Thickness: Minimum 20 mm.

Quality: Maximum 5% content of silt and clay.

3.5 ASPHALT WEARING SURFACE

Aggregate properties

Description: Clean, sound, hard, angular, of uniform quality, free from deleterious matter in conformance with the **Aggregate properties table**.

Standard: To AS 2758.5.

Mineral filler: To AS 2150 clause 4.2.

Aggregate properties table

Property	Test method	Value
Particle shape	AS 1141.14	≤ 25
Wet strength	AS 1141.22	≥ 100 kN
Wet/dry strength variation	-	≤ 35%

Bituminous materials

Hot mix asphalt: To AS 2150.

Medium cut back bitumen: To AS 2157.

Bitumen emulsion: To AS 1160.

Mix design

Design: To AS 2891.5 and AS 2150.

Variations in mix properties: Make sure that the maximum variation between the mix property of each sample and the job mix value conforms to the **Mix property table**.

Mix property table

Mix property	Maximum variation from job mix value
Aggregate passing 4.75 mm sieve or larger	± 7% by mass
Aggregate passing 2.36 mm to 300 µm sieves	± 5% by mass
Aggregate passing 150 µm sieve	± 2.5% by mass
Aggregate passing 75 µm sieve	± 1.5% by mass
Bitumen content	± 0.3% by mass
Added filler content	± 0.3% by mass

Mix property	Maximum variation from job mix value
Mixing temperature	± 10℃

3.6 SEGMENTAL PAVERS

Standards
General: To AS/NZS 4455.2.

Properties
Minimum material and dimensional requirements: To AS/NZS 4455.2 Table 2.8.

Salt attack resistance grade: To AS/NZS 4455.2 Table 2.7.

Slip resistance classification: To AS 4586.

Bedding sand and joint filling sand
Quality: Well-graded, clean, hard, uncoated grains of uniform quality and free of soluble salts.

Grading for bedding sand: Conform to the following grading:

AS Sieve	% 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

Grading for joint filling sand: Conform to the following grading:

AS Sieve	% 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

Concrete edge restraint
Properties: To the *0319 Minor concrete works*.

Compressive strength: 25 MPa.

3.7 OTHER MATERIALS

Tactile ground surface indicators
Standard: To AS 1428.4.1.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General
Requirement: Conform to *1101 Control of traffic*.

4.2 PREPARATION OF SUBGRADE

General
Extent: Prepare a uniform subgrade for the full pavement formation, extending at least to the back of kerbs.

Existing services: Before commencing earthworks, locate and mark existing underground services in the areas affected by the earthworks operations.

Clearing and excavations

Clearing: Remove all the top soil, vegetation, debris and any existing pavements.

Bulk excavations/levelling: Excavate to correct levels and profiles as the basis for the pavement, filling and landscaping. Make allowance for compaction, settlement or heaving.

Rock: Do not use explosives.

Existing footings: If excavation is required within the zone of influence of an existing footing, construct temporary shoring or underpinning, as shown on the drawings, to maintain the support of the footing and prevent damage to the structure and finishes supported by the footing.

Removal of unsuitable material: Remove any soft, weak, saturated or organic material within the top 300 mm of the subgrade and replace with good quality fill.

Stockpiling: If stockpiling is permitted along the line of the trench excavation, do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along gutters.

Disposal of excess excavated material: Remove excess excavated material from site not required or unsuitable for fill to AS 3798 clause 6.1.8.

Erosion and sedimentation control: To *1102 Control of erosion and sedimentation (Construction)*.

Filling

Placing: Place fill in near-horizontal layers of uniform thickness. Bring the fill to optimum moisture content by watering. Compact each layer with suitable roller.

Compaction

General: Uniformly compact the subgrade to the documented density.

Inspection type: **HOLD POINT.**

Proof rolling method and equipment: To AS 3798 clause 5.5.

Protection of adjacent structures: Do not use compacting equipment against concrete retaining walls or detention tank walls until the concrete has been in place for 28 days, unless the walls are back propped.

4.3 PREPARATION OF BASE AND SUBBASE

Surface preparation

Before laying the subbase: Inspect the subgrade and make sure there are no soft spots or surfaces weakened by moisture.

Placing

Spreading: Spread the material in uniform layers, without segregation.

Maximum thickness of layers: 150 mm.

Trimming: Trim the subbase to the documented cross falls.

Compaction

Compaction: Uniformly compact the subbase to the documented density and thickness.

Inspection type: **HOLD POINT.**

Base and subbase for flexible pavement

Moisture content: Maintain the required moisture content by adding water to the entire surface of the layer after spreading.

Tolerances: Conform to the following:

- Subbase:
  - . Absolute level tolerance: ± 15 mm.
  - . Relative level tolerance: ± 10 mm.
- Base:
  - . Absolute level tolerance: ± 10 mm.
  - . Relative level tolerance: ± 10 mm.

Subbase for rigid pavement

Extent of the subbase: Conform to the following:

- At kerbs: Extend the subbase at its full depth to at least the back of kerbs.
- Along edges without kerbs: Extend the subbase at least 300 mm beyond each side of the pathway.

Absolute level tolerance: + 0 mm to - 10 mm.

No subbase requirement

General: Provide polyethylene sheeting and/or a blinding layer of sand.

Inspection type: **HOLD POINT.**

Polyethylene sheeting: Provide minimum 200 mm taped laps.

Subsurface drainage: Provide subsurface drainage, as documented.

Surface level

General: Provide a finished surface which is free draining and evenly graded between level points.

Tolerances: Conform to the **Summary of limits and tolerances table**.

4.4 CONCRETE BASE

Installation of side forms

Preparation: Clean and recoat the forms before using. Apply a release agent to the interior of the formwork.

Tolerances on position:

- Vertical tolerances:
  - Absolute level tolerance: ± 10 mm.
  - Relative level tolerance: ± 12 mm.
- Horizontal tolerance:
  - Absolute level tolerance: ± 10 mm.

Fixed forms: Stake forms in position using at least 3 steel stakes per form, not more than 1.5 m apart. Lock joints between form sections to prevent movement.

Slip forms: Provide side clearance for slip form operation.

Installation of reinforcement

Tolerances in fabrication and fixing: To AS 3600.

Location, cover and details: As shown on the drawings.

Splicing mesh: Overlap a minimum of 2 crosswires.

Supports: Provide bar chairs at the following minimum spacing:

- Bars: 60 bar diameters.
- Fabric: 800 mm.

Tying: Secure the reinforcement against displacement by tying at intersections with either wire ties, or clips.

Inspection type: **HOLD POINT.**

Installation of Cores, fixings and embedded items

General: Provide cores, fixings and embedded items as documented on the drawings.

Installation: Fix into position to prevent movement during concrete placement. If clashing with reinforcement, reposition reinforcement and maintain cover. Do not cut reinforcement.

Inspection type: **HOLD POINT.**

Concrete mix supply

Standard: To AS 1379.

Elapsed delivery time: To the **Elapsed delivery time table**.

Elapsed delivery time table

Concrete temperature at time of discharge (°C)	Maximum elapsed time (hours)
10 – 24	2.00
24 – 27	1.50
27 – 30	1.00
30 – 32	0.75

Pre-mixed supply: Do not add water on site.

Weather: Undertake special protection measures if placing concrete in rainy weather or at temperatures above 30°C or below 10°C.

On-site slump test

Frequency: Test at least one sample from each batch.

Test method: To AS 1012.3.1.

Acceptance criteria:

- Fixed form with manual operated vibration: 50 - 60 mm.
- Slip form with no side forms: 30 - 50 mm.

Concrete placing

Preparation:

- Wet wether: Remove any water ponding on the subbase/subgrade.
- Dry weather: If there is no polyethylene sheeting or sand blinding layer directly under the concrete base, dampen the subbase/subgrade.

Placing: Place concrete uniformly over the width of the pavement so that the face is generally vertical and normal to the direction of placing.

Hand spreading:

- Method: Use shovels.
- Placing sequence: Commence from one corner (usually the lowest point) and proceed continuously out from that point.

Surface tolerance:

- Absolute level tolerance: ± 10 mm.
- Relative level tolerance: ± 12 mm.

Compaction

Slab thickness 100 mm or less: Compaction throughout the placing, screeding and finishing processes. If required use a hand-held screed vibrator at the surface. Do not use immersion vibrators.

Slab thickness > 100 mm and downturns: Use an immersion vibrator.

Concrete placing records

General: Keep on site and make available for inspection a log book recording each placement of concrete, including the following information:

- Date of concrete placement.
- Delivery dockets noting the specified grade and source of concrete.
- Slump measurements.
- The portion of work.
- Volume placed.

Concrete finish

Initial finishing: Screed the concrete to the level of formwork, bull float and leave to set.

Final finishing: After all the bleed water has evaporated from the surface, start the operations to achieve the documented finish.

Concrete curing

General: Start curing immediately after finishing and continue for a minimum period of 3 days.

Curing method: Choose from the following methods:

- Cover sheet method: Cover concrete surface with plastic sheets. Overlap at least 150 mm and anchor down to prevent displacement.
- Moisture application method: Spray constantly with water in form of fog or mist.
- Curing compound method: Apply curing compound to the manufacturer's recommendations.

Coloured concrete: Do not cure by covering with plastic sheeting, damp sand or wet hessian.

Inspection type: **HOLD POINT.**

Installation of joints

General: Construct isolation, expansion, contraction and construction joints straight and plumb and extend continuously from edge to edge of the pavement.

Joint layout, spacing and joint widths: As shown on the drawings.

Expansion joints and keyed contraction joints: Before placing concrete, install steel form strips and securely fasten to the side forms.

Doweled expansion joints: Install expansion cap at one end of the dowel and coat that half of the dowel with bond breaking compound.

Sawn or tooled contraction joints: Install in freshly placed concrete by power sawing or placing a crack inducing insert.

Construction joints:

- At completion of concrete pour: Finish the concrete square at the construction joint. Let the reinforcement run through the joint.
- Before subsequent concrete pour: Remove the formwork and any loose material and roughen the old surface.

Inspection type: **HOLD POINT.**

Joint sealing

General: Fill with joint sealer as shown on the drawings.

Preparation: Make sure the joint space is dry, clean and free from loose material.

Sealant type: Provide silicone sealant in conformance with the manufacturer's recommendations.

Completion

Protection: During the curing period, protect the paving surfaces from traffic and construction plant. Give notice before opening the pavement to traffic.

Reinstating adjacent surfaces: Remove side forms and reinstate surfaces adjacent to the new pavement.

Inspection type: **HOLD POINT.**

4.5 ASPHALT WEARING SURFACE

General

Standard: To AS 2150.

Weather conditions: Place asphalt surfacing in dry weather.

Placing

Spreading: Spread the mix in a uniform layer covering the full width of the pavement.

Trimming: Trim to documented cross falls, levels and grades. Trim edges to a straight line.

Compaction: Uniformly compact the pavement surface to documented thickness.

Surface tolerances: ± 10 mm.

Shape and roughness tolerances: To AS 2150 Tables 15 and 16.

Joints

Standard: To AS 2150 clause 12.6.

General: Minimise the number of joints and make joints that are well bonded and sealed and provide a smooth riding surface across the joint.

Transverse joints: Construct a transverse joint if the operation is stopped for more than 20 minutes or the pavement temperature falls below 90°C. Construct to a straight vertical face for the full depth of the layer, and offset in adjoining spreader runs and layer to layer by at least 1 m.

Edges: Form exposed edges of each paver run while hot to a straight line with a dense face inclined between vertical and 45°.

Cold joints: Tack coat the surface of cold joints before placing the adjoining asphalt.

Completion

Reinstating adjacent surfaces: Reinstate surfaces next to new pavements and associated elements.

Inspection type: **HOLD POINT.**

Traffic on pavement: Give notice before opening the pavement to traffic.

4.6 SEGMENTAL PAVERS

Concrete edging or kerb

Construction: Fixed form, extrusion or slip forms to AS 2876.

Perimeter: Provide edge restraints to bedding and units, where not provided by other structures.

Drainage: Position edge restraint and pavers so that the top of the pavers are slightly above the front edge of the edge restraint.

Edge restraint shape: Make sure the edge restraint has a vertical or near vertical side abutting the pavers.

Edging: Place in a shallow trench between timber forms. Wood float finish flush with the adjacent finished grass level.

Control joints: Provide contraction joints 20 mm deep every 3 m.

Timing: Carry out concrete edge restraints before bedding course. Allow concrete edge restraints to harden before vibration of the surface course.

Sand bedding course

Preparation: Remove all loose material from the prepared base.

Geotextile: Place fabric between the base course and the bedding sand.

Spreading: Screed uncompacted sand over prepared base uniformly to achieve a 30 mm thick layer. Maintain sand at a uniform loose density and moisture content.

Bedding course drainage: Where ponding water at edge restraint, drain bedding course to existing subsurface drain or drainage pit using geotextile and 20 mm diameter PVC pipe.

Laying pavers

Pattern: Lay paving units on the screeded sand bedding to the nominated pattern shown on the drawings.

Joints: 2 – 5 mm gap.

Cut courses: 50 mm minimum plan dimension. On footpaths and other linear elements, use at least two cut courses and maintain symmetry.

Control: Control alignment and laying pattern by stringlines or chalked stringlines every 5 m intervals.

Variable width areas: Include in situ concrete infill strips to make a straight area for paving and take up the variable width.

Control joints: If there is a concrete base, provide paving control joints:

- Located over concrete base control joints.
- 10 mm wide and filled with bitumen impregnated fibreboard.

Laying around obstacles: Finish public utility access pits, drainage inlets and other penetrations in the paving with a concrete surround:

- Make sure the outside dimensions of the pit are square or rectangular and make a smooth connection with the laying pattern of the pavers.
- Drainage inlets: Position the top of the drainage inlet slightly below the top of the pavers.

Compaction of bedding

Compaction: Compact the sand bedding after laying paving units using a vibrating plate compactor and appropriate hand methods, and continue until lipping between adjoining units is eliminated.

Progressive compaction: Arrange the paving operations to enable the following:

- Compactor proceeds progressively behind the laying face without undue delay.
- Compaction is completed before stopping work on any day.
- No compaction within 1 m of the laying face except on completion of the pavement against an edge restraint.

Joint filling: Compact all paving units to design levels before the commencement of joint filling.

Tolerances: Conform to the following:

- Absolute level tolerance: ± 8 mm.
- Relative level tolerance: ± 8 mm.
- Lippage: ≤ 2 mm.

Joint filling

Filling: Spread dry sand over the paving units and fill the joints by brooming. Undertake one or more passes with the vibrating plate compactor and refill the joints with sand. Repeat the process until the joints are completely filled.

Timing: As soon as compaction is carried out, fill gaps with jointing material.

Completion
Protection: Prevent all vehicular and pedestrian traffic from using the pavement until all compaction and joint filling is completed and all edge restraints are in place.

Conformance: Test for levelness, flatness and lippage tolerances:

Cleaning: Leave pavements clean on completion.

Reinstating adjacent surfaces: Reinstate surfaces next to new pavements and associated elements.

Inspection type: **HOLD POINT.**

Traffic on pavement: Give notice before opening the pavement to traffic.

4.7 LANDSCAPING

General
Landscaping around pathways and cycleways: To *0257 Landscape - roadways and street trees.*

Protection from landscaping
Root barriers: Where trees are planted such that their canopies extend to the edge of pathways and cycleways, isolate them by providing a 600 mm deep root barrier to prevent the development of large roots directly beneath the pavement.

4.8 RESTORATION

For road openings and restoration
General: Openings and restoration of pathways for maintenance or utility services conform to *1151 Road openings and restoration* or *1152 Road openings and restoration (Utilities)* as appropriate.

4.9 STREET LIGHTING

Lighting on pathways and cycleways
General: If street lighting is to be provided conform to *1196 Street lighting*.

5 LIMITS AND TOLERANCES

Application
Summary: The limits and tolerances applicable to construction of rigid pavements are summarised in **Summary of limits and tolerances table.**

Summary of limits and tolerances table

Activity	Limits/Tolerances	Worksection clause/subclause
Concrete pavements		
Subbase surface level	Absolute level tolerance: + 0 mm to - 10 mm	**Preparation of base and subbase**
Concrete base surface level	Absolute level tolerance: ± 10 mm Relative level tolerance: ± 12 mm	**Concrete base**
Asphalt pavements		
Subbase surface level	Absolute level tolerance: ± 15 mm Relative level tolerance: ± 10 mm	**Preparation of base and subbase**
Base surface level	Absolute level tolerance: ± 10 mm Relative level tolerance: ± 10 mm	
Asphalt surface level	± 10 mm.	**Asphalt wearing surface**
Segmental pavements		
Segmental paving surface level	± 8 mm.	**Segmental pavers**

6 MEASUREMENT AND PAYMENT

6.1 MEASUREMENT

General

Payments made to the Schedule of Rates: To *0152 Schedule of rates – supply projects,* this worksection, the drawings and Pay items.

Lump sum prices: Not acceptable.

Unpriced items: If any item, for which a quantity of work is listed in the Schedule of Rates, is not priced, make due allowance in the prices of other items for the cost of the activity.

Methodology

The following methodology will be applied for measurement and payment:

- Concrete payment rates: At the scheduled rates provided the concrete meets the strength requirements shown in the **Concrete strength requirements table** or as otherwise documented.
- Reduction in payment rates: Where any concrete does not reach the strength specified in the **Concrete strength requirements table**, 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 specified 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 or for any remedial work to rectify the deficiency.

0292 MASONRY WALLS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide masonry walls including footings, subsoil drains, masonry wall construction and backfilling as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- *0136 General requirements (Construction).*
- *0152 Schedule of rates – supply projects.*
- *0161 Quality (Construction).*
- *0319 Minor concrete works.*
- *1102 Control of erosion and sedimentation.*
- *1171 Subsurface drainage.*
- *1172 Subsoil and foundation.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1012	Methods of testing concrete.
AS 1012.3.1-1998	Determination of properties related to the consistency of concrete - Slump test.
AS 1012.9-1999	Determination of the compressive strength of concrete specimens.
AS 1141	Methods for sampling and testing aggregates.
AS 1141.11.1-2009	Particle size distribution – Sieving method.
AS 1289	Methods for 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.
AS 1289.5.6.1-1998	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
AS 2350	Methods of testing portland and blended cements
AS 2350.12-2006	Preparation of a standard mortar and moulding of specimens
AS 2758	Aggregates and rock for engineering purposes.
AS 2758.1-1998	Concrete aggregates.
AS 3610-1995	Formwork for concrete.
AS 3610.1-2010	Documentation and surface finish
AS 3700-2011	Masonry structures.
AS 3972-2010	General purpose and blended cements.
AS/NZS 4455	Masonry units, pavers, flags and segmental retaining wall units.
AS/NZS 4455.1:2008	Masonry units.
AS/NZS 4680:2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.
AS 4678-2002	Earth-retaining structures.

Other publications

Clay Brick and Pavers Institute

Design Manual 3 – 1996 The full brick manual.

1.4 STANDARDS

General

Masonry structures: To AS 3700.

Earth retaining structures: To AS 4678.

1.5 SUBMISSIONS

Approval

Submissions: To the Superintendent's approval.

Design

Submit: Design changes proposals.

Materials

Submit the following:

- Masonry test results.
- Concrete test results.
- Reinforcement test results.
- Joint sealant test results.

Samples

Submit: Samples for colour of masonry units and colour of mortar.

1.6 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause/subclause	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Design Changes	Submit proposed changes to design	2 weeks prior to commencing on site	Superintendent
MATERIALS			
Masonry	Evidence of conformance for masonry units	2 weeks prior to commencing on site	Superintendent
EXECUTION			
Establishment – Founding level	Level and dimensions of footings	1 working day prior covering works	Superintendent
Excavation - Compaction	Survey to confirm the levels of the base	1 working day prior covering works	Superintendent
Excavation – Unsuitable foundation	Excavate unsuitable material and backfill with sound material and recompact	1 working day prior covering works	Superintendent
Subsoil drains - General	Completed subsoil drains	2 working days prior covering works	Superintendent
Drainage layer	Completed drainage layer	2 working days prior covering works	Superintendent
Reinforced concrete footing – Placement and compaction	Placement of reinforcing steel	1 working day prior covering works	Superintendent
Masonry wall construction – Hollow	Placement of reinforcement	1 working day prior covering works	Superintendent

Clause/subclause	Requirement	Notice for inspection	Release by
core walls reinforcement			
Backfilling for retaining walls – Clean up before backfill	Approval to removal bracing and backfill	3 working days prior covering works	Superintendent
Backfilling for retaining walls – Curing	Approval and tests for early backfill	3 working days prior covering works	Superintendent

2 PRE-CONSTRUCTION PLANNING

2.1 DESIGN CHANGES

Proposed changes

Approval: If changes are proposed to location, length, height, design levels or strength, submit details to the Superintendent prior to commencement of excavation. This is a **HOLD POINT**.

3 MATERIALS

3.1 MASONRY

Type and quality

Standard: To AS/NZS 4455.1 for masonry units.

Concrete masonry: Provide irregular faced units that may be either split face, profiled, textured or rock-faced as documented or as directed by the Superintendent.

Colour: Provide the colour of masonry units as documented and within the agreed range as approved by the Superintendent.

Dimension stone: Provide the type and quality to the dimensions as documented or as directed by the Superintendent.

Evidence of conformance

Conformance: Do not place the masonry units in position until the documentary evidence has been provided to and accepted by the Superintendent that the units comply with the requirements of this worksection and AS/NZS 4455.1. This is a **HOLD POINT**.

3.2 CEMENT

Properties

Standard: To AS 3972.

- Type: GP.

3.3 SAND

Properties

Standard: To AS 2758.1.

Texture: Provide clean sand free from salts, vegetable matter and impurities.

3.4 MORTAR

Properties

Standard: To AS 3700 clause 11.4.

Mix: To AS 3700 Table 11.1.

Pigments: Provide suitable pigments to match the colour of the adjacent units.

3.5 CONCRETE

Specification

Location: Provide concrete with:

- Compressive strength: greater than 20 MPa.
  - . Testing: To AS 1012.9.
- Maximum nominal size of aggregate: 20 mm.
  - . Testing: To AS 1141.11.1
- Nominated slump at the point of placement: Less than 80 mm.
  - . Testing: To AS 1012.3.1.

3.6 STEEL REINFORCEMENT

Protection

Galvanizing: If documented, provide galvanizing of reinforcing steel as follows:

- Average minimum coating thickness of 85 µm 98% by mass of zinc.
  - . Testing: To AS/NZS 4680.
- Do not combine galvanised and uncoated components.

3.7 JOINT SEALANT

Type

Joint sealant type: An Approved elastic polyurethane joint sealant.

3.8 BACKFILL MATERIAL

Alternative material

Backfill: If proposed, submit alternative backfill material details for approval by the Superintendent.

Backfill material

Backfill: Except as specified above, progressively backfill excavations for foundations and for the construction of the masonry walls to the level of the surrounding ground with material from cuttings, or with other material acceptable to the Superintendent.

4 EXECUTION

4.1 ESTABLISHMENT

Set out

Location: Using recovery pegs, set out the masonry walls as documented for location, length and height.

Founding level

Definition: The level at the underside of the 50 mm mass concrete blinding layer below the reinforced concrete footing.

Level and dimensions: The levels and dimensions of footings are subject to confirmation or alteration before construction, as the Superintendent may direct changes to the levels and dimensions of footings necessary to ensure a satisfactory foundation. This is a **HOLD POINT**.

4.2 EXCAVATION

General

Requirement: Excavate to the required width, depths and dimensions of footings, as documented, including the 50 mm mass concrete blinding layer.

Cleaning: Remove all loose material.

Rock: Thoroughly clean out minor fissures and fill with concrete, mortar or grout.

Surplus material: Use surplus excavated material in the construction of embankments, or spoiled.

Compaction

Time: After compaction trim the surfaces so that the level is everywhere less than 25 mm above the design foundation level.

Confirmation: Survey to confirm the levels of the base. This is a **HOLD POINT**.

Over-excavation

Fill and backfill: Fill any over-excavation below foundation level as follows:

- In rock: Use concrete of same quality as that of the footing.
- In soil: Use approved fill material and recompact.

Safety

Bracing: Supply and erect any sheeting and bracing to support the excavation in a safe manner and in accordance with statutory requirements.

Dewater: Keep the excavation free of water.

Unsuitable foundation

Unsuitable material: If the foundation material is found to be unsuitable to support the proposed structure, excavate such material and backfill with sound material, and recompact. This is a **HOLD POINT**.

Disposal: Spoil the unsuitable material from the excavation below foundation level.

4.3 SUBSOIL DRAINS

General

Conformance: Conform to the requirements of the *1171 Subsurface drainage* and *1172 Subsoil and foundation drains* worksections.

Location: Provide a subsoil drainage line at the base of the drainage layer as documented.

Requirements: Provide subsoil drains as follows, unless documented otherwise:

- 100 mm diameter slotted corrugated plastic pipe.
- Seamless tubular filter fabric.
- Surrounded with a minimum of 100 mm of Type A Filter Material contained within a layer of geotextile fabric.

Laying: To an even line and uniform grade of greater than 2% fall towards the outlet. This is a **HOLD POINT**.

Outlet: Provide outlets that discharge either into adjacent stormwater gully pits, or through adjacent fill batter, or headwalls.

Marking: Mark discharge points to be clearly visible.

Drainage layer

Geotextile: Provide a layer of geotextile complying with the *1171 Subsurface drainage* worksection between the back of the wall units and the granular drainage layer.

Granular layer: Provide a continuous granular drainage layer behind the wall as follows:

- Full height of the wall.
- Width as documented (measured perpendicular to the face of the wall)
- Progressively placed in layers less than 150 mm and compacted as documented. This is a **HOLD POINT**.

Composition: Broken stone or river gravel, consisting of clean, hard, durable particles graded from 50 mm to 10 mm to AS 1141.11.1 as follows:

- Maximum particle dimension: 50 mm;
- Passing the 9.5 mm AS sieve: less than 5% by mass.

4.4 REINFORCED CONCRETE FOOTING

General

Compliance: Conform to the *0319 Minor concrete works* worksection and AS 3610.

Drawings

Conformance: Construct the reinforced concrete footing, as documented.

Concrete blinding slab

General: Provide a 50 mm concrete blinding slab in the base of excavation for the footings.

Formwork

Extent: All vertical concrete surfaces unless otherwise documented.

Compliance: To *0319 Minor concrete works* worksection or AS 3610 and AS 3610.1.

Placement and compaction

Reference: Provide reinforced concrete footing in accordance with *0319 Minor concrete works* for:

- Placement and compaction of concrete.
- Joints.
- Finishing.
- Curing and protection of concrete.
- Placement of reinforcing steel. This is a **HOLD POINT**.

Tolerance

Conform to the following:

- Finished level of the footing to be less than ± 10 mm from the specified levels.
- Horizontal alignment of the footing to be less than ± 25 mm from the specified alignment.

4.5 MASONRY WALL CONSTRUCTION

General

Standard: To AS 3700 Section *12 Construction*.

First course

Surface: Clean the surface on which the first course is to be laid.

Placement: Place masonry in horizontal courses and to the details, as documented.

Weepholes: Provide weepholes in the wall, as documented.

Rate of construction: Limit the rate of new construction to eliminate joint deformation, slumping or instability

Mortar joints

Thickness: Provide 10mm thick bed joints and perpends.

Finish: In hollow masonry units, provide face shell bedded mortar and for structural work ironed mortar.

Joint reinforcement: Provide horizontal joint reinforcement, consisting of two 3.0 mm galvanized wires at a maximum of 600 mm centres vertically.

Control movement joints

Location: Provide control movement joints built into masonry, as documented, but at least as follows:

- Joint spacing: Less than 10 m.
- Joint width: 12 mm.

Joint filling

Cleaning out: Prior to filling joints make sure that joint surfaces are completely clean and free from any hard or incompressible material for the full width and depth of the joint.

Preparation: Insert a suitable backing rod at a depth of 12mm below the wall faces.

Filling: Fill the joint with an elastic polyurethane joint sealant approved by the Superintendent.

Conformance: Sealing of joints shall be carried out in accordance with the sealant manufacturer's instructions and recommendations.

Colour: Obtain the Superintendents approval of sealant colour from samples provided.

Hollow core walls reinforcement

Location: Provide reinforcement, as documented, and:

- Tie vertical steel reinforcement to steel starter bars through cleanout holes in each reinforced hollow unit and fixed in position at the top of the wall by plastic clips.
- Lay horizontal steel in contact with rebated webs. Hold in position using plastic clips if vertical steel is to be positioned subsequent to wall construction.
- Maintain cover to horizontal steel in lintel blocks by the use of wheel type plastic clips.
- Provide minimum cover of 15 mm to the inside face of the block is unless specified otherwise. This is a **HOLD POINT**.

Concrete grout

Preparation: Ensure that the bottoms of the hollow cores are cleaned of loose material before commencing core filling.

Core filling: Provide concrete grout as follows:

- Minimum Cement content: 300 kg/m^3.
- Minimum compressive cylinder strength: 20 MPa.
  . Testing to: AS 1012.9.
- Slump: 200 mm nominal.
- Requirement: Completely fill the hollow units

Tolerance

Standard: To AS 3700 clause 12.5 and Table 12.1.

Cleaning of masonry

Standard: Conform to the *CBPI Design Manual 3 – The full brick manual*.

Free standing wall: If the wall is constructed as a free standing wall, clean both sides of the wall of all mortar splashes and stains.

Acid cleaning: If acid cleaning is required, conform to the following:

- Acid mixture: 1 part of hydrochloric acid to 15 parts of water.
- Mortar joints: Minimum of 7 days old before cleaning commences.
- Thoroughly wet by hosing before any acid solution is applied. All masonry being cleaned shall be keep wet ahead of the acid application.
- Thoroughly hose off the acid mixture as the cleaning proceeds.
- If high pressure water jet method is used for cleaning, take extreme care to avoid 'blowing out' the joints.

4.6 BACKFILLING FOR RETAINING WALLS

Cleanup before backfill

Removal: If masonry walls are constructed as retaining walls, remove all timbering, bracing and rubbish before backfill is placed. This is a **HOLD POINT**.

Curing

Early backfill: Backfill against the retaining walls only after 95 % of the design strength of the masonry wall has been achieved. This is a **HOLD POINT**.

Testing for concrete or mortar compressive strength to AS 2350.12.

Sealing tops and ends of walls

Tops and ends of walls: Seal completely using compacted earth or other treatment as documented, the top of masonry walls over the full length and the vertical edge at both ends of all masonry walls.

Other forms of sealing

Erosion control: Where erosion is likely to occur, backfill around the ends of walls using stone fill or lean mix concrete. In this case the extra work will be paid for as a variation to the works.

4.7 COMPACTION

General

Level of compaction: Compact the foundations and backfill in conformance with the **Relative compaction levels table.**

Relative compaction levels table

	Foundations or backfill	**Relative compaction**
(a)	Foundations or base of excavation to a depth of 150 mm below foundation levels	95%
(b)	Fill placed at over-excavation for footing	95%
		Density Index
(c)	Granular drainage layer, subsoil filter material, material replacing unsuitable material and backfill material	70%

Testing: To AS 1289.5.4.1 or AS 1289.5.6.1 for non cohesive material.

Layers: Unless otherwise directed by the Superintendent, compact all material in layers of less than 150 mm of compacted thickness.

4.8 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/tolerances**	**Worksection Clause/subclause**
Excavation		
Foundation Level	Level of foundation for footing at any point < 25 mm above the design foundation level.	EXECUTION/Excavation
Reinforced concrete footing		
Finished Level	Finished level of footing < ± 10 mm from the specified levels.	EXECUTION/Reinforced concrete footing
Horizontal Alignment	Horizontal alignment of footing < ± 25 mm from the specified alignment.	
Masonry		
Control movement joint	Spacing ≤ 10 m. Joint width = 12 mm.	EXECUTION/Masonry wall construction/Control movement joints

0293 CRIB RETAINING WALLS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide proprietary timber crib and precast concrete crib retaining walls as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- *0136 General requirements (Construction).*
- *0152 Schedule of rates – supply projects.*
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319* Minor concrete works.
- *1102* Control of erosion and sedimentation.
- *1171* Subsurface drainage.
- *1172 Subsoil and foundation.*

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

Standards

AS 1012	Methods of testing concrete.
AS 1012.3.1-1998	Determination of properties related to the consistency of concrete - Slump test.
AS 1012.9-1999	Determination of the compressive strength of concrete specimens.
AS 1141	Methods for sampling and testing aggregates.
AS 1141.11.1-2009	Particle size distribution – Sieving method.
AS 1289	Methods for 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 1289.5.6.1-1998	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
AS 1604	Specification for preservative treatment.
AS 1604.1-2010	Sawn and round timber.
AS 1720	Timber structures
AS 1720.1-1997	Design methods
AS 1720.2-2006	Timber properties
AS 1726-1993	Geotechnical site investigations.
AS 3600-2009	Concrete structures.
AS 3610-1995	Formwork for concrete.
AS 3610.1-2010	Documentation and surface finish
AS 4678-2002	Earth-retaining structures.
AS/NZS 4680:2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.
AS 5605-2007	Guide to the safe use of preservative – treated timber

1.4 STANDARDS

General
Formwork design and construction: To AS 3610 and AS 3610.1.

Concrete materials and construction: To AS 3600.

Earth retaining structures: To AS 4678.

Geotechnical site investigation: AS 1726.

Timber construction: To AS 1720.

1.5 SUBMISSION

Approval

Submissions: To the Superintendent's approval.

Materials

Submit the following:

- Concrete test results.
- Steel reinforcement test results.
- Backfill material.

1.6 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS Table

Clause/subclause	Requirement	Notice for inspection	Release by
Substitution	Submit alternative systems	28 days prior to delivery of components	Superintendent
Design Changes	Submit proposed changes to design	2 weeks prior to commencing works	Superintendent
Certificates of compliance	Verify materials quality	1 week prior to using the materials in the works	
EXECUTION			
Establishment – Founding level	Level and dimensions of footings	1 working day prior to covering	Superintendent
Excavation - Compaction	Survey to confirm the levels of the base	1 working day prior to covering	Superintendent
Excavation – Unsuitable foundation	Excavate unsuitable material and backfill with sound material and recompact	1 working day prior to covering	Superintendent
Subsoil drains - General	Completed subsoil drains	2 working days prior to covering	Superintendent
Drainage layer	Completed drainage layer	2 working days prior to covering	Superintendent
Reinforced concrete footing – Placement and compaction	Placement of reinforcing steel	1 working day prior to covering	Superintendent
Backfilling for retaining walls – Clean up before backfill	Approval to removal bracing and backfill	3 working days prior to covering	Superintendent

2 PRE-CONSTRUCTION PLANNING

2.1 SUBSTITUTION

Proposed alternative

Alternative systems: If an alternative system to the one documented is proposed, submit detailed drawings, design calculations and Engineer's certification, and full details of installation procedures for approval to the Superintendent a minimum of 28 days prior to delivery of components to site for incorporation into the Works. This is a **HOLD POINT**.

2.2 DESIGN CHANGES

Proposed changes

Approval: If changes are proposed to location, length, height, design levels or strength, submit details to the Superintendent prior to commencement of excavation. This is a **HOLD POINT**.

Costs of changes to suit construction procedures: Borne by the Contractor.

2.3 CERTIFICATES OF COMPLIANCE

Verification

Verification: Provide certificates from a NATA registered laboratory. Perform all phases of any particular test at one laboratory. Accompany the certificate with all relevant test results carried out within twelve months of the submission date. This is a **HOLD POINT**.

3 MATERIALS

3.1 PRECAST CONCRETE CRIB WALL COMPONENTS

Proprietary systems

Type: Provide proprietary precast concrete crib wall systems of reinforced, segmental or prestressed concrete interlocking or pinned stretchers and headers of the dimensions as documented.

3.2 TREATED TIMBER CRIB WALL COMPONENTS

Proprietary systems

Type: Provide proprietary timber crib wall systems of:

- Insect and fungi resistant treated timber: To AS 5605
- Timber design and properties: To AS 1720.1 and 1720.2.
- Minimum Hazard Class: H4 to AS 1604.1.
- Interlocking or pinned stretchers and headers of the dimensions as documented.

3.3 CONCRETE

Specification

General: Provide concrete to AS 3600 such that:

- Compressive strength: greater than 20 MPa.
  - . Testing: To AS 1012.9.
- Maximum nominal size of aggregate: 20 mm.
- Nominated slump at the point of placement: less than 80 mm.
  - . Testing: To AS 1012.3.1.

3.4 STEEL REINFORCEMENT

Protective treatment

Galvanizing: If documented, provide galvanizing of reinforcing steel as follows:

- Average minimum coating thickness of 85 µm 98% by mass of zinc.
  - . Testing: To AS/NZS 4680.

3.5 BACKFILL MATERIAL

Quality

Type: Granular material as follows:

- Free from clay.
- Maximum dimension less than 50 mm.
- Plasticity Index of not less than 2 or more than 12 when tested in accordance with AS 1289.3.3.1.

Alternative material

Backfill: If proposed, submit alternative backfill material details for approval by the Superintendent.

4 EXECUTION

4.1 ESTABLISHMENT

Set out

Location: Set out the crib wall structure as documented. Identify the location, length and height of the wall, together with the line of the top of the cut batter.

Founding level

Definition: The level at the underside of the 50 mm mass concrete blinding layer below the reinforced concrete footing.

Level and dimensions: Confirm the levels and dimensions of footings before construction. The Superintendent may direct changes to the levels and dimensions of footings necessary to ensure a satisfactory foundation. This is a **HOLD POINT**.

4.2 EXCAVATION

General

Requirement: Excavate to the required width, depths and dimensions of footings as documented, including the 50 mm mass concrete blinding layer.

Cleaning: Remove all loose material.

Rock: Thoroughly clean out minor fissures and fill with concrete, mortar or grout.

Surplus material: Use surplus excavated or spoiled material in the construction of embankments.

Compaction

Time: After compaction, trim the surfaces so that the level is less than 25 mm above the design foundation level.

Confirmation: Survey to confirm the levels of the base. This is a **HOLD POINT**.

Over-excavation

Fill and backfill: Fill any over-excavation below foundation level as follows:

- In rock: Use concrete of same quality as that of the footing.
- In soil: Use approved fill material and recompact.

Batter slope trimming

Alignment: From the batter slope and alignment of the excavation ensure that at no point the line of the batter is more than 25 mm inside the line of the specified batter slope, after allowing for the width of the crib wall and the granular drainage layer behind the wall. Confirm the batter slope and alignment of the excavation for the crib wall by survey.

Surplus material: Use surplus excavated or spoiled material in the construction of embankments, as directed by the Superintendent.

Safety

Bracing: Supply and erect any sheeting and bracing to support the excavation in a safe manner.

Dewater: Keep the excavation free of water.

Unsuitable foundation

Unsuitable material: If the foundation material is found to be unsuitable to support the proposed structure, excavate such material and backfill with sound material, and recompact.

Spoil: Discard the unsuitable material.

This is a **HOLD POINT**.

4.3 SUBSOIL DRAINS

General

Conformance: Conform to the requirements of the *1171 Subsurface drainage* and *1172 Subsoil and foundation drains* worksections.

Location: Provide a subsoil drainage line at the base of the drainage layer as documented.

Requirements: Provide subsoil drains as follows, unless documented otherwise:

- 100 mm diameter slotted corrugated plastic pipe.
- Seamless tubular filter fabric.
- Surrounded with a minimum of 100 mm of Type A Filter Material contained within a layer of geotextile fabric.

Laying: To an even line and uniform grade of greater than 2% fall towards the outlet. This is a **HOLD POINT**.

Outlet: Provide outlets that discharge either into adjacent stormwater gully pits, or through adjacent fill batter, or headwalls.

Marking: Mark discharge points to be clearly visible.

Drainage layer

Geotextile: Provide a layer of geotextile complying with the *1171 Subsurface drainage* worksection between the back of the crib wall units and the granular drainage layer.

Granular layer: Provide a continuous granular drainage layer behind the crib wall as follows:

- Full height of the wall.
- Width as documented (measured perpendicular to the face of the wall)
- Progressively placed in layers less than 150 mm and compacted as documented. This is a **HOLD POINT**.

Composition: Broken stone or river gravel, consisting of clean, hard, durable particles graded from 50 mm to 10 mm to AS 1141.11.1 as follows:

- Maximum particle dimension: 50 mm;
- Passing the 9.5 mm AS sieve: Less than 5% by mass.

4.4 REINFORCED CONCRETE FOOTING

General

Compliance: Conform to *0319 Minor concrete works,* AS 3610 and AS 3610.1.

Drawings

Conformance: Construct the reinforced concrete footing as documented.

Concrete blinding slab

General: Provide a 50 mm concrete blinding slab in the base of excavation for the footings.

Formwork

Extent: All vertical concrete surfaces unless otherwise documented.

Placement and compaction

Reinforced concrete footing: Provide reinforced concrete footing in accordance with *0319 Minor concrete works* for:

- Placement and compaction of concrete.
- Joints.
- Finishing.
- Curing and protection of concrete.

Placement of reinforcing steel. This is a **HOLD POINT**.

Tolerance

Requirement: Conform to the **Summary of limits and tolerances table**.

- Finished level of footing: ± 10 mm from the specified levels.
- Horizontal alignment of footing: ± 25 mm from the specified alignment.

4.5 ERECTION OF CRIB WALL

Manufacturers' recommendations

Requirement: Provide all works in crib wall construction to conform with manufacturers' recommendations, commencing at the lowest part of the wall, with alternating rows of accurately positioned interlocking stretchers and headers.

Course levels and jointing

Requirement: Provide wall units such that they are placed so as to form closely butted joints, and are checked for line and level after each course is laid and conform to the following:

- Variation between the level of each course of stretcher units from the planned level: < 25 mm.
- Maximum deviation of a course of stretcher units from a 3 m straight-edge placed longitudinally along the wall: < 10 mm.

Header unit ends vertical

Vertical alignment: Provide header units that maintain the ends vertical for the full height of the wall, and the ends of stretcher units closely abutted and vertical over the height.

Joints

Bearing: Provide each unit bearing evenly on the underlying unit and connected to it as documented by the manufacturer.

Joints: Provide dry mortarless joints except where otherwise documented. If shown as mortar bedded, provide joints between units properly bedded in a cement mortar containing a sand/cement ratio of 3:1 and an approved bonding additive.

Maintain shape

Slope: Maintain the slope of the batter and a plane face or even curvature over the full area of the work. Make sure the variation of slope between the completed crib wall and the specified batter slope is less than 25 mm.

4.6 BACKFILLING FOR RETAINING WALLS

Cleanup before backfill

Removal: Remove all timbering, bracing and rubbish before backfill is placed.

This is a **HOLD POINT**.

Progressively placed

Backfill: Progressively place selected backfill within the crib wall as each course of stretchers and headers is installed.

Care: During compaction avoid damaging or distorting the wall.

Backfill material

Backfill: Except as specified above, progressively backfill excavations for foundations and for the construction of the crib walls to the level of the surrounding ground with material from cuttings, or with other material acceptable to the Superintendent.

Sealing tops and ends of walls

Tops and ends of walls: Seal completely using compacted earth or other treatment as documented, the top of crib walls over the full length and the vertical edge at both ends of all crib walls.

Other forms of sealing

Erosion control: Where erosion is likely to occur, backfill around the ends of walls using stone fill or lean mix concrete. In this case the extra work will be paid for as a Variation to the Works.

4.7 COMPACTION

General

Level of compaction: Compact the foundations and backfill in conformance with the **Relative compaction levels table.**

Relative compaction levels table

	Foundations or backfill	**Relative compaction**	**Density index**
(a)	Foundations or base of excavation to a depth of 150 mm below foundation levels	95%	
(b)	Fill placed at over-excavation for footing	95%	

	Foundations or backfill	**Relative compaction**	**Density index**
(c)	Granular drainage layer, subsoil filter material, material replacing unsuitable material and backfill material		70%

Testing: To AS 1289.5.4.1 or AS 1289.5.6.1 for non-cohesive material.

Layers: Unless otherwise directed by the Superintendent, compact all material in layers of less than 150 mm of compacted thickness.

5 LIMITS AND TOLERANCES

5.1 APPLICATION

General

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/tolerances**	**Worksection Clause/subclause**
Excavation		
Foundation level	Level of foundation for footing at any point must not be more than 25 mm above the design level.	EXECUTION/Excavation
Batter slope	Batter slope and alignment of excavation must not be more than 25 mm inside the line of the specified batter slope behind the line of the wall and granular drainage layer.	EXECUTION/Excavation
Reinforced concrete footing		
Finished level	Finished level of footing: ± 10 mm from the specified levels.	EXECUTION/Reinforced concrete footing
Horizontal alignment	Horizontal alignment of footing: ± 25 mm from the specified alignment.	EXECUTION/Reinforced concrete footing
Crib wall		
Level of stretcher units	Level of each course: < 25 mm from the specified level.	EXECUTION/Erection of crib wall
Deviation of stretcher units	Maximum deviation of each course of stretcher units: < 10 mm from a 3 metre straight edge.	Erection of crib wall
Batter slope of wall	The completed crib wall: < 25 mm from the specified batter slope.	Erection of crib wall

1101 CONTROL OF TRAFFIC

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

Traffic control: Provide traffic control for works on roads. Construct the work with the least possible obstruction to traffic.

Performance

General: Provide the following, as documented:

- Personnel plant and equipment.
- Temporary roadways and detours.
- Arrangement for traffic.
- Traffic control devices.

Requirements: Ensure the safety of workers and safety and convenience of road users at all times.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Traffic control.*
- *1102 Control of erosion and sedimentation.*
- *1111 Clearing and grubbing.*
- *1112 Earthworks (Roadways).*
- *1121 Open drains, including kerb and channel (gutter).*
- *1141 Flexible pavement base and subbase.*
- *1192 Signposting.*
- *1193 Guide posts.*
- *1194 Non-rigid road safety barrier system.*
- *1351 Stormwater drainage (Construction).*
- *1352 Pipe drainage.*
- *1354 Drainage structures.*
- *1143 Sprayed bituminous surfacing.*
- *1144 Asphaltic concrete (Roadways).*
- *1163 Rigid concrete road safety barrier systems.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

AS 1742	Manual of uniform traffic control devices
AS 1742.3-2009	Traffic control for works on roads
AS 1742.14-1996	Traffic signals
AS 1743-2001	Road signs - Specifications
AS 1744-1975	Forms of letters and numerals for road signs (known as Standard alphabets for road signs)
AS/NZS 1906	Retroreflective materials and devices for road traffic control purposes

AS/NZS 1906.1:2007	Retroreflective sheeting
AS/NZS 1906.4:2010	High-visibility materials for safety garments
AS 4191-1994	Portable traffic signal systems
AS/NZS 4192-2006	Illuminated flashing arrow signs
AS/NZS 4602	High visibility safety garments
AS/NZS 4602.1:2011	Garments for high risk applications

Other publications

AUSTROADS

AGRD03-2010	Guide to road design - Geometric Design
AP-R337-09-2009	National approach to traffic control at work sites
AGRS 06-09-2009	Guide to road safety Part 6: Road safety audit.
AGTM06-2007	Guide to Traffic management – Intersection, interchanges and crossings

1.4 STANDARDS

General

Standard: To AS 1742.3 and AP-R337/09.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- TCP: Traffic Control Plan.
- TGS: Traffic Guidance Scheme.
- TMP: Traffic Management Plan.

Definitions

General: For the purposes of this worksection 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.

1.6 SUBMISSIONS

Approval

Submissions: To the Superintendent's approval.

Approvals

- Traffic guidance scheme.
- Statutory approvals from council or other relevant authority.

Drawings

- Temporary roadways and detours.
- Signpost layout plan.
- Pavement marking details.

Execution details

- Schedule of working times.

1.7 INSPECTION

1.8 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Traffic guidance scheme	Approval of Traffic guidance scheme	4 weeks before proposed commencement on site	Superintendent.
Traffic guidance scheme	Approvals from Council and other Authorities for	4 weeks before proposed commencement on site	Superintendent.

Clause title/Item	Requirement	Notice for inspection	Release by
	Temporary traffic arrangement		
Levels of Traffic Guidance Schemes	Carry out a risk assessment for works not involving complex traffic arrangements or staged works or both	4 weeks before proposed commencement on site	Superintendent.
EXECUTION			
Side roads and property accesses - Access	Proposal for access	5 working days prior to carrying out works	Superintendent.
Side roads and property accesses – Notice to property owners	Approval to deny vehicular access and provide notice to property owners	3 working days prior to carrying out works	Superintendent.
Plant and equipment – Inadequate traffic control devices	Rectify non conforming traffic control devices	1 working day of notice	Superintendent.
Opening to traffic – Opening temporary road ways and detours to traffic	Redirection onto existing roadway in the event of failure	1 working day	Superintendent.
Opening to traffic – Opening temporary road ways and detours to traffic	Inspect and approve all roadways and detours prior to opening	2 working days prior to carrying out works	Superintendent.
Opening to traffic – Opening completed work	Written notice and procedure for road opening	5 working days prior to carrying out works	Superintendent.

WITNESS POINTS table – On-site activities

Clause/Item	Requirement	Notice for inspection by the Superintendent
PRE-CONSTRUCTION PLANNING		
Traffic Guidance Scheme	Site copy of TGS	Progressive
Safety Audit	For complex traffic arrangements and staged works carry out safety audits	Progressive
MATERIALS		
Barriers and fencing – Boom gates	Provide if requested	Prior to commencing works
Barriers and fencing – Cones and bollards	Restrictions for use of cones when attended by an employee.	Progressive
Temporary markings – Line marking	Ineffective line marking, remark within 48 hours.	Progressive
Temporary markings – Old markings	Obliterate or remove old markings.	Progressive
Temporary markings – Raised Pavement markers	Replace ineffective markers within 24 hours.	Progressive
EXECUTION		

Clause/Item	Requirement	Notice for inspection by the Superintendent
Personnel - Traffic controllers	Submit names and declaration of proposed traffic controllers	Prior to commencing work
Personnel - Traffic controllers	Additional traffic controller required where sight distance is restricted	Progressive
Personnel - Night and poor light	Flood light as required.	Progressive
Plant and equipment – Temporary speed zoning	Diary and method of works	Progressive
Plant and equipment – Arrangement and placement of traffic control devices	To the approved TGS	Progressive
Temporary roadways and detours - Drainage	Pavement drainage construction	Progressive
Temporary roadways and detours – Wearing surface	Width of wearing surface and position of finish tying into existing works	3 working days prior to carrying out works
Temporary roadways and detours – Construction under traffic	Approval required to construct under traffic	3 working days prior to carrying out works
Temporary roadways and detours – Construction under traffic	Prior notice of work commencing under traffic	5 working days prior to carrying out works
Opening to traffic – Opening temporary roadways and detours to traffic	Traffic switch requires workers on site for a minimum of 2 working days	2 working days
Opening to traffic – Maintain temporary roadways and detours	Ensure safe surface for traffic	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 TRAFFIC GUIDANCE SCHEME

General

Requirement: Submit a traffic guidance scheme for approval at least 4 weeks prior to proposed commencement on site. The Traffic guidance scheme must include both the traffic management plan and the Traffic control plan. The Traffic Guidance scheme must be prepared by a competent person. Where the control of traffic does not require pavement or drainage works the period of notice will be 2 weeks. This is a **HOLD POINT**.

Obtain: All necessary approvals from Councils and other authorities for temporary traffic arrangements. This is a **HOLD POINT**.

Site copy: Keep an approved copy off the Traffic Guidance Scheme on site at all times. This must be used to check the arrangement and maintenance of traffic control devices. This is a **WITNESS POINT**.

Level of Traffic guidance schemes

Levels: For traffic guidance schemes conform to the following:

- a) Short term and mobile works not involving full or part road closure.
- b) Works involving relatively simple part-roadway closures.
- c) Works involving complex traffic arrangements or staged works or both.

Risk assessments: Carry out for (a) and (b) considering factors such as traffic volume and speed, road geometry and width and the general behaviour of road users. If the risk can not be tolerated a fully protected work site will be required. This is a **HOLD POINT**.

Traffic Management Plan

Include: The Traffic Management Plan must include the following:

- Design drawings for any temporary roadways and detours to conform with **Design drawings** showing pavement, wearing surface and drainage details.
- Details of arrangements for construction under traffic.
- Traffic Control Plan(s).
- Vehicle Movement Plan (s) – Planning for movement of work vehicles including deliveries, personnel and contractors and gang trucks.
- Application for temporary speed zoning changes.
- Special consideration to the safety of the workers, pedestrians, cyclists.
- Names, addresses and means of communicating with personnel nominated for contact outside normal working hours to arrange for adjustments or maintenance of traffic control devices and temporary roadways and confirmation that this list has been supplied to the local Police.

Traffic Control Plan

Include: The Traffic Control Plan must include the following:

- A proposal to erect a Regulatory Traffic Control Device showing locations and times of operation.
- Appropriate temporary speed zoning signs.
- Boom gates.
- Portable traffic signals.
- Temporary fixed traffic signals.
- A signpost layout plan showing:
  - Location, size and legend of all temporary signs.
  - Temporary regulatory signs and temporary speed zones.
  - All traffic control devices such as temporary traffic signals, linemarking, pavement reflectors, guideposts, guardfence and barrier boards.
- Working times when traffic control measures are in place to minimise disruption to traffic during periods of peak flows.
- Take particular care when requiring reversal of traffic flows or the separation of unidirectional flow by medians or other physical separation.

Safety Audit

Audit: Conduct a safety audit for the construction phase as recommended in AGRS 06-09 for complex traffic arrangements and staged works. This includes risk assessments for the workers safety. This is a **WITNESS POINT**.

2.2 DESIGN

Design standards

Standard alignment and grading: Adopt the specific provisions of this worksection, AUSTROADS AGRD03, Local Authority's design standards.

Intersections: Design intersections to AUSTROADS AGTM06.

Road safety: Conform with documentation on road safety to AGRS 06-09.

Design drawings

Requirement: Submit design drawings for approval that show:

- Alignment and grading at a horizontal scale of 1:2000 for rural roads and 1:500 for urban roads. Where the temporary road rejoins the existing road, extend levels showing the full cross section along the existing road for a minimum length of 200 m.
- A sight distance diagram if opposing traffic is to use a single carriageway.
- Intersections, and any other locations where traffic may be required to make turning, merging or diverging movements, at a scale of 1:500.
- Pavement marking details.

- Sufficient cross-sections to indicate the feasibility of making connections between various parts of the work.
- Sufficient dimensions, especially lane widths, to make clear the geometry and clearances of the proposed Works.
- A north point or some other location method to orientate the plan.
- Pavement type and surface type.
- Roadside furniture.
- Drainage culverts and pits.

Signage

Signing: Careful considerations must be given to the signing of the work site regardless of the occupation time of the site. This includes:

- Protection of workers.
- Provision of adequate warning of changes in surface condition and the presence of personnel or plant engaged in work on the road.
- Adequate instruction of road users and their guidance safely through, around or past the work site.

3 MATERIALS

3.1 SIGNS

Specifications

Selection of signs: To AS 1742.3.

Design and manufacturing of signs: To AS 1743.

Details of each letter: To AS 1744.

Reflective material: Class 1 material complying with AS 1906.1.

Sign size: To AS 1742.3, AS 1743 and Annexure.

Signs for night work: Floodlit if outside of the car headlight beams to AS 1742.3.

Flashing arrow signs: To AS/NZS 4192 and installed to AS 1742.3.

Supplementary signs

Annexure: Signs supplementary to AS 1742.3 and AS 1743.

Use: In lieu of or in addition to those shown in AS 1743 as follows:

- Heavy machinery crossing temporary sign SW5-22 in lieu of trucks entering sign W5-22.
- Cycle hazard grooved road temporary sign ST1-10 in addition to T1-10 where the road is grooved and is a hazard to cyclists.
- Tar spraying possible short delay temporary sign ST3-1 in addition to T3-1 for bituminous surfacing works.
- Changed traffic conditions ahead temporary sign ST1-6 in addition to T1-1, T1-6, T2-6 and T2-21 on long term works, sidetracks and detours.

3.2 BARRIERS AND FENCING

Barrier boards

Standard: To AS 1742.3.

Size: 150 to 200 mm high, 4 m maximum length.

Colour: Alternate diagonal stripes of black and retroflective yellow terminating in yellow at each end.

Retroreflective sheeting: Minimum Class 1 to AS/NZS 1906.1.

Placement: Do not place parallel to the direction of traffic flow.

Support: Mount on trestles or fixed posts at about 1 m above the pavement.

Support Material: Timber, metal or other suitable material.

Support Colour: Yellow.

Stability: Provide concrete blocks, sandbags or other approved devices to ensure barriers are stable.

Bases: Keep the bases of the trestles within the ends of the boards.

High visibility flexible mesh fencing
Standard: To AS 1742.3.

Height: Approximately 1 m.

Colour: Orange.

Support: Top of the fence is at least 800 mm above ground level at all times.

Posts: Use temporary post-mounted delineators.

Location: Erect parallel to and in close proximity to traffic.

Boom gates
Type and location: As requested by the Superintendent or Local Roads Authority. This is a **WITNESS POINT**.

Cones and bollards
Standard: To AS 1742.3.

Cones: Fluorescent red or orange material resilient to impact.

Small cones: Used in most built up areas, footpaths, shared paths, and speeds < 70 km/hr. 450 to 500 mm high.

Large cones: Minimum 700 mm high all other locations or instead of the small cones.

Spacing: To AS 1742.3 and all purposes with speed limit less then 50 km/h maximum spacing 4 m.

Bollards: Vertical tube fluorescent red or orange material resilient to impact. At least 750 mm high and 100 mm diameter.

Placement: Locate traffic cones and bollards to AS 1742.3.

Restrictions: Unless cones are firmly fixed in position use only while work is in progress, or in locations where there is an employee in attendance to reinstate any of the cones which have been dislodged by traffic. Alternatively use bollards or barriers. This is a **WITNESS POINT**.

Cones and bollards used under night conditions: White horizontal retroreflective class 1 material band, size and location to AS 1742.3.

3.3 TEMPORARY MARKINGS

Pavement reflectorised markings
Pavement markings: Include painted lines, roadmarking tape and raised pavement markers.

Standard: To AS 1742.3.

Edgelining: Where the adjoining roadway is edgelined, provide edgelining to temporary roadways.

Linemarking
Type: Pavement marking tape.

Maintenance: If the pavement linemarking becomes ineffective remark within 48 hours of direction by the Superintendent. This is a **WITNESS POINT**.

Arrows
Location: If single carriageway is opened adjacent to or in lieu of an existing dual carriageway length.

Place: Pavement arrows indicating the direction of flow of traffic at not more than 500 m.

Remove: Arrows if the section is then reincorporated as dual carriageway.

Old markings
Removal: Obliterate or remove all superseded pavement markings immediately before, or after placement of, new markings. Do not obliterate by painting on a final surface. This is a **WITNESS POINT**.

Raised pavement markers
Ineffective markers: Replace raised pavement markers which have become ineffective, within 24 hours of direction by the Superintendent. This is a **WITNESS POINT**.

3.4 TRAFFIC SIGNALS

Portable traffic signals
Standard: To AS 4191.

Use: Short term applications of shuttle control where a single lane has to be used alternately by traffic from opposite directions or at road crossings or intersections.

Temporary fixed traffic signals
Standard: To AS 1742.14.

Design and installation of temporary fixed traffic signals: To AS 1742.14.

Use: Longer term shuttle operations or for non-shuttle control of intersecting traffic flows.

Traffic warning lamps
Installation: To AS 1742.3.

Maintain: In good working order, correctly aligned and positioned with respect to the direction of traffic flow each night, before the site is left unattended.

4 EXECUTION

4.1 SIDE ROADS AND PROPERTY ACCESSES

Access
Passage: At all times provide safe and convenient passage for vehicles, pedestrians and stock to and from side roads and property accesses connecting to the roadway.

Alternative access: Submit proposal for approval prior to commencing the work affecting access.

This is a **HOLD POINT**.

Notice to property owners

Denial of vehicular access: Where access needs to be denied due to particular construction activities undertake the following:

- Obtain the approval the of the Superintendent.
- Advise the property owners of such occurrences by way of letter drop at least 24 hours prior to such an interruption.
- Repeat this advice verbally to the property owner in a courteous manner.
- Keep these interruptions to an absolute minimum. This is a **HOLD POINT**.

4.2 PERSONNEL

Traffic controllers
Standard: To AS 1742.3.

Personnel: Submit names of proposed traffic controllers with a signed declaration that they are appropriately trained in the duties of traffic controllers to AS 1742.3. This is a **WITNESS POINT**.

Recognition marks: A distinguishing mark on the outer garment of authorised traffic controllers indicating their authority.

Location of traffic controllers: One traffic controller will remain at the head of each traffic queue while it is halted.

Restricted sight distance: An additional traffic controller must be placed at the tail end of the queue. This is a **WITNESS POINT**.

Two-way radio: Where both ends of the work are not intervisible, use two-way radio for the traffic controller at each end, or an intermediate traffic controller, from whom both other traffic controllers take their cue, is stationed where both can see extremities of the work.

Night and poor light
Wand: Use an illuminated red cone wand (torch) with a minimum capacity of 30,000 candela to control traffic.

Lighting: The traffic controller and the work area adjacent must be illuminated where possible by flood lighting. Position the flood lighting above the work area and direct downwards and incline slightly to illuminate the face of the STOP/SLOW bat. This is a **WITNESS POINT**.

Flood lighting: Must not create glare for approaching drivers.

Environmental effects: Consider the adverse effects of high lighting levels close to residential property.

Approved clothing for work personnel
Standard: To AS 1742.3, AS/NZS 4602 and AS/NZS 1906.4.

Requirements: All personnel are required to wear a garment or garments of the classification appropriate for the time of work as follows:

- Class D—garments for daytime use only. Red-orange or yellow.
- Class N—garments for night-time use only. Retroreflective strips of White or yellow.
- Class D/N—garments for both day and night use. Red-orange or yellow.

Flammable: Potentially flammable clothing must not be worn close to work likely to generate flame or hot splatter / molten metal.

4.3 PLANT AND EQUIPMENT

Plant delineation

Plant and equipment: When working in a position adjacent to traffic with a projection beyond the normal width of the item, for example, a grader blade. Direct traffic around such plant and equipment as follows:

- Day light conditions: Attach a fluorescent red flag to the outer end of the projection.
- Night or poor light conditions: Provide an additional traffic controller with an illuminated red wand.

Night time Clearance

Remove plant: Where traffic is permitted to use the whole or portion of the existing road, remove all plant items and similar obstructions from the normal path of vehicles

Lateral clearance: At least 6 m where practicable, with a minimum clearance of 1.2 m.

Lamps: Flashing yellow lamps may be used to draw attention to advance signs. Do not use for delineation.

Signs and devices

Conform to the following:

- Must be installed by a competent person.
- Must be appropriate to the conditions at the work site and used to AS 1742.3 unless a competent person has carried out a risk assessment for an alternative arrangement.
- Must be erected before work commences at a work site.
- Regularly check and maintain in a satisfactory condition.
- Remove from the work site as soon as practicable after works complete including stone removal and line marking.
- Keep records of all signing and delineation at roadway or part roadway closures.
- Relocate or reposition traffic control items so they are visible and perform their regulatory function.
- Place 1m clear of the travelled path. For works taking longer than 2 weeks signs must be mounted on poles sunk into the ground and duplicated on the right side of the road if physically possible.

Temporary speed zoning

General: Conform to the following:

- Arrange for the supply of appropriate temporary speed zoning signs, including posts and fittings, for erection where a temporary speed limit has been approved by the Local Council Traffic Committee or Road Authority.
- Erect these signs, cover the signs when the speed zone is not in use and remove the signs when the speed zone is no longer required as part of the provision for traffic as directed or approved.
- Keep a diary recording operation times of the speed zone to be made available when requested. This is a **WITNESS POINT**.

Arrangement and placement of traffic control devices

Layout: To the approved **Traffic guidance scheme** and AS 1742.3. This is a **WITNESS POINT**.

Cover and/or remove: All temporary traffic control devices when no longer required without delay and maintain unambiguous safe guidance to traffic.

Maintain: All traffic control devices in accordance with AS 1742.3 so that they are in good order and in the correct positions day and night. At all times the signs should be neat, clean, clear and legible.

Unacceptable traffic control devices

Do not use: The following items for traffic control:

- Steel drums.
- Isolated or non-continuous barrier units.
- Barrier boards parallel to and within 4m of the direction of traffic flow.

Inadequate traffic control devices

Nonconforming traffic control devices: Where the Contractor fails to provide and maintain traffic control devices as specified in this worksection and to conform with the approved Traffic Guidance Scheme and Standards. This is a **HOLD POINT**.

4.4 TEMPORARY ROADWAYS AND DETOURS

Drainage

General: Construct drainage structures and drains in accordance with the following worksections:

- *1121 Open drain, including kerbs and channel (gutter).*
- *1351 Stormwater drainage.*
- *1352 Pipe drainage.*
- *1354 Drainage structures.*

Design frequency: Provide for run-off due to one in five year ARI rainfall, without overflow affecting the road.

Pavement drainage: Design and construct pavements to prevent water ponding on the wearing surface or shoulders. Construct temporary formations not to dam water. This is a **WITNESS POINT**.

Temporary roadways

General: Construct Temporary roadways in accordance with the following worksections:

- *1102 Control of erosion and sedimentation.*
- *1111 Clearing and grubbing.*
- *1112 Earthworks (Roadways).*
- *1141 Flexible pavement base and subbase.*

Temporary kerbing: To conform with:

- Forming temporary medians, traffic islands or pavement edges.
- Height < 150 mm.
- Securely fastened to the pavement.
- Clearly delineate.
- As seen by the approaching traffic the width must be in a continuous line of 150 mm.
- Conform to *1121 Open drains, including kerb and channel (gutter)*.

Wearing surface

General: Construct surfacing to conform with the worksections:

- *1143 Sprayed bituminous surfacing, and/or*
- *1144 Asphaltic concrete (Roadways).*

Quality: Firm, even and skid resistant under all weather conditions and designed to remain sound during use.

Width of the wearing surface: As shown on the drawings or width of the traffic lanes plus the width of each shoulder. This is a **WITNESS POINT**.

Tie-in to existing work: Carry the wearing surface onto any existing connecting roadway so as to finish square to the existing roadway centreline. This is a **WITNESS POINT**.

Road safety barrier

Location: On all 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 and as otherwise documented.

Type: Corrugated steel or precast concrete safety barriers.

Erection: To conform with the following:

- *1163 Rigid road safety barrier systems.*
- *1194 Non-rigid road safety barrier systems.*

Construction under traffic

Situation: Where a temporary roadway or a detour is not provided or available then construction under traffic is permitted provided the minimum widths are achieved. This is a **WITNESS POINT**.

Minimum widths: Conform to the following:

- Through traffic on a two lane roadway a minimum of one 3.5 m lane width.
- Multilane roads minimum 3.5 m lane width in both directions.

Carriageway restoration: To a safe and trafficable state for through traffic prior to ceasing work each day.

Prior notice of work: Notify the Superintendent of the arrangements and methods for traffic control at least five working days before undertaking any work which would involve construction under traffic. This is a **WITNESS POINT**.

4.5 OPENING TO TRAFFIC

Opening temporary roadways and detours to traffic

Program: Complete all signposting, pavement marking, guard fence and portable or temporary traffic signals before the opening of temporary roadways to traffic.

Traffic switch: To a temporary roadway or detour must only occur where the Contractor's usual workforce will be on site for a minimum of two days thereafter. This is a **WITNESS POINT**.

Arrange: The opening of temporary roadways so that sections of existing roadway being replaced are not disturbed for a minimum of forty-eight hours.

Roadway failure: In the event of temporary roadway failure direct the traffic back onto the existing roadway. This is a **HOLD POINT**.

Inspection: Do not open temporary roadways and detours (including portable or temporary traffic signals sites) to traffic until they have been inspected and approved in writing. This is a **HOLD POINT**.

Partial completion: The use of the completed Works or part of the Works in providing for traffic is not considered as full opening to traffic and not a reason for payment under the completion of the works.

Maintain: Temporary roadways and detours and ensure the road surface is kept safe for traffic. Repair any potholes or other failures without delay. This is a **WITNESS POINT**.

Opening completed work

Prior notice: Provide the Superintendent with at least five working days written notice confirming the date of opening completed work to traffic. Determine the procedure for opening through consultation with the Superintendent and local Police. This is a **HOLD POINT**.

Complete: All permanent signposting, pavement markings, guard fence and traffic signals relevant to the completed work under the Contract prior to opening completed work to traffic.

Remove: All temporary traffic control devices no longer required for the safety of traffic, when the Works or part thereof are opened to traffic.

Restore: The area to a condition at least equivalent to that at commencement.

5 MEASUREMENT AND PAYMENT

5.1 MEASUREMENT

General

Payments made to the Schedule of Rates: To *0152 Schedule of rates – supply projects*, this worksection, the drawings and Pay items 1101.1.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology

The following methodology will be applied for measurement and payment:

- Drainage is measured and paid in accordance with:
  - *1121 Open drain, including kerbs and channel (gutter).*
  - *1351 Stormwater drainage.*
  - *1352 Pipe drainage.*
  - *1354 Drainage structures.*
- Temporary roadways and detours is measured and paid in accordance with:
  - *1102 Control of erosion and sedimentation.*
  - *1111 Clearing and grubbing.*

. *1112 Earthworks (Roadways).*
. *1121 Open drain, including kerbs and channel (gutter).*
. *1141 Flexible pavement base and subbase.*

- Wearing surface is measured and paid in accordance with:
  . *1143 Sprayed bituminous surfacing, and/or*
  . *1144 Asphaltic concrete (Roadways).*
- Road safety barriers is measured and paid in accordance with:
  . *1163 Rigid road safety barrier systems.*
  . *1194 Non-rigid road safety barrier systems.*

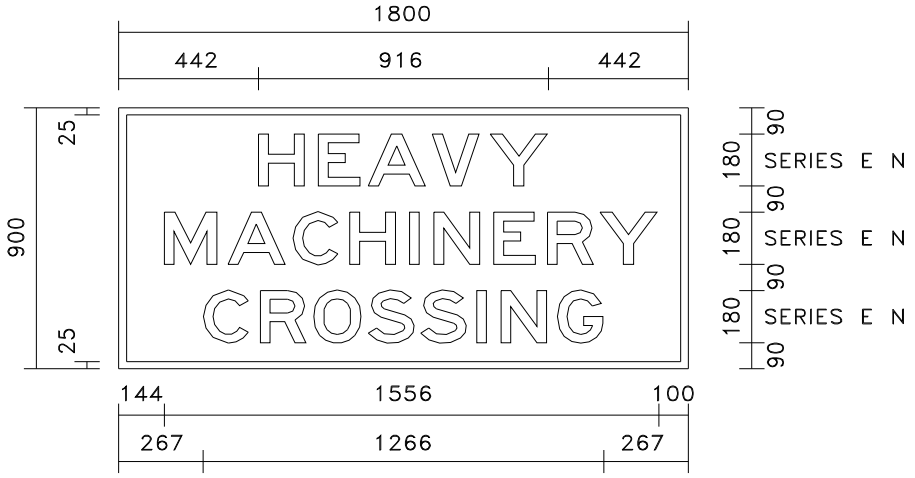
All activities for the construction, maintenance and removal of temporary roadways, including side-tracks and divided road crossovers, and detours detailed in this worksection, to the requirements of specific activity worksections parts, are measured and paid in accordance with those worksections parts.

5.2 PAY ITEMS

Pay items	Unit of measurement	Schedule Rate scope
1101.1 Control of traffic	Lump Sum item	All costs associated with: - All documentation and approvals: - The design of temporary roadways and detours, traffic switching operations, the provision of traffic controllers (as specified), signposting, roadmarkings, raised pavement markers, lights, barriers. and - Any other traffic control devices required for the safe movement of traffic and the protection of persons and property in accordance with this worksection. - Progress payments to be made on a pro-rata basis of work done under this item, having due regard to the duration of the Contract.

6 ANNEXURES

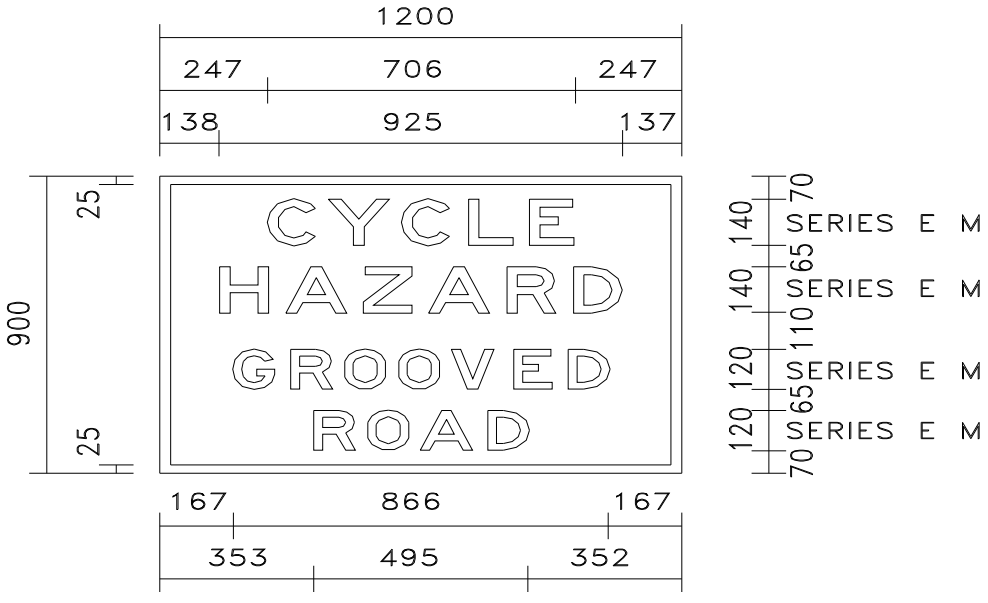
6.1 SUPPLEMENTARY TEMPORARY WARNING SIGNS IN ADDITION TO AS 1743 AND AS 1742.3.



Dimensions are in mm

Colours: Black letters and border on yellow reflectorised ground.

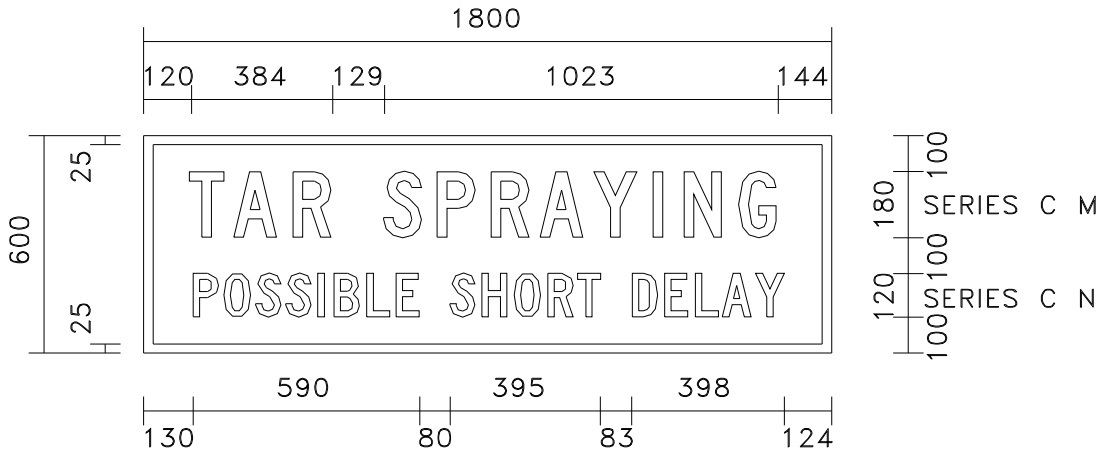
Sign SW5-22



Dimensions are in mm

Colours: Black letters and border on yellow reflectorised ground.

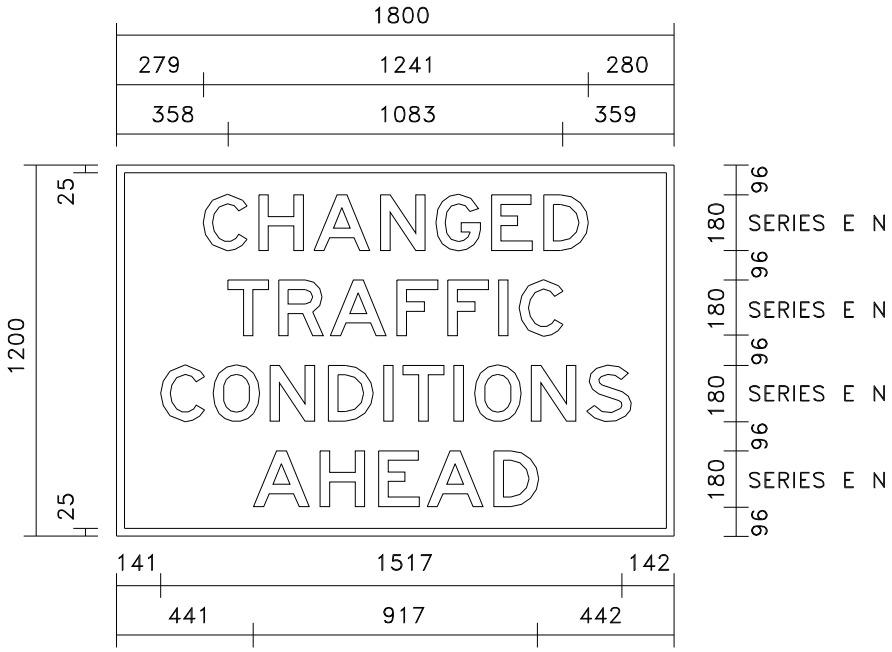
Sign ST1-10



Dimensions are in mm

Colours: Black letters and border on yellow reflectorised ground.

Sign ST3-1



Dimensions are in mm

Colours: Black letters and border on yellow reflectorised ground.

Sign ST1-6

1102 CONTROL OF EROSION AND SEDIMENTATION (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide the works and implement measures to control erosion and sedimentation , as documented and in accordance with the approved Environmental Management Plan.

Design
Requirements: Design the control measures for erosion and sedimentation to comply with statutory requirements. Preclude any potential hazard to persons or property.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0257 Landscape – roadways and street trees.*
- *1101 Control of traffic.*
- *1111 Clearing and grubbing.*
- *1112 Earthworks (Roadways).*
- *1121 Open drains, including kerb and channel (gutter).*

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

Institute of Public Works Engineering Australia (IPWEA) - Local Government Salinity Management Handbook 2002 a resource guide for the public works professional.

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:

CEMP: Environmental Management Plan.

ESCP: Erosion and Sediment Control Plan.

NTU: The units of turbidity from a calibrated nephelometer are called Nephelometric Turbidity Units.

SWMP: Soil and Water Management Plan.

Definitions
General: For the purposes of this worksection 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.
- Sediment: Sediment is the result of erosion, and consists of small detached soil particles. It occurs when the transportation of detached soil particles ceases or slows and the soil particles fall out of suspension.

1.5 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Documents
- Contractors Environmental Management Plan (CEMP).
- Soil and Water Management Plan(SWMP).
- Erosion and Soil Control Plan (ESCP).
- Program for coordination of work schedules including order of works and timing.

Drawings
- Access and haulage tracks.
- Borrow pits and stock areas.
- Compound areas.
- Features of the site.
- Relevant construction details.

Calculations
- Survey of embankments.

1.6 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause/subclause	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Contractors Environmental Management Plan (CEMP) - General	Submit CEMP with detailed section plans for each catchment area and site section	7 days before site disturbance on each section	Superintendent
EXECUTION			
Erosion and sedimentation control measures - Stockpile sites	Proposed stockpile locations	7 days before site disturbance or material delivery	Superintendent
Earthworks – Embankments and sediment removal	Survey information for volume measurement	3 working days before embankment construction or sediment removal	Superintendent

WITNESS POINTS table

Clause/subclause	Requirement	Notice for inspection by the Superintendent
EXECUTION		
Erosion and sedimentation control measures - Control measures	Diversion and catch drains - constructed and lined before the adjacent ground is disturbed and the excavation is commenced	3 working days before ground disturbance
	Areas of erodible material not approved for clearing or disturbance clearly marked, fenced off or protected against disturbance	3 working days before the adjacent ground is disturbed
Erosion and sedimentation control measures - Access and exit areas	Decontamination - shake-down or other methods for the removal of soil materials from motor vehicles	7 days before site disturbance
Cleaning - Sedimentation	Cleaning out of permanent	3 working days before proposed

Clause/subclause	Requirement	Notice for inspection by the Superintendent
control structures	sedimentation control structures	clean out
Temporary erosion and sedimentation control - General	Provide temporary erosion and sedimentation control measures	7 days before site disturbance
Temporary erosion and sedimentation control - Control measures	Provide temporary sediment traps and trash barriers	3 working days before ground disturbance
Temporary erosion and sedimentation control - Maintenance	Provide access roads for inspection and maintenance sedimentation control works	Progressive
Temporary erosion and sedimentation control - Removal	Removal of temporary erosion and sedimentation control works	3 working days before each stage of progressive removal

2 PRE-CONSTRUCTION PLANNING

2.1 CONTRACTORS ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

General

Minor works: Prepare a CEMP covering erosion and sedimentation control.

Major works: Prepare a SWMP including both CEMP and ESCP.

Site sections: At least seven days before the natural surface is disturbed on each of these sections, submit a CEMP for that section. Superimpose the plan on the drainage drawings of the works. This is a **HOLD POINT**.

Responsibility: The Contractor has the responsibility to provide whatever measures are required for the effective erosion and sedimentation control at all times.

Responsibilities

Adherence: Adhere to the approved CEMP. Submit a revised CEMP for approval seven days in advance of an intended variation from the approved plan.

Salinity prevention: In known salt affected areas, seek advice from the relevant land and water resource authority to ensure that the proposed CEMP conforms to the current salinity prevention measures outlined in the IPWEA publication, *Local Government Salinity Management Handbook*.

Minimising erosion

Objective: To minimise the quantity of soil lost during construction due to land clearing and earthworks.

Content: Provide documentation and program scheduling to address the following:

- Minimum land clearance, particularly of areas of highly erodible soils and steep slopes prone to water and wind erosion.
- Progressive revegetation and mulching, as each site section is complete.
- Coordination of work schedules for multiple contractors, to avoid delays resulting in disturbed land remaining unstabilised.
- Time schedules for the construction of structures and the implementation of measures to control erosion and sedimentation. Where possible, program the work to avoid seasonal intense rain storms.
- An order of works based upon construction and stabilisation of all culverts and surface drainage works, at the earliest practical stage.
- A Time schedule to address **HOLD POINTS** and **WITNESS POINTS**.

Documentation: Implement ahead of, or in conjunction with clearing and grubbing operations (as required by *1111 Clearing and grubbing)* all permanent and temporary erosion and sedimentation control measures, including the control measures.

Site sections: For implementation divide the site into sections based on the catchment area draining to each permanent drainage structure in the works and based on the area bounded by the road reserve.
Site section information: Provide diagrams indicating the following:

- Access and haulage tracks.
- Borrow pits and stockpile areas.
- Compound areas, such as Contractor's facilities and concrete batching areas.
- Features of the site, including contours and drainage paths.
- Relevant construction details of all erosion and sedimentation control structures.

2.2 SOIL AND WATERMANAGEMENT PLAN - SUPPLEMENT

General

Objective: To minimise the generation of contaminated stormwater.

Content: Provide documentation to address the following:

- Minimising the quantity of uncontaminated stormwater entering cleared areas.
- Establishing cut-off or intercept drains to redirect stormwater away from cleared areas and sloping to stable (vegetated) areas or effective treatment installations.
- Reducing water velocities.

Preparation

Expertise: Employ an experienced consultant to design, document and technically report on the implementation of the plan and submit details of experience.

Environmental assessment: Identify and obtain information on any relevant environmental impact that may be caused by the works.

Risk assessment: Identify and quantify risks and remedial action that may arise from the construction of the works.

Sediment controls

Objective: To minimise the impact of contaminated water on receiving waters.

Content: Provide documentation to address the following:

- Installing erosion and sediment control measures before construction where possible.
- Identifying drainage lines and install control measures to handle predicted stormwater and sediment loads generated in the mini catchment.
- Designing erosion and sediment run-off control measures appropriate to the site conditions to handle storm events with 2 year ARI with intensity of 6 hours, for temporary structures, and 50 year ARI, for permanent structures.
- Preparing an inspection, maintenance and cleaning program for sediment run-off control structures.
- Creating contingency plans for unusual storm events.
- Planning for the continual assessment of the effectiveness of sediment control measures.

De-watering work sites

Objective: To ensure that de-watering operations do not result in turbid water entering natural waterways.

Content: Provide documentation to address the following with regard to de-watering by pumping:

- Treating contaminated water if the turbidity exceeds 30 NTU.
- Only pump water into natural waterways that does not exceed regulatory water quality standards.
- Pumping water, wherever practical, to vegetated areas of sufficient width to remove suspended soil, or to sediment control structures.
- Monitoring turbidity hourly, if discharge is to a natural waterway.

Dust control

Objective: To ensure there is no health risk or loss of amenity due to emission of dust to the environment.

Content: Provide documentation to address the following:

- Suppressing dust by watering.
- Installing wind fences.

Management of stockpiles and batters

Objective: To manage soil stockpiles so that dust and sediment in run-off are minimised.

Content: Provide documentation to address the following:

- Minimising the number of stockpiles, and the area and the time stockpiles are exposed.
- Separating soil and overburden stockpiles.
- Locating stockpiles away from drainage lines, at least 10 m away from natural waterways and where least susceptible to wind erosion.
- Designing stockpiles and batters with slopes no steeper than 2H:1V.
- Stabilising stockpiles that will remain bare for more than 28 days by covering with mulch, anchored fabrics or seeding with sterile grass.
- Establishing sediment controls around unstabilised stockpiles and batters.

Working in waterways and floodplains

Objective: To minimise stress on aquatic communities when working in a waterway.

Content: Provide documentation to address the following:

- Planning in-stream works to minimise contact time.
- Establishing special practices to minimise impacts on the waterway and disturbance of the banks.
- Stabilising the banks and the in-stream structures so they do not contribute to the sediment load.
- Maintaining minimum flows to ensure the viability of aquatic communities. Ensure the free passage of fish.
- Designing crossings that do not contribute to the sediment load.
- Preparing a contingency plan for severe rainfall events.
- Preparing a reinstatement plan for work in a stream that could alter the waterway structure.

3 EXECUTION

3.1 PROVISION FOR TRAFFIC

General

Control of traffic: Conform to the following:

- Conform with *1101 Control of traffic*.
- Conform with **Traffic Guidance Scheme** in *1101 Control of traffic*.

3.2 EROSION AND SEDIMENTATION CONTROL MEASURES

Control measures

Construction: To the CEMP and the drawings.

Requirement: Provide erosion and sedimentation control measures to include, but not limited to, the following:

- The installation of permanent drainage structures before the removal of topsoil and before the commencement of earthworks for formation within the catchment area of each structure.
- The prompt completion of all permanent and temporary drainage works, once commenced, to minimise the period of exposure of disturbed areas.
- The construction of diversion and catch drains to divert uncontaminated runoff from outside the site, clear of the site. Construct and line catch drains before the adjacent ground is disturbed and the excavation is commenced. This is a **WITNESS POINT**.
- To provide for the passage of uncontaminated water through the site without mixing with contaminated runoff from the site.
- The provision of contour and diversion drains across exposed areas before, during and immediately after clearing and the re-establishment and maintenance of these drains during soil removal and earthworks operations.
- The provision of sediment filtering or sediment traps, ahead of and in conjunction with earthworks operations, to prevent contaminated water leaving the site.

- The restoration of the above drainage and sedimentation control works on a day to day basis to ensure that no disturbed area is left without adequate means of containment and treatment of contaminated water.
- The limitation of areas or erodible material exposed at any time to those areas being actively worked. Clearly mark, fence off or otherwise protect any areas not approved for clearing or disturbance. This is a **WITNESS POINT**.
- The minimisation of sediment loss during construction of embankments by means such as temporary or reverse superelevations during fill placement, constructing berms along the edge of the formation leading to temporary batter flumes and short term sediment traps.
- The progressive revegetation of the site, in accordance with *0257 Landscape - Roadways and street trees*.

Stockpile sites

Location: Areas pre-approved for such use.

Protection: Provide a 5 m buffer zone to between stockpile sites and any stream or flow path. Protect all stockpiles from erosion and contamination of the surrounding area by use of the measures approved in the CEMP. This is a **HOLD POINT**.

Access and exit areas

Decontamination: Include shake-down or other methods approved for the removal of spoil materials from construction plant or vehicles. This is a **WITNESS POINT**.

3.3 EARTHWORKS

Permanent erosion and sedimentation control basins

Planned levels: Construct earthworks for permanent erosion and sedimentation control basins to the documented levels and dimensions shown on the drawings or such levels and dimensions as determined by the Superintendent.

Site preparation: Clear the entire storage and embankment foundation area of permanent erosion and sedimentation control basins in accordance with *1111 Clearing and grubbing*. Strip topsoil and any unsuitable material under embankments to conform with *1112 Earthworks (Roadways)*.

Embankments and sediment removal

Embankments: To *1112 Earthworks (Roadways)*.

Survey information: If payment for embankment construction or sediment removal is on a Schedule of Rates basis provide survey information sufficient to subsequently measure the volume of the constructed embankment and sediment removal. This is a **HOLD POINT**.

3.4 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 conform with the requirements for rock filled wire mattress and geotextile in *1121 Open drains, including kerb and channel (gutter)*.

Plastic pipe outlet: Install a low flow outlet consisting of a 150 mm diameter plastic pipe in the locations shown on the drawings. No extra payment will be made for this work which forms part of the construction of the sedimentation control basin.

3.5 DROP INLET SEDIMENT CONTROL

Permanent traps

Timing: Construct permanent drop inlet sediment traps and inlet control banks, on completion of gully pits as shown on the drawings. These permanent drop inlet sediment traps and inlet control banks are additional to the temporary sedimentation control measures that may be required during construction of the gully pits.

Purpose: Construct the inlet control banks as required to prevent the surface flows bypassing the gully pits. The drop inlet sediment traps are to 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 with the associated inlet control banks to consist of at least two courses of sandbags containing a 10:1 sand/cement mix as shown on the drawings.

- Key the bags at least 25 mm into the surface, dampen sufficiently to ensure hydration of the cement and tamp lightly to provide mechanical interlock between adjacent bags.

3.6 CLEANING

Sedimentation control structures

Timing: Clean out permanent sedimentation control/structures, whenever the accumulated sediment has reduced the capacity of the structure by 50% or more, or whenever the sediment has built up to a point where it is less than 300 mm below the spillway crest. This is a **WITNESS POINT**.

Pay item criteria: Clean out due to failure to provide or maintain specified erosion **Control Measures**, will not be included in pay items.

Removal of sediment: Remove accumulated sediment from permanent sedimentation control structures, in such a manner as not to damage the structures.

Disposal: Remove the sediment to a nominated soil stockpile site or dispose in such locations that the sediment will not be conveyed back into the construction areas or into watercourses.

Access: Provide and maintain suitable access to permanent sedimentation control structures, to allow cleaning out in all weather conditions.

Completion

Cleaning: Clean all permanent sedimentation control structures, prior to Practical Completion of the Works.

3.7 TEMPORARY EROSION AND SEDIMENTATION CONTROL

General

Continuous control: Ensure that effective erosion and sedimentation control is provided at all times during the contract. Remove and/or reinstate any temporary or redundant control works at appropriate times during the contract.

Runoff: Prior to dispersing any runoff must be free of pollutants as defined in the relevant legislation. Disperse clean runoff to stable areas or natural water courses.

Control: Provide temporary erosion and sedimentation control measures where the natural surface is disturbed by construction, including roads, depot and stockpile sites. This is a **WITNESS POINT**.

Maintenance: Provide and maintain slopes, crowns and drains on all excavations and embankments to ensure satisfactory drainage at all times. Do not allow water to pond on the works unless such ponding is part of an approved CEMP.

Control measures

Temporary drains: Control runoff from areas exposed during the work by construction of temporary contour drains and/or temporary diversion drains, which take the form of a channel constructed across a slope with a ridge on its lower side. They may require progressive implementation and frequent alteration as the work progresses.

Contour drains: Provide contour drains across the natural surface at approximately the same elevation. Immediately after a construction site is cleared, intercept and divert runoff from the site to nearby stable areas at non-erosive velocities. Construct as follows:

- Contour drains, as shown on the drawings, formed with a grade of not less than 1% or greater than 1.5% and spaced at intervals of not less than 20 m or greater than 50 m, depending on the erodibility of the exposed soil.

Diversion drains: Provide diversion drains across haul roads and access tracks when such roads and access tracks are identified as constituting an erosion hazard due to their steepness, soil erodibility or potential for concentrating runoff flow, constructed as follows:

- Formed to intercept and divert runoff from the road or track to stable outlets.
- Spacing of diversion drains not greater than that required to maintain runoff at non-erosive velocities.

Temporary sediment traps: Provide devices during construction to remove sediment from runoff flowing from areas of 0.5 ha or more before the runoff enters stormwater drainage systems, natural water courses or adjacent land. This is a **WITNESS POINT**.

Trash barriers: Provide and maintain trash barriers to prevent debris from entering natural watercourses.

Batter protection: Take all necessary action to protect batters from erosion during the contract. 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.

Maintenance

Maintenance and inspection: Inspect all temporary erosion and sedimentation control works after each rain period and during periods of prolonged rainfall. Rectify any defects revealed by such inspections immediately. Clean, repair and augment, as required, the works, to ensure effective erosion and sedimentation control thereafter.

Access: Provide and maintain access from within the road reserve, or from other acceptable locations, for clearing out sedimentation control works. This is a **WITNESS POINT**.

Removal

Timing: Remove all temporary erosion and sedimentation control works 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. This is a **WITNESS POINT**.

4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

General

Payments made to the Schedule of Rates: To *0152 Schedule of rates – supply projects*, this worksection, the drawings and Pay items **1102.1** to **1102.5** inclusive.

Lump Sum prices: Not acceptable for any item other than **Pay Item 1102.1**.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology

The following methodology will be applied for measurement and payment:

- Clearing and grubbing is measured and paid in accordance with *1111 Clearing and grubbing*.
- Landscaping works are measured and paid in accordance with *0257 Landscape – roadways and street trees*.
- Topsoil stripping and removal of unsuitable material are measured and paid in accordance with *1112 Earthworks (Roadways)*.

4.2 PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1102.1 Temporary erosion and sedimentation control	Lump sum	All costs associated with the installation, maintenance, inspection and removal of the temporary erosion and sedimentation control measures in accordance with **Temporary erosion and sedimentation control** inclusive and the drawings.
1102.2 Earthworks for permanent erosion and sedimentation control basins	m^3. The volume will be determined by calculation using the end area method.	All costs associated with compacted embankment constructed in accordance with **Earthworks for permanent erosion and sedimentation control basins** and the drawings. The schedule rate to cover the excavation of material from within the sedimentation control basin and embankment construction required under **Earthworks for permanent erosion and sedimentation basins** and will be an average rate for all

Pay items	Unit of measurement	Schedule rate scope
		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 Excavation in 1112 *Earthworks (Roadways)*.
1102.3 Inlets, spillways and low flow outlets for sedimentation control basins	m^2 of horizontal surface area	All costs associated with the rock filled mattress constructed in accordance with **Inlets, spillways and low flow outlets for sedimentation control basins and sediment traps** and the drawings.
1102.4 Drop inlet sediment traps and inlet control banks	'Each' drop	All costs associated with **drop inlet sediment trap** including inlet control bank constructed in accordance with **Drop inlet sediment control** and the drawings.
1102.5 Cleaning of permanent sedimentation structures	m^3 of in-place sediment	All costs associated with sediment removal from the structure in accordance with **Cleaning sedimentation control structures**. The volume of sediment removed will be determined by survey or by methods approved by the Superintendent. The schedule quantity is a provisional quantity.

1111 CLEARING AND GRUBBING

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide clearing and grubbing of vegetation to allow site works for roadway construction to conform with drawings, permits, vegetation clearing schedules as documented.

Performance
Requirements: Provide cleared land, remove and dispose of all rubbish and materials unsuitable for subsequent works as shown on the drawings and directed by the Superintendent.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0257 Landscape – roadways and street trees.*
- *1101 Control of traffic.*
- *1102 Control of erosion and sedimentation.*
- *1195 Boundary fences for road reserves.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1473.1-2000	Wood-processing machinery – safety Part 1: Primary timber milling machinery
AS 1744-1975	Forms of letters and numerals for road signs (known as Standard alphabets for road signs).
AS 4373-2007	Pruning of amenity trees.
AS/NZS 4671: 2001	Steel reinforcing materials.

1.4 STANDARDS

General
Standard: To AS 4373.

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviation apply:

CTPO: Council's Tree Preservation Officer.

Definitions
General: For the purposes of this worksection the following definition apply:

- Council: Local Government and/or authority having responsibility for the area to be affected by the works.
- Environmental officer: Council appointed person authorised to determine specific environmental matters.

1.6 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Documents
Submit the following for approval:

- Weed management plan as noted in **Pre-construction planning**.
- Drawings: Showing area of work completed at the time of each progress claim.
- Calculations: Confirmation of areas or units claimed for 'Execution.'
- Execution details: Method statements for selective clearing and proposed equipment.
- Technical data: Survey diagrams to record set out results.

1.7 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause/subclause	Requirement	Notice for inspection	Release by
EXECUTION			
Limits of clearing			
Survey	Decision on the removal of miscellaneous items	7 days before proposed removal	Superintendent
Extent of clearing	Submit peg out and extent of clearing survey	7 days before proposed commencement of clearing	Superintendent
Trees to be preserved			
Tagging	Confirm clearing perimeters and mark trees to be preserved	7 days before proposed site clearing	Superintendent and CTPO
Work near trees noted for protection	Work method statement for works within the exclusion zone	7 days before proposed works	Superintendent and CTPO
Excavation within 4m of tree trunks	Develop appropriate work methods to avoid damage to the tree for approval	7 days before proposed excavation	Superintendent and CTPO
Trees within proposed embankment areas	Direction to remove or protect trees within proposed embankments	7 days before proposed site clearing	Superintendent and CTPO
Unsound trees in road reserve	Direction on removal of trees or branches not within the clearing limits	7 days before proposed site clearing	Superintendent and CTPO
Timber falling on private property	Written consent of owner to leave in place or to enter property to remove	Prior to carrying out works	Superintendent
Damage	Approval for any rehabilitation of vegetation or fauna habitat	3 working days prior to carrying out works	Superintendent
Grubbing			
Blasting	Explosives not permitted without prior approval	Progressive	Superintendent
Disposal of materials			
Burning of material	Approval prior to disposal of timber and other	Prior to burning	Superintendent

Clause/subclause	Requirement	Notice for inspection	Release by
	combustible materials by burning		

WITNESS POINTS table – On site activities

Clause/subclause	Requirement	Notice for inspection
EXECUTION		
Existing Utility services - Marking	Locate all underground pipe and cables	Before commencing any earthworks
Weed control - Procedures	Tag all areas identified in the Weed Management Plan	7 days before commencing works
Trees to be preserved – Work near trees noted for protection	Exclusion zone around protected trees	Progressive
Trees to be preserved – Tree protection	Tree's and roots not to be cut or damaged	Progressive
Grubbing - Backfill	Backfill and compact grub holes	Progressive
Chipping of cleared vegetation - Stockpiling	Stockpile location approval	Prior to stockpiling

2 PRE-CONSTRUCTION PLANNING

2.1 WEED MANAGEMENT PLAN

Content
Details required:

- Identification of weeds and infestation zones within the work site/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.

2.2 ESTABLISHMENT

Survey: Provide a qualified survey team to prepare site plans and carry out pegging.

Program: Provide planning resources to allocate plant and personnel for the contract period.

Control measures: In advance or in conjunction with clearing and grubbing operations implement adequate measures in accordance with *1102 Control of erosion and sedimentation*.

3 EXECUTION

3.1 EXISTING UTILITY SERVICES

Marking
Location: Before commencing earthworks, locate and mark existing underground services in the areas to be affected by the works including clearing, excavating and trenching.

Contact: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia. Underground pipe and cables are located (possible within two working days). See www.1100.com.au.

Prevent damage: Take all measures to prevent damage to existing underground and overhead utility services. Do not excavate by machine within 1 m of existing underground services. This is a **WITNESS POINT.**

3.2 LIMITS OF CLEARING

Survey
Submission: Submit a survey plan showing the proposed area for clearing to confirm the clearing perimeters. This is a **HOLD POINT**.

Pegging: Requirement for pegging includes surveying the areas and locating recovery pegs.

Extent of clearing

Clearing: The areas to be cleared are as shown on the drawings or schedules supplied and areas that will be occupied by:

- The completed Works.
- Erosion and sedimentation measures.
- Stockpile sites and borrow areas.
- A clearance zone of 4 m beyond tops of cuts and toes of embankments where the natural fall of the ground is towards the roadway.
- A clearance zone of 2 m beyond the tops of cuts and toes of embankments where the natural fall of the ground either slopes away from the roadway or is level.

Removal of miscellaneous items: Submit the requirement for any removal of minor miscellaneous items such as minor structures (eg. fences and livestock yards), redundant kerb and gutter, bitumen surfacing, footpaths and driveways, rubbish and any other materials located within the extent of the clearing. This is a **HOLD POINT**.

Planning and programming: Clearing is to be carried out progressively with only the minimum area of land left disturbed at any time. Ensure that only the absolute minimum area for construction is cleared.

Trees outside limits of work: Plan all operations to ensure that there is no damage to any trees outside the limits of clearing specified or approved.

Natural landscape features: Protect against disturbance any natural rock outcrops, natural vegetation, soil and water courses outside the limits of clearing.

3.3 WEED CONTROL

Procedures

Tagging: Tag areas identified in the **Weed management plan**. The Superintendent may require additional areas. This is a **WITNESS POINT**.

Implementation: Avoid spreading weeds during the clearing operations and remove all identified weeds as a separate operation.

Spraying: All persons engaged in spraying to have a current pesticide operator's licence as issued by the local authority.

3.4 TREES TO BE PRESERVED

Tagging

Inspection: The Superintendent and CTPO will inspect the proposed area for clearing to confirm the clearing perimeters and mark with ribbon markers, or indicate to the Contractor the trees to be preserved or transplanted. This is a **HOLD POINT**

Program: Implement protective measures before commencement of clearing.

Signage

Warning sign: Display a sign in a prominent position at each entrance to the site, warning that trees and plantings are to be protected during the contract. Remove on completion.

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: The area within 4 m of the trunks of trees tagged to be protected is to be an exclusion zone. The following activities must not occur within this zone unless prior approval has been received:

- Erection of structures.
- Excavation and filling.
- Changes to soil profiles.
- Stockpiling of spoil.
- Storage of other materials.
- Driving or parking of any vehicle or machinery.

This is a **WITNESS POINT**

Work method statement: Approval by both the Superintendent and the CTPO is required for works within the exclusion zone of the protected trees. Submit a detailed work method statement involving the protection methods listed in **Tree protection**. This is a **HOLD POINT.**

Harmful materials: Keep the area within the dripline free of sheds and paths, construction material and debris. Do not place bulk materials and harmful materials under or near trees. Do not place spoil from excavations against tree trunks. Prevent wind-blown materials such as cement from harming trees and plants.

Transplanting

Method: The lifting and temporary storage of the nominated vegetation for transplanting to conform with *0257 Landscape – roadways and street trees*.

Excavation within 4 m of tree trunks

Damage prevention: Submit a work method statement prior to any excavation within 4 m of the trunk of any tree. The work method must avoid damage to the tree and its root system. This work method must be approved by the Superintendent and CTPO. This is a **HOLD POINT**.

Open excavations: Work methods should minimise the time period an excavation is left open under tree canopies.

Tree protection

Tree enclosures: Temporary protective enclosures must be 10 times the trunk diameter at 1500 mm measured as a radius from the trunk and may consist of wire, mesh or chain material.

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.

Trunk protection: If space is not available for tree enclosures provide 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: Where excavations are to be made near trees, add continuous 900 mm high corrugated galvanized steel sheeting, bedded 150 mm into the ground, wired to the enclosure.

Damage: Prevent damage to tree bark and root system. Do not attach stays and guys to trees.

Tree roots: No tree roots to be cut without prior approval. This is a **WITNESS POINT**.

Work under trees: Do not remove or add topsoil to the area within the dripline of the trees.

Hand methods: Use hand methods to locate, expose and cleanly remove the roots on the line of excavation. If it is necessary to excavate within the drip line, use hand methods such that root systems are preserved intact and undamaged.

Clearing machines: Fit machines used for pushing and heaping operations with root takes or similar and operate to ensure as little soil as possible is removed and heaped with the cleared vegetative material.

Roots: Do not cut tree roots exceeding 50 mm diameter. Where it is necessary to cut tree roots, use means of cutting that do not unduly disturb the remaining root system. Immediately after cutting, water the tree and apply a liquid rooting hormone to stimulate the growth of new roots (e.g. Formula 20® or Hormone 20®).

Backfill material: Backfill around tree roots must be a mixture consisting of three parts by volume of topsoil and one part of well rotted compost. The compost is to have a neutral pH value, free from weed growth and harmful materials.

Backfill layers: Backfill layers to be each of 300 mm maximum depth.

Compaction of backfill: Place layers of backfill and compact to a dry density similar to that of 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 necessary, including where roots are exposed at ambient temperature greater than 35°C. Thoroughly water the root zone surrounding the tree immediately after backfilling.

Compacted ground: Do not compact the ground or use skid-steel vehicles under the tree dripline. If compaction occurs, give notice and obtain instructions.

Compaction protection: Protect areas adjacent to the tree dripline, if required submit within the work method statement a proposal for an elevated platform to suit the proposed earthworks machinery.

Mulching: Spread 100 mm thick organic mulch to the whole of the area covered by the drip line of all protected trees.

Trees within proposed embankment areas

Notice: Give notice immediately where a tree marked for preservation is located within an area proposed for embankment construction. The Superintendent will decide after approval from the CTPO whether the tree is to be removed or protected. This is a **HOLD POINT**.

Variation to the contract: The cost of protective measures for **Trees within proposed embankment areas** will be paid for as a variation to the Contract.

Unsound trees in road reserve

Clearing: Seek approval from CTPO and the Superintendent to clear any unsound tree remaining within the road reserve, but outside the limits of clearing that is likely to fall upon the roadway. This is a **HOLD POINT.**

Pruning: Cut back by hand close to the bole of the tree or main branches, any branch overhanging the road formation to within 0.5 m of the tree trunk to conform with AS 4373.

Disposal: Dispose of any unsound trees and over hanging branches to conform with **Chipping of cleared vegetation**.

Timber falling on private property:

- Prevention: Take every precaution to prevent timber from falling on private property at all times.
- Owners consent: If timber does fall on private property obtain written consent from the property owner for it to remain there or approval to enter the property and remove it for disposal. Submit the owners written consent. This is a **HOLD POINT**.

Damage

Restoration: Make good damage of any kind, including damage to trees or fencing, occurring during clearing operations and construction.

Rehabilitation: Any damage caused by the Contractor to vegetation, landforms or fauna habitat must be rehabilitated in consultation with an environmental officer. Restore to the pre-existing condition within the shortest period of time. This is a **HOLD POINT**.

Methods: This may include but is not limited to 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.

3.5 GRUBBING

General

Extent of grubbing: All trees and stumps on, or within the limits of clearing which are unable to 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 finished surface level, whichever is the lower.

Blasting: Explosives are not permitted for any site activity without prior approval. This is a **HOLD POINT**.

Backfill

Backfill holes: To prevent the infiltration and ponding of water immediately backfill holes or depressions remaining after trees and stumps have been grubbed with soil material similar to the adjacent ground. Compact the backfill material to the density of the existing material in the adjacent ground. This is a **WITNESS POINT**.

3.6 TREATMENT OF CLEARED VEGETATION

Milling

Millable timber: Trim branches to conform with AS 1473.1 any timber species identified for milling. 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 and stockpile clear of construction for later placement any tree trunks nominated for salvage as fauna habitat logs.

Wood chip mulch

Prepare: Cut or split to a size to facilitate chipping or incorporation into the existing topsoil as specified all remaining timber that is not for milling or use as fauna habitat logs or for disposal offsite.

Wood-chip mulch: Produce a wood-chip mulch derived from crowns of trees and branches of shrubs cleared under this worksection.

Dimensions of wood-chip mulch: Produce the wood-chip mulch from branches having a maximum diameter of 100 mm and the chipped material produced is not to have two orthogonal dimensions exceeding 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

Landscaping: Stockpile the wood-chip mulch for subsequent use in landscaping to conform with *0257 Landscape – roadways and street trees* or for use at other locations as directed. This is a **WITNESS POINT**.

Mixing: Unless specified otherwise, the mixing of cleared vegetation into the existing topsoil occurs during the topsoil operation s and prior to the removal and stockpiling.

Avoid degradation: Stockpiling operations to ensure that the properties of the cleared vegetation are not degraded and made unsuitable for use in the revegetation works.

Avoid contamination: Stockpiles of vegetation must be free from stones, soil, rubbish and other materials and not be contaminated with matter toxic to plant growth.

Shape: Stockpiles of chipped vegetation 5 m bottom width, 1.5 m high, batter 1 H: 1.5 V.

Weed free: Maintain weed free vegetation stockpile sites for the duration of the stockpiling period. Treat weeds as many times as necessary to control the weed species.

Location: Locate stockpile sites away from drainage lines and position to allow ease of transport of materials at any time. Stockpiles must not impinge on drivers sight lines or affect road safety.

Rehabilitation: Rehabilitate stockpile sites to conform with *0257 Landscape – roadways and street trees*.

3.7 DISPOSAL OF MATERIALS

General

Removal from site: Unless otherwise specified elsewhere in this worksection, all materials cleared and grubbed become the property of the Contractor and are to be removed from the site and disposed of legally.

Burning of disposed material: Approval required for disposal by burning timber and other combustible material. If approved comply with all Statutory Regulations applicable to burning off during the period of the Contract. This is a **HOLD POINT**.

Hazard minimisation: Perform any burning off in such a manner that no damage is done to any protected trees or trees outside the limits of clearing. Ensure that smoke resulting from such burning off does not cause a traffic hazard.

4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

General

Payments made to the Schedule of Rates: To *0152 Schedule of rates – supply projects*, this worksection, the drawings and Pay items **1111.1** to **1111.3** inclusive.

Lump Sum prices: Not acceptable.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology

The following methodology will be applied for measurement and payment:

- Erosion and sedimentation control measures are measured and paid in accordance with *1102 Control of erosion and sedimentation (Construction)*.
- Clearing and grubbing for boundary fencing is measured and paid in accordance with *1195 Boundary fencing for road reserves*.

4.2 PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1111.1 Clearing and grubbing	Hectare	All costs associated with all documentation, survey, clearing and grubbing within the plan area bounded by the limits of clearing specified in Limits of clearing.
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 specified in Limits of clearing. The schedule quantity is a provisional quantity.
1111.3 Wood-chipping	'm³' in stockpile.	All costs associated with wood-chipping and stock piling the schedule quantity is a provisional quantity.

1112 EARTHWORKS (ROADWAYS)

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide Earthworks for roadways as documented.

Performance
Requirements: Conform to this worksection, the Drawings and Standards as directed and approved.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0257 Landscape – roadways and street trees.*
- *1101 Control of traffic.*
- *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.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection 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 1289.5.1.1-2003	Soil compaction and density tests—Determination of the dry density or 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 1289.5.7.1-2006	Soil compaction and density tests—Compaction control test—Hilf density ratio and Hilf moisture variation.
AS 1289.6.1.1-1998	Soil strength and consolidation tests—Determination of the California Bearing Ratio of a soil—Standard laboratory method for a remoulded specimen.
AS 2187	Explosives—Storage, transport and use.
AS 2187.1-1998	Storage.
AS 2187.2-2006	Use of explosives.
BS 6472	Guide to evaluation of human exposure to vibration in buildings
BS 6472-1-2008	Vibration sources other than blasting

Other publications
Workplace Relations Ministers' Council(WRMC) Australian Code for the Transport of Explosives by Road and Rail 2009

1.4 STANDARD

General
Soil testing: To AS 1289 (Various).

1.5 INTERPRETATION

Definitions
General: For the purposes of this worksection 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: 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 ≥ 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.
- Topsoil: The surface soil reasonably free from subsoil, refuse, clay lumps, stones and timber fragments.
- Unsuitable material: Material with properties outside the values set out in **Annexure A** and as determined as unsuitable by the Superintendent.

1.6 SUBMISSIONS

Approvals
- Submissions: To the Superintendent's approval.
- Planning approval for spoil and borrow.
- Permits for access to spoil and borrow locations.

Documents
General:
- Drawings: Work as Executed Drawings.
- Calculations: Survey records, cut and fill calculations.
- Execution details: As documented. Refer to **HOLD POINTS, WITNESS POINTS.**

Technical data
General:
- CBR tests.
- Proof rolling and deflection monitoring.
- Compaction tests.

Materials:
- Select materials.
- Synthetic membrane.

1.7 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause/subclause	Requirement	Notice for inspection	Release by
EXECUTION			
Establishment - Protection of earthworks	Replace and/or dry out wet material to minimise any consequent delays to the operations	1 working day prior to next activity	Superintendent
Establishment - Stockpile sites	Approval to use of any stockpile site not shown on the Drawings	3 working days before stockpiling	Superintendent

Clause/subclause	Requirement	Notice for inspection	Release by
Removal of topsoil - Survey	Schedule of surface levels	3 working days before removal	Superintendent
Cuttings - Ripping floors of cuttings	Submit ripped or loosened material for inspection	Before recompaction commences	Superintendent
Cuttings - Compacting floors of cuttings	Inspection of compacted cutting floor	Prior to placing any subsequent layers over the completed cutting floor	Superintendent
Batter - Variation for batter slopes	Superintendent to order variation if a batter slope is redetermined after completion	Progressive	Superintendent
Unsuitable material - Floor inspection	Re-present the floor of the excavation after the removal of unsuitable material	Prior to backfilling with replacement material	Superintendent
Embankments - Foundations	Inspection of the embankment foundation area.	1 working day prior to next activity	Superintendent
Embankments - Bridging layer	Inspection and direction for bridging layer where required	3 working days before proceeding	Superintendent
Placing fill - Trimming tops of embankments	Inspection of the completed surface to receive subsequent pavement layers	Prior to placing any subsequent pavement layers	Superintendent
Selected material zone - Inspection	Inspection of the completed select material zone surface prior to placing any subsequent pavement layers	1 working day before proceeding	Superintendent
Fill adjacent to structures - Treatment at weepholes	Proposal to use synthetic membrane geotextile	3 working days before proposed use	Superintendent
Compaction and moisture requirements - Deflection monitoring or proof rolling	Present the completed work for deflection monitoring or proof rolling	2 working days before next activity	Superintendent

WITNESS POINTS table – On-site activities

Clause/subclause	Requirement	Notice for inspection
PRE-CONSTRUCTION PLANNING		
Natural surface - Contractor's survey system	Survey method and results, including any discrepancies	At least 7 days notice
EXECUTION		
Removal of topsoil - Program	Inspect cleared site prior to removal of topsoil	3 working days prior to removal
Cuttings - Floors of cuttings	Floors to be no more than 50 mm above or below the designed floor and provide suitable support	1 working day before next activity
Batters - Excavation beyond the batter line	Minor change in the general slope of the batter to suit the site	1 working day before next activity

Clause/subclause	Requirement	Notice for inspection
	conditions	
Transition from cut to fill - Terrace	Excavate a terrace for the width of the selected material zone to a depth of 900 mm below and parallel to the cutting floor.	1 working day before excavating terrace
Unsuitable material - General	Material deemed unsuitable for embankment or pavement support in its present position	Progressive
Embankments - Bridging layer	Supply and place bridging layer	1 working day prior to importing material
Placing fill - Rock pieces	Modify grading of fill material to achieve compaction	Progressive
Fill adjacent to structures - General	Concrete strength required for early filling to structures	3 working days prior to fill placement
Spoil – Haulage disposal	Obtain planning approval and any permits	3 working days before commencing activity
Borrow - Requirement	Obtain planning approval and any permits	3 working days before commencing activity

2 PRE-CONSTRUCTION PLANNING

2.1 PROGRAMMING

Management

Resources: Provide planning resources to allocate plant and personnel for the contract period.

Quality: Program the work to meet the constraints of **HOLD POINTS, WITNESS POINTS**.

2.2 NATURAL SURFACE

Contractor's survey system

Approval: Submit details of the Contractor's proposed survey system for approval within 14 days of possession of site being granted and prior to commencement of clearing and grubbing or earthworks.

Verification: The contractor may receive verified ground models prior to commencement of Contract. They will be 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.

Discrepancies: If the Contractor considers any areas of the model not to be representative, or submitted plans to be inaccurate, give not less than 7 days notice, prior to commencement of Works to allow checking.

Survey: Submit survey verifying existing ground profile. This is a **WITNESS POINT**.

Costs: If the subsequent check survey reveals the ground model and plans to be correct, then the Contractor is to bear the cost of the check survey.

2.3 MANAGEMENT OF STOCKPILES AND BATTERS

Dust and sediment minimisation

Manage: Soil stockpiles so that dust and sediment in run-off are minimised as follows:

- Minimise the number of stockpiles, and the area and the time stockpiles are exposed.
- Keep topsoil and underburden stockpiles separate.
- Locate stockpiles away from drainage lines, at least 10 m away from natural waterways and where they will be least susceptible to wind erosion.
- Ensure that stockpiles and batters are designed with slopes no greater than 2:1 (horizontal/vertical).
- Stabilise stockpiles and batters that will remain bare for more than 28 days by covering with mulch or anchored fabrics or seeding with sterile grass.

- Establish sediment controls around unstabilised stockpiles and batters.
- Suppress dust on stockpiles and batters, as circumstances demand.

3 MATERIALS

3.1 MATERIAL CHARACTERISTICS

Assumptions

Quality and quantity: The Contractor is responsible for any assumptions made for the material or the quantity. This may include:

- 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 deficiency

Embankment material: Use material from excavations if acceptable for embankments.

Deficiency: If a deficiency of material for embankment construction is created by the Contractor electing to use the material for other purposes, make good that deficiency from sources of material meeting the quality requirements specified in **Benching in cuttings.**

3.2 CONTAMINATED MATERIAL AND WASTES

Excavating contaminated material

Contamination: Excavate and dispose of all contaminated material in an environmentally responsible manner including the following:

- Assay material uncovered on-site prior to disposal. If the wastes include putrescibles wastes, then also analyse leachate and landfill gases.
- Excavate material in a manner which avoids off-site environmental problems.
- Seal remaining contaminated material or wastes, where only part of the tip has been excavated, to ensure than 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 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 ESTABLISHMENT

Excavation method

General: Provide a method statement covering excavation procedures based on geotechnical information shown on the drawings and/or geotechnical report.

Blasting: Provide details of special procedures for design and execution of blasting to meet all statutory and environmental requirements and in accordance with Annexure B.

Protection of earthworks

Erosion and sedimentation control: Install effective erosion and sedimentation control measures to *1102 Control of erosion and sedimentation* prior to commencing earthworks and maintain these control measures for the duration of the contract.

Drainage of working areas: Maintain drainage of all working areas throughout the period of construction to ensure run-off of water without ponding, except where ponding forms part of an approved erosion and sedimentation control system.

Salinity prevention: In salt affected areas, take adequate precautions to minimise ingress of surface water into the groundwater table.

Wet weather precautions: If rain is likely or if work is not proposed to continue in a working area on the following day, take precautions to minimise ingress of any 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 the Contractor not providing adequate protection of earthworks, replace and/or dry out the material to minimise any consequent delays to the operations. This is a **HOLD POINT**.

Batter indicators

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, at each cross section shown on the Drawings, or at each change in the slope of the batter, whichever is the lesser.
- Verified interval to not be more than 5 m height.

Information on the indicator: Clearly mark the chainage/station, offset from control line and slope distance to 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: Additional pegs and indicators may be required to suit the Contractor. Do not paint these with the same colours used for the specified setting out pegs and stakes.

Transitions cuttings/embankments: Mark with clearly labelled stakes in accordance with **Transition from cut to fill** and **Foundations for embankments** the position and extent of all transitions from cuttings to embankments and foundations for shallow embankments.

Stockpile sites

Additional stockpile sites: Obtain approval to use any stockpile site not shown on the Drawings. State the maximum dimensions of the proposed stockpile. This is a **HOLD POINT**.

Clearing and grubbing: To *1111 Clearing and grubbing*.

Temporary erosion and sedimentation control measures: To *1102 Control of erosion and sedimentation*.

Restoration: To *0257 Landscape – roadways and street trees* following completion of the work.

4.3 REMOVAL OF TOPSOIL

Program

Timing: Commence removal of topsoil after erosion and sedimentation controls have been implemented and when clearing, grubbing and disposal of materials have been completed on that section of the Works to *1102 Control of erosion and sedimentation (Construction)* and *1111 Clearing and grubbing*.

This is a **WITNESS POINT**.

Extent of work

General: Remove topsoil throughout the length of the Work and stockpile separately clear of the work. Take care to avoid contamination by other materials.

Cuttings: Remove topsoil to a depth quoted in **Annexure A** or as directed.

Embankments: Remove topsoil over the base of embankments up to the depth below the natural surface quoted in **Annexure A**, or as directed.

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 quoted in **Annexure A** to its full depth as directed.

Survey

Earthwork volumes: Provide earthwork volumes if payment is on a 'Schedule of Rates' basis unless alternative arrangements have been made. After removing the topsoil, determine the surface levels in each cutting and embankment at sufficient locations to calculate the volume of excavation for general earthworks and the volume of compacted fill. This is a **HOLD POINT**.

Stockpiles

Height and batter: Conform to the following:

- Maximum height: 2.5 m.
- Maximum batter slope: 2 H:1.

Trim: To a simple shape.

Erosion control

Stabilisation: Track roll or stabilise by other approved means to minimise erosion.

Seeding: Where seeding of stockpiles is recommended, conform to *0257 Landscape – roadways and street trees*.

4.4 CUTTINGS

Cuttings in rock

Dimensions: Provide detailed procedures to maintain accurate dimensions and uniform batters in rock.

Acceptable material

Cut: Construction of cuttings includes all operations associated with the excavation of material within the limits of the batters including benching, treatment of cutting floors and transition from cut to fill.

Preparation: Loosen and break down materials encountered in cuttings so that they are acceptable for incorporation in the Works.

Acceptable material: Refer to **Unsuitable material** and **Embankment construction** and **Embankment material**.

Benching in cuttings

Benches: Cut batters to be benched at locations and widths shown on the Drawings notwithstanding the tolerances permitted under **Batter tolerances**.

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 encountered after topsoil has been removed, adjust excavation methods to ensure blending of the materials, to obtain material meeting the requirements of **Embankment material**.

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.

Tolerance: Trim the floors to a level ± 50 mm to the designed floor level.

Unsuitable material: Remove as set out in **Unsuitable material.** This is a **WITNESS POINT**.

CBR testing: Prior to ripping the cutting floor, determine the CBR to AS 1289.6.1.1 of the material in the floor. Sufficient tests to be taken to represent all the various materials which may exist in the cutting floor. A direction will be given if material in the floors of cuttings has a CBR value less than the value quoted in **Annexure A**.

Ripping floors of cuttings

Loosen: Rip material of the floor to a minimum depth of 200 mm below the designed floor level for the width of the selected material zone (or subbase layer, where no selected material zone). The maximum dimension of any particles in the ripped or loosened zone not to exceed 150 mm.

Inspection: Submit ripped or loosened material for inspection before re-compaction commences. This is a **HOLD POINT**.

Compacting floors of cuttings

Compaction: Re-compact ripped or loosened material to conform with **Compaction and moisture requirements**. No account to be taken of the volume involved in loosening when measuring the volume of excavations.

Trim: After re-compaction, re-trim the floors of cuttings parallel with the finished wearing surface.

Tolerances: Refer to **Annexure A**.

Inspection: Prior to placing subsequent layers over the completed cutting floor, present the completed surface for inspection. Verify as part of the quality system that the completed surface has achieved full conformance with all respects of this worksection. This is a **HOLD POINT**.

4.5 BATTERS

Batter slopes

Profile: Provide batter slopes as shown on the Drawings or directed on the basis of site inspection and investigation during the excavation.

Tops of cuttings: Neatly round tops of cutting to the dimensions shown on the Drawings.

Cutting batters: Batters for cuttings to be 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.

Batter tolerances: The tolerances for the excavation of batters are given in **Excavation tolerances for batters table**.

Excavation tolerances for batters table

Location	**Tolerance (mm)**	
	Slope 1:1 or flatter	**Steeper than 1:1**
Toe of batter and level of table drain	+ 0 - 150	+ 0 - 200
2 m above table drain and higher	+ 300 - 300	+ 300 - 600
Between level of table drain and 2 m above table drain	pro rata basis	pro rata basis
Note: Tolerances are measured normal to the batter surface with (+) measured towards the roadway.		

Variation for batter slopes

Instruction: A variation to the Contract will be issued where batter slope of any section of a cutting after it has been completed to conform with this Clause is changed. The Contractor will require to reset out, remove additional material and retrim the batter. This is a **HOLD POINT**.

Costs: The costs of changing the batter slopes will be paid as a variation to the Contract.

Excavation beyond batter line

Corrective measures: Submit details of the material and/or methods proposed to restore the specified slope and stability of the batter. This is a **WITNESS POINT**.

Minor over excavation: Minor change in the general slope of the batter to suit the site conditions may be approved, however, this does not constitute a variation for batter slopes.

Batters steeper than 1:1: A direction to restore batter slopes may be given 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 specified. The batter will be required to be restored to the average batter slope using randomly mortared stone.

Restoration material:

- Stone: Similar to the sound rock in the cutting and the
- Mortar: Coloured to match the colour of the rock.

4.6 TRANSITION FROM CUT TO FILL

Intersection line

Survey: Mark the position of the intersection line between cutting and embankment occurring at the underside of the selected material zone or pavement subbase, after the removal of topsoil and before the excavation of any cutting commences.

Terrace

Construction: 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 **Figure Transition from cut to fill**, unless otherwise approved. This is a **WITNESS POINT**.

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 in the embankments or dispose of as directed.

Quantities: Material incorporated in embankments to be included in the excavated volume for **Pay item 1112.2** and spoil to be included in the excavated volume of **Pay item 1112.3**.

Quality and compaction: The material placed above the terrace to satisfy the requirements of **Embankment material** and be compacted to conform with **Compaction and moisture requirements**.

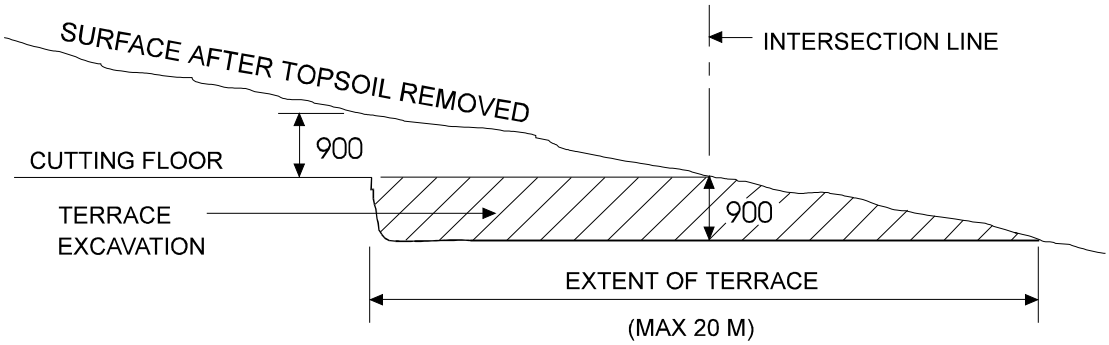


Figure - Transition from cut to fill

4.7 UNSUITABLE MATERIAL

General

Location: Unsuitable material is that occurring below the designed floor level of cuttings and below the nominated depth for stripping topsoil beneath embankments.

Unsuitable: If unsuitable material is identified for embankment or pavement support in its present position, remove and replace. This is a **WITNESS POINT**.

Extent of excavation

Removal: Excavate unsuitable material as directed

Floor inspection

Extent: After removal of the unsuitable material, and prior to backfilling with the replacement material, present the floor of the excavation for inspection. This will determine whether a sufficient depth of unsuitable material has been removed. This is a **HOLD POINT**.

Compaction: To conform with **Compaction and moisture requirements**, prior to replacing material.

Replacement material

Quality: Replace unsuitable material with material from cuttings, or with material borrowed in to conform with **Borrow**, of the quality specified in **Embankment material**.

Status: Replacement material is deemed to form part of embankment construction.

Construction: Place to conform with **Placing fill for embankment construction** and to conform with **Compaction and moisture requirements**.

Resultant unsuitable material: Rework or replace any material deemed to have become unsuitable because of inappropriate construction activities.

4.8 EMBANKMENTS

Embankment construction

Scope: Embankment construction includes:

- All operations associated with the preparation of the foundation areas on which fill material is to be placed, and the placing and compacting of approved material within areas from which unsuitable material has been removed.
- The placing and compacting of fill material and of materials of specified quality in nominated zones throughout the Works.
- All other activities required to produce embankments as specified to the alignment, grading and dimensions shown on the Drawings.
- Pre-treatment, such as breaking down or blending material or drying out material containing excess moisture.

Embankment material

Source and quality: Obtain the material for embankment construction from the cuttings within the Works to conform with **Benching in cuttings**, and supplement by borrow to conform with **Borrow** and from other sources as approved if necessary.

Quality: Free of tree stumps and roots, clay, topsoil, steel, organic material and other contaminants and suitable to be compacted to conform with **Compaction and moisture requirements**.

Availability: Program the work so that material of the quality specified in **Placing fill for embankment construction** and **Selected material zone** for the upper zones of the formation is available when required.

Foundations

Timing: Make the embankment foundation area available for inspection by the Superintendent following removal of topsoil This is a **HOLD POINT**.

Unsuitable material: If any underlying material is unsuitable remove and replace the material to conform with **Unsuitable material**.

Preparation: Grade and level the general area, adjust the moisture content where necessary and compact the top 200 mm as specified in **Compaction and moisture requirements**.

Foundations for shallow embankments

Type: Shallow embankments are those embankments of a depth less than 1.5 metres from the top of pavement to natural surface.

Quantity: Survey and calculate the extent of the area of shallow embankments after removal of topsoil.

Preparation: Loosen the material exposed to a depth of 200 mm, adjust the moisture content of the loosened material and compact as specified in **Compaction and moisture requirements**, after removing topsoil and unsuitable material.

Foundation damage: Use suitable equipment and techniques to minimise surface heaving or other foundation damage.

Bridging layer

Status: If a bridging layer has been specified as a foundation treatment in the Contract documents, supply and place it as part of **Pay item 1112.2**.

Material: The bridging layer to consist of free-draining granular material with or without geotextile interlayer as specified on the Drawings.

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 **Compaction and moisture requirements** not to apply to the bridging layer.

Status: If it is necessary to import suitable material from off site and if no suitable borrow source is available as provided in **Natural surface and earthworks materials**, the supply and placing of the bridging layer may be treated as a Variation to the Contract. This is a **WITNESS POINT**.

Seepage from foundations: A bridging layer may also be employed, subject to approval, where ground water or seepage is encountered in the foundation area or where the Contractor demonstrates that it is impracticable to achieve the degree of compaction specified for the foundation in **Compaction and moisture requirements**. This is a **HOLD POINT**.

Unacceptable location: If its proximity to the pavement is likely to affect the pavement design.

Working platform: As an alternative to a bridging layer, approval of a working platform created by the chemical stabilisation of in situ material to conform with *1113 Stabilisation* may be required.

Hillside embankments

Criteria: 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 4H:1V in any direction.

Terrace: Extent and method as follows:

- Cut horizontal terraces over the whole area to be covered by new filling.
- Step the existing slope or batter in successive terraces, each at least 1 metre in width, and cut the terraces progressively as the embankment is placed.
- Coincide terraces with natural discontinuities wherever possible.
- Provide subsoil drainage if required.
- Compact excavated material as part of the new embankment material.

Excavated volume: No account to be taken of the material removed in terracing when determining the excavated volume for **Pay item 1112.2**.

Batter slopes

Design criteria: The batter slopes shown on the Drawings represent the estimated requirements for the expected types of materials.

Redetermination: Batter slopes may be changed as directed following further assessment of the materials encountered on site.

Slope: When completed, the average planes of the batters of embankments are to conform to those shown on the Drawings or as directed.

Tolerance: Conform to the following:

- For a vertical distance to 1 m below the shoulder, no point on the completed batter to vary from the specified slope line by more than 150 mm when measured at right angles to the slope line.
- At distances greater than 1 m vertically below the shoulder, no point on the completed batter to vary from the specified slope line by more than 300 mm when measured at right angles to the slope.
- In no case is the edge of the formation at the underside of the pavement to be nearer to the roadway than shown on the Drawings and the batter slope at no point be steeper than the specified slope.

Slope undulations: Avoid and remove undulations in the general plane of the batter.

Slope redetermination: A direction to change the slope of any section of an embankment batter that has been completed to conform with this Clause, will constitute a Variation to the contract. The Contractor will require to reset out and remove or add fill material and retrim the batter.

Batter slope for median areas

Requirement: The batter slopes for median areas to conform to those shown on the Drawings and undulations in the general plane of the batter slope are not permitted.

Batter tolerances:

- For a horizontal distance of 2 m from the edge of the shoulder, no point on the completed batter to vary from the specified slope line by more than 50 mm when measured at right angles to the slope line within 24 hours after compaction.
- At distances greater than 2 m horizontally from the edge of the shoulder, no point on the completed batter to vary from the specified slope line by more than 100 mm when measured at right angles to the slope line within 24 hours after compaction.

Free draining: The medians to be graded so as not to pond water.

Rock facing of embankments

Type: Embankment batters, including embankments at bridge abutments, to be faced with clean, hard, durable rock.

Location: Where shown on the Drawings.

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 in such a manner as to prevent movement down the batter or onto the roadway.
- Ensure that, under no circumstances, any rock can be dislodged and roll onto any adjacent roadway or track in use.
- Provide traffic control procedures to ensure safe passage of vehicles and pedestrians.

Mechanical interlock: Build up the rock facing in layers ahead of each layer of filling. Place rock by hand or plant in such a manner that its least dimension is vertical and that mechanical interlock between the larger stones occurs.

Excess fine material: Remove rock facing that has an excess of fine material surrounding it, together with the fine material, and replace rocks.

Rock supply: Adjust working methods and program the work so as to obtain hard and durable rock of the specified dimensions as it is required.

Graded filter: Fill the 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 which 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.

Leaching: Use an appropriate geotextile for embankment construction to prevent the leaching out of fines from the fill material as shown on the drawings..

4.9 PLACING FILL

General

Uniformity of material: Select the methods of excavation, transport, depositing and spreading of the fill material so as to ensure that the placed material is uniformly mixed.

Embankment stability: Construct the embankment and stabilise by compaction of the fine material embedding the rock pieces. Compact fine material to meet the requirements of **Compaction and moisture requirements**.

Sources of material and processing: Determine suitable sources of material and any processing to satisfy these quality requirements.

Layer thickness

Placement: Place layers parallel to the grade line and compact to conform with **Compaction and moisture requirements**.

Description: Uniform compacted layers of thickness not exceeding 200 mm

Large rock: Approval required to increase thickness where more than 25% by volume of the filling consists of rock with any dimension larger than 150 mm.

Direction: Approval required to increase in the compacted layer thickness to 300 mm, provided that the relative compaction specified in **Compaction and moisture requirements** is attained.

Rock pieces

Maximum size: Less than two-thirds of the approved compacted layer thickness measured in any direction. Reduce any larger rock pieces in size for incorporation in the embankment layers.

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 achieve the specified compaction of each layer and produce a dense, compact embankment.

Insufficient fine material: If deemed insufficient fine material is present to fill the voids, obtain additional fine material from other places in the work or change the method of winning fill material. This is a **WITNESS POINT**.

Stony patches

Insufficient fine material: Rework stony patches having insufficient fine material to achieve compaction, with additional fine material blended in to achieve a dense, compact layer.

Equipment selection for placement: In placing embankment layers, use suitable equipment and techniques to avoid surface heaving or other damage to the foundations and underlying embankment layers.

CBR value

Value: Compacted embankment material in the selected material zone and below (or subbase layer, where no selected material zone) to have a CBR value not less than that quoted for the depth(s) specified in **Annexure A**.

Test method: The CBR value of the material to be determined by Test Method AS 1289.6.1.1

Trimming tops of embankments

Embankment: Trim the top of embankments parallel to the designed 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 at these levels to meet the requirements of **Compaction and moisture requirements.**

Tolerances: Trim to maximum 10 mm above or 40 mm below the levels as calculated above.

Inspection: Present the completed surface for inspection before placing any subsequent pavement layers over the completed top of embankment filling. Verify as part of the quality system that the completed surface has achieved full conformance with all respects of this worksection. This is a **HOLD POINT**.

4.10 SELECTED MATERIAL ZONE

Site won selected material

Quality: Conform to the following:

- Free from stones larger than 100 mm maximum dimension and have no less than 50% passing the 19 mm sieve.
- Have a CBR value not less than that specified in **Annexure A** for the fraction passing 19 mm AS sieve.
- Plasticity Index of 15 maximum.

Stabilisation: If chemical stabilisation is specified these requirements must apply to the selected material immediately prior to incorporating the stabilising agent.

Winning material: Obtain the selected material from cuttings excavated under the Contract or from borrow areas as specified in **Borrow**.

Working methods: Use working methods to yield material that conforms to the requirements of this Clause, and break down oversize rock if required.

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 at least sufficient material is reserved to complete the selected material zone over the whole work.

Extra material: If suitable available material has not been conserved, provide material of equivalent quality.

Placing and compaction

Layers: Place and compact in layers with the compacted thickness of each layer not exceeding 150 mm, homogeneous and free from patches containing segregated stone or excess fines. Refer to **Compaction and moisture requirements**.

Non-complying material: Exclude all non-complying material from all areas.

Top of the selected material zone: Compact and trim parallel with the designed 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 A.**

Inspection

Timing: Present the completed surface for inspection prior to placing any subsequent pavement layers over the completed select material zone surface.

Conformance: Verify as part of the quality system that the completed surface has achieved full conformance with all respects of this worksection. This action is a **HOLD POINT**.

4.11 FILL ADJACENT TO STRUCTURES

General

Payment: Supply and placement of fill adjacent to structures is deemed to be part of **Pay item 1112.2**.

Structure types: Structures include bridges, precast and cast-in-place box culverts and retaining walls.

Cross references: Fill adjacent to other culverts and drainage structures to be provided to conform with *1351 Stormwater drainage (Construction), 1352 Pipe drainage, 1353 Precast box culverts* and *1354 Drainage structures.*

Time of placement: Do not place fill against structures, retaining walls, headwalls or wing walls within 21 days after placing of the concrete.

Approval required: To decrease the lag time the walls may be supported by struts, or the Contractor can demonstrate that 85% of the design strength of the concrete has been achieved. This includes concrete in bridge decks and fill placement that impacts the position, stability and serviceability of bridge deck member bearings. This is a **WITNESS POINT**.

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:

- The maximum particle dimension not to exceed 50 mm,
- No more than 5 % by mass to pass the 9.5 mm AS sieve.

Extent: Continuous in the line of the weepholes, extend at least 300 mm horizontally into the fill and extend from 200 below to at least 450 mm vertically above the level of the weepholes, where practicable.

Geotextile membrane: Alternatively, provide a geotextile membrane of equivalent drainage characteristics at no extra cost. Store and install in accordance with Manufacturer's instructions. The use of geotextile is subject to approval. This is a **HOLD POINT**.

Selected backfill

Location: Place selected backfill adjacent to structures to conform with **Selected backfill width and height table.**

Material: Selected backfill to consist of a granular material having a maximum dimension not exceeding 50 mm and a Plasticity Index, determined by AS 1289.3.3.1, neither less than 2 nor more than 12.

Selected backfill width and height table

Structure type	**Selected 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
Where H = height of structure)		

Placement: Place the selected 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, meeting the requirements of **Compaction and moisture requirements**.

Horizontal terraces: Cut the existing embankment slope behind the structure in the form of successive horizontal terraces, each terrace being at least 1 m in width, and the selected backfill placed to conform with **Placing fill for embankment construction**.

Spill through abutments: Do not dump rocks against the columns or retaining walls, build up evenly by individual placement around or against such 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.

4.12 SPOIL

General

Spoil: The surplus material from excavations under the Contract that is not required to complete the Works as specified or material from excavations under the Contract whose quality is deemed to be unacceptable for incorporation in the Works.

Incorporation in the works

Embankments: The Superintendent may direct flatter batter slopes or uniform widening on embankments that have not been commenced. The surface shaped to provide a tidy appearance and effective drainage.

Surplus material: Spread and compact the surplus material as specified in **Placing fill for embankment construction** and **Compaction and moisture requirements** for material in embankments.

Haulage disposal

Planning approval: Obtain planning approval and bear all costs in obtaining such approval by Council's Town Planning Manager, if handling of spoil is involved. This is a **WITNESS POINT**.

Method: Dispose of spoil in a manner and at approved locations. Compact spoil as specified in **Compaction and moisture requirements** for material in embankments.

Payment

Haulage: Disposal of spoil as follows:

- Up to five kilometres from the point of excavation to be included in **Pay item 1112.2**.
- If haulage exceeds five kilometres, payment to be made at the rate nominated in **Annexure A** for haulage of spoil.

4.13 BORROW

Requirement

Criteria: Unless provided by the Contract, borrow will only be authorised for:

- Constructing cuttings and embankments to the batter slopes as directed.
- 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 quality: As approved and to conform with **Embankment material**, **Rock facing of embankments**, or **Fill adjacent to structures**.

Permits: Obtain approval by Council's Town Planning Manager and any permits required for entry on land and pay any royalty for such borrow material. This is a **WITNESS POINT**.

Authorities: Comply with any 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: Ensure 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 by the Superintendent.

Drainage: Provide drainage outlets acceptable to the Superintendent.

Batter slopes:

- Not steeper than 4 H: 1 V.
- To be left in a tidy and safe condition.

Site preparation and restoration: For borrow within the defined working area for the Works as specified, site preparation to be in accordance with *1111 Clearing and grubbing* and **Removal of topsoil**.

Restoration: Restore borrow sites to *0257 Landscape – roadways and street trees*.

Widening of cutting: If borrow material is obtained by uniformly widening a cutting, apply the requirements of **Excavation**, **Batter tolerances** and **Treatment of floors of cuttings** to the redetermination of batter slopes, the trimming of batters and the compaction of floors of cuttings respectively.

Payment

Borrow: Payment to be made to the Contractor as follows:

- Within the specified working area is deemed to be part of **Pay item 1112.2**.
- If the Superintendent accepts that borrow must to be obtained from locations outside the specified working area for the Works, such work to be treated as a Variation to the Contract.

Haulage: If haulage exceeds five kilometres, payment to be made at the rate nominated in **Annexure A** for haulage of borrow.

4.14 COMPACTION AND MOISTURE REQUIREMENTS

Trimming and compaction

Sequence: Compact all layers uniformly to not less than the relative compaction specified before the next layer is commenced.

Trimming: Trim each layer of material prior to and during compaction to avoid bridging over low areas and to present a smooth surface at the top of each layer.

92% Compaction

Requirements: Compact the following areas to provide a relative compaction, not less than 92% determined by AS 1289.5.7.1 or AS 1289.5.4.1 for modified compactive effort to the following:

- Each layer of material replacing unsuitable material as detailed in **Unsuitable material**.
- Each layer of material placed in embankments, up to 1.5 metres from the top of the pavement.
- Fill placed adjacent to structures up to 1.5 metres 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 specified.

Unsuitable material: Stockpile unsuitable material as directed by the Superintendent and compact by track rolling.

97% Compaction

Requirements: Compact the following areas to provide a relative compaction of not less than 97% as determined by AS 1289.5.7.1 or AS 1289.5.4.1 for modified compactive effort to the following:

- Foundations for shallow embankments.
- The whole area on the floor of cuttings.
- Each upper zone layer of the embankment within 1.5 metres from the top of pavement.
- Each layer of the selected material zone as specified in **Selected material zone**.
- Any areas of material of specified quality which may be shown on the Drawings or specified elsewhere behind kerbs and/or gutters or adjacent to rigid pavements.
- The fill material placed adjacent to structures as specified in **Fill adjacent to structures** and **Selected backfill** in each layer within 1.5 metres from the top of the pavement.

Shallow cutting

Definition: Cut the prepared subgrade to a depth below natural surface of less than 0.5 metres where the vertical alignment design is such that a substantial portion of the road is required to be built at or close to the natural surface.

Treatment: Treat the floor of shallow cutting as specified in **Treatment of 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 200 mm determined by AS 1289.5.7.1 or AS 1289.5.4.1, for modified compactive effort.

Cut-fill transition

Requirement: Approval is required when shallow cutting conditions occur, the specified transition from cut to fill may be modified such that the depth of terrace excavation at the transition from cut to fill is reduced from 900 mm to 250 mm.

Proof rolling

Requirement: Proof roll as directed in **Annexure A** sections where ripping or loosening of the cutting floor is not required.

Locations: Proof rolling to conform with **Deflection monitoring or proof rolling**.

Moisture content

Compaction timing: Adjust the moisture content of the material at the time of compaction to permit the specified compaction to be attained at a moisture content which is within the range set out in **Annexure A** of the optimum moisture content as determined by AS 1289.5.1.1 or AS 1289.5.7.1.

- Wet material: Do not compact material that has become wetted up 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 where approved, by the use of hydrated or quick lime at the Contractor's cost.
- Drying: Alternatively the Contractor may transport the wet material to a stockpile site for drying out and later use as fill material at the Contractor's cost.
- Dry material: If the material is too dry for compaction as specified, add water. Apply water uniformly and thoroughly mix with the material until a homogeneous mixture is obtained.

Compaction

Extent: Undertake compaction to obtain the specified 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.

Repair: Loosen, recondition and recompact rain damaged surfaces before placing another layer of material.

Compaction and moisture tests

Test locations: Determine sampling locations for testing as described in 0161 *Quality – Construction*.

Preparation: Prepare the area at the determined locations for specified compaction and moisture tests.

Moisture content: Prior to testing, work the lot to ensure uniform moisture content and compaction of all material within the lot.

Test representation: The test/s then taken are to be considered to represent the total volume of material placed within the lot.

Further testing: If the material which is present has not achieved uniformity required by this Clause or **Placing fill for embankment construction**, further testing may be directed. The Superintendent to nominate the area to be represented by the additional testing.

Material not conforming: If such testing confirms that material not conforming to the worksection is present, perform remedial work as necessary to achieve conformance to the requirements of **Compaction and moisture requirements**.

Deflection monitoring or proof rolling

Presentation for testing: Present the work available in lots, for the Superintendent to carry out deflection monitoring or proof rolling. Further compact as directed due to results of proof rolling. This is a **HOLD POINT**.

Timing: Following completion of the formation to the underside of the selected material zone and completion of the selected material zone.

Size: A continuous length of formation of at least 300 m, or lesser length as approved, and a single carriageway width which is generally homogeneous with respect to material and appearance.

Boundaries: Identify the boundaries of each lot with stakes clearly labelled to the satisfaction of the Superintendent.

Costs: The cost of preparing the surface for deflection monitoring or proof rolling is included in the rate for **Pay item 1112.2**.

4.15 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 shown on the Drawings.

5 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	Location or timing	Limits/Tolerances	Worksection clause/subclause
Batter slopes			
Excavation	At toe of batter and level of table drain	Batter ≤ 1:1, + 0, - 150 mm Batter > 1:1, + 0, - 200 mm	**Batters/ Excavation tolerances for batters**
	2 m above table drain and higher	Batter ≤ 1:1, ± 300 mm Batter > 1:1, + 300, - 600 mm	
	Between level of table drain and 2 m above table drain	Pro-rata basis	
Embankment	1 m below shoulder	± 150 mm	**Embankments/ Batter slopes**
	More than 1 m below shoulder	± 300 mm	**Embankments/ Batter slopes**
Median Areas	2 m from edge of shoulder	± 50 mm	**Embankments/ Batter slopes for median areas**
	More than 2 m from edge of shoulder	± 100 mm	
Embankments			
Trimming tops of embankments	At completion of embankment construction	Parallel to the designed grade line, + 10 mm or - 40 mm of	**Placing fill/Trimming tops**

Activity	Location or timing	Limits/Tolerances	Worksection clause/subclause
		the levels specified	**of embankments**
Selected material	Rock Quality	Minimum CBR value as per **Annexure A**	**Selected material zone/Site won selected material**
Selected backfill	Adjacent to structures	Plasticity Index 2 to 12	**Fill adjacent to structures/ Selected backfill**
Plus (+) is towards the roadway/surface and minus (–) is away from the roadway/surface. Tolerances are measured at right angles to the slope line.			

6 MEASUREMENT AND PAYMENT

6.1 MEASUREMENT

General

Payments made to the Schedule of Rates: To *0152 Schedule of rates – supply projects*, this worksection, the drawings and Pay items **1112.1 to 1112.6** inclusive.

Lump Sum prices: Not acceptable.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology

The following methodology will be applied for measurement and payment:

- Control measures for erosion and sedimentation are measured and paid in accordance with *1102 Control of erosion and sedimentation.*
- Clearing and grubbing of stockpile sites and borrow areas is measured and paid in accordance with *1111 Clearing and grubbing.*
- Seeding and restoration of stockpile sites and borrow areas is measured and paid in accordance with *0257 Landscape – roadways and street trees*.
- Traffic control for blasting operations is measured and paid in accordance with *1101 Control of traffic*.
- Fill adjacent to culverts, other than box culverts, and drainage structures is measured and paid in accordance with *1351 Stormwater drainage (Construction)*, *1352 Pipe drainage*.
- Selected backfilling to box culverts is measured and paid in accordance with *1353 Precast box culverts*.
- Working platforms created by chemical stabilisation are measured and paid in accordance with *1113 Stabilisation*.

6.2 PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1112.1 Removal and stockpiling of topsoil	m^3 excavated 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 directed to be removed by the Superintendent, plus; - The volume removed from under embankments calculated by	- All costs associated with all activities associated with stripping topsoil, carting and placing into stockpile, then stabilising and trimming the stockpiles.

Pay items	Unit of measurement	Schedule rate scope
	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 A,** plus; - The additional volume of topsoil removed from shallow embankments below the depth nominated in **Annexure A** and calculated on the basis of plan area multiplied by the directed depth of excavation, or as directed.	
1112.2 General earthworks	m^3 measured as 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 pretreatment 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**; - 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 **Treatment of 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, or by other methods which may be approved by the Superintendent.
1112.3 Unsuitable material to spoil	m^3 measured as volume of excavation	This **Pay item** refers only to unsuitable material as defined in **Unsuitable material** which is removed to spoil stockpile. If the material is such that the volume of excavation cannot be measured, the Superintendent will determine the conversion factors to be applied to the

Pay items	Unit of measurement	Schedule rate scope
		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 its disposal as spoil in accordance with **Spoil**. When 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. Each rate to be applied 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. The volume to be determined by multiplying the theoretical plan area of the top of the selected material zone with its nominated thickness.	All costs associated with extra costs involved in stockpiling, processing, placing, compaction and trimming of material, 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 shown on the Drawings or as directed by the Superintendent. No account is to be taken of level tolerances.
1112.5 Haulage of spoil	Per bank m^3 for each kilometre or part thereof in excess of five kilometres.	Where an approved location for spoil disposal is more than five kilometres by road from the point of excavation of material being spoiled, payment to be made for haulage at the rate nominated in **Annexure A** and include all costs associated with this activity.
1112.6 Haulage of borrow	Per bank m^3 for each kilometre or part thereof in excess of five kilometres.	Where an authorised borrow site that was not nominated in the Contract, is more than five kilometres by road from the point of delivery of borrow material to the Works, payment to be made for haulage at the rate nominated in **Annexure A** and include all costs associated with this activity.

7 ANNEXURE A

7.1 EARTHWORKS INFORMATION

Worksection 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 –_____mm
Embankments /Foundations for embankments	Requirements of material in foundations for shallow embankments:				
	- Moisture Content within the range of _____% to _____% of optimum.				
Selected material/Site won selected material	Upper Zones of Formation & Selected Material Zone				
	Material within each zone to have a CBR value of not less than that given in the table below under the nominated test conditions.				
	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.				
Selected material zone/ Placing and compaction	Construction tolerances for Selected Material Zone are: - designed grade and - cross fall				+_____mm +_____mm
Spoil/ Payment	**Haulage of spoil under Pay item 1112.5 to be payable at the rate of $_____ per bank cubic metre per kilometre in excess of 5 km.**				
Borrow/ Payment	**Haulage of borrow under Pay item 1112.6 to be payable at the rate of $_____ per bank cubic metre per kilometre in excess of 5 km.**				
Compaction and moisture requirements/ Proof rolling	Shallow cuttings				
	- Sections of work nominated to be in shallow cutting: ……..…..				
	- Ripping or loosening [is / is not] required in shallow cutting.				
	- Proof rolling of subgrade [is / is not] required.				
Compaction and moisture requirements/ Moisture content	Moisture Content of material placed in embankments:				
	- Material in upper zones of formation within the range of ___% to ___% of optimum				
	- All other embankment material within the range of ___% to ___% of optimum				

8 ANNEXURE B - BLASTING

HOLD POINTS table

Item/Clause title	Requirement	Notice for inspection	Release by
General			
Pre-blast survey	Determine and record the existing condition of all structures	7 days before the start of blasting operations	Superintendent
Survey report	Advise Superintendent of blasting charge details and adequacy of survey	3 days before the start of blasting	Superintendent
Proposed blasting procedure	Written details of the proposed blasting procedure including proposed measures to limit noise and damage	Before the start of blasting operations - progressive	Superintendent
Control of air blast over-pressure			
Excessive air blast over-pressure	Suspend further blasting work and submit proposals of additional steps and precautions to avoid recurrence	24 hours prior to next activity	Superintendent

WITNESS POINTS table – On site activities

Item/Clause title	Requirement	Notice for inspection
General		
Licences	Obtain all necessary licences and comply with all Government and Council regulations.	7 days before initiating blasting
Blasting records		
Recording procedure	Prepare records as holes are loaded and signed by the Powderman	On the day of the blast
Advice to residents	Report any special condition affecting any resident	Progressive – 24 hours prior to blasting
Control of ground vibration		
Monitoring vibrations	Design may be adjusted provided that further ground vibration monitoring is done and it is demonstrated that peak particle velocity limits are not exceeded	24 hours before next activity

8.1 GENERAL

Licences

Requirement: When explosives are permitted to be used by the Superintendent, and the Contractor wishes to undertake blasting, obtain all necessary licences from the appropriate authorities, and comply with all Government and Council regulations relating to transport, storage, handling and the use of explosives and also to the rules set out in AS 2187.1 and AS 2187.2.

Conform to the following:

- The transport of explosives to be in accordance with the *Australian Code for the Transport of Explosives by Road and Rail*. This is a **WITNESS POINT.**

- Comply with the requirements of the Environment Protection Authority (EPA).
- The Contractor to be liable for any accident, damage or injury to any person, property or thing, resulting from the use of explosives.

Pre-blast survey

Requirement: Before the start of blasting operations, conduct a survey in the presence of the Superintendent to determine and record the existing condition of all structures likely to be affected by any blast. This is a **HOLD POINT**.

Extent of survey: The survey to include all structures (including utility services) within 500 m of any blast and extended where the Maximum Instantaneous Charge proposed is likely to produce peak particle velocities greater than allowable at structures more remote from a blast site.

Survey report

Content: Submit a written report of the survey, supported by photographs where necessary, together with a list of any existing defects in the structures, to the owner of each structure and to the Superintendent before blasting commences.

Maximum instantaneous charge: Submit for approval the Maximum Instantaneous Charge and the Contractor's validation of the adequacy of the proposed structural survey at least three working days before the survey is due to commence. This is a **HOLD POINT**.

Blast monitoring: Amend survey where required due to the outcome of blast monitoring.

Proposed blasting procedure

Written submission: Before each blasting operation, submit written details of the proposed blasting procedure including:

- The quantity and type of explosive to be detonated
- The blasting pattern to be used
- Measures proposed to limit noise
- To ensure that vibration from blasting does not adversely affect nearby structures.

This action is a **HOLD POINT**.

Release of the **HOLD POINT** does not in any way reduce the Contractor's responsibility set out in **Contractor to obtain licences**.

Limits on vibration: To BS 6472-1.

Ground vibration: Ground vibration caused by blasting not to exceed the values of peak particle velocity listed in the **Limiting peak particle velocity table**.

Limiting peak particle velocity table

Point of Potential Damage (within 1 km of blasting site)	**Peak Particle Velocity**
Completed and cured bridge structures or sub-structures (e.g. completed abutment)	25 mm/sec
Bridgeworks and structural retaining walls under construction	20 mm/sec
Residential premises, schools, hospitals and other buildings	5 mm/sec (with 10% not to exceed 10 mm/sec)
Buildings or monuments of historical significance	2 mm/sec

Advice to residents

Procedure: Advise all residents within a radius of 1 km, by letter drop before blasting operations commence. Details to include the likely times, frequency and duration of blasting and precautions being taken to ensure that damage to property will not result. Ensure residents acknowledge receipt of this advice. Report any special condition or approval requirement affecting any resident to the Superintendent. This is a **WITNESS POINT**.

Time limits: Unless otherwise approved, blasting operations to be confined to the periods Mondays to Fridays (excluding public holidays), 9 am to 3 pm.

Safety precautions: When blasting operations are being carried out, take precautions to ensure the safety of persons and animals and the road to be closed to traffic and the appropriate signs erected in accordance with *1101 Control of traffic*.

Warning procedure: Establish and observe a standard warning procedure at all times to AS 2187.2.

Presplitting

Where presplitting is carried out the spacing of presplit drill holes not to exceed 750 mm centre to centre.

8.2 BLASTING RECORDS

Records to be kept

Requirement: Maintain accurate records of each blast showing the details listed below:

- Date and time of blast.
- Location, number and diameter of holes loaded.
- Depth of each hole loaded.
- Inclination of holes.
- Maximum and minimum burden.
- Types of explosives used.
- Charge distribution in each hole.
- Maximum Instantaneous Charge.
- Delay periods and sequence.
- Total amount of charges in the blast.
- Length and type of stemming in each hole.

Recording procedure

Methodology: Prepare the records as holes are loaded and signed by the Powderman. Provide a copy to the Superintendent on the day of the blast. This is a **WITNESS POINT**.

8.3 CONTROL OF AIR BLAST OVER-PRESSURE

Proximity to noise sensitive locations

Application: This Clause only applies where a noise sensitive location exists within 1 km of the blasting site.

Noise control manual: The Contractor's attention is drawn to the recommendations given in the EPA Environmental criteria for road traffic noise for the reduction of air blast over-pressure.

Noise limitations: Limit the noise emanating from blasting operations to an over-pressure level of 115 decibels (linear peak) at any noise sensitive location (such as residential premises, schools or hospitals). Up to 10% of the total number of blasts may exceed this value provided a level of 120 decibels is not exceeded at any time.

Monitoring of air blast over-pressure

Procedure: Conform to the following:

- Arrange for the monitoring of air blast over-pressure to ensure compliance with the specified limits.
- All monitoring to be carried out by personnel possessing current NATA registration.
- Report all test results on NATA endorsed test certificates which include a clear statement as to compliance or non-compliance with the requirements of this worksection.
- In general, establish a monitoring location near the perimeter of the noise sensitive location at the point closest to the maximum charge.
- Submit a copy of the monitoring record to the Superintendent.

Excessive air blast over-pressure

Procedure: In the event that the measured air blast over-pressure exceeds the specified limits, suspend further blasting work and submit proposals detailing any additional steps and precautions that will be taken to ensure that for any future blast, the limiting over-pressure will not be exceeded. This is a **HOLD POINT**.

8.4 CONTROL OF GROUND VIBRATION

Monitoring vibrations

Requirement: Arrange for the monitoring of ground vibrations to ensure compliance with the peak particle velocity limits shown in the **Limiting peak particle velocity table**. All monitoring to be carried out by personnel possessing current NATA registration for such monitoring.

Total results: Report all test results on NATA endorsed test certificates to include a clear statement as to compliance or non-compliance with the requirements of this Part of the worksection.

Monitoring locations: In general, establish a monitoring location near the perimeter of the structure or building at the point closest to the maximum charge.

Record: Submit a copy of the monitoring record to the Superintendent.

Blasting site relationship: To minimise the risk of peak particle velocity limits being exceeded, develop a blasting site relationship between peak particle velocity, distance and blasting charge.

Maximum Instantaneous Charge: For the first blast, set up monitors at not less than five points at varying distances away from the blasting site. The Maximum Instantaneous Charge for the first blast is not to exceed that calculated and certified by an approved explosives specialist. Submit a calculated relationship for Maximum Instantaneous Charge to AS 2187.2, and for future blasting, ground vibration as vector peak particle velocity.

Adjustment of blast design: For subsequent blasts, the MIC and other aspects of blast design may be adjusted provided that further ground vibration monitoring is undertaken and the mean regression line redetermined to demonstrate that peak particle velocity limits are not exceeded. This is a **WITNESS POINT**.

Line plots: The Contractor to make the regression line plots available to the Superintendent, if so requested.

1113 STABILISATION

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide stabilisation of subgrade and pavement courses using the specified materials and processes as documented.

Performance
Requirements: Provide the work in accordance with the specification, standards, quality requirements and approved work plan.

Design
Authority requirements: Conform to statutory requirements for Work Health and Safety.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*
- *1112 Earthworks (Roadways).*
- *1141 Flexible pavement base and subbase.*
- *1351 Stormwater drainage (Construction).*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection 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 1289.4.2.1-1997	Soil chemical tests - Determination of the sulfate content of a natural soil and the sulfate content of the groundwater - Normal 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 1289.6.1.1-1998	Soil strength and consolidation tests - Determination of the California Bearing Ratio of a soil - Standard laboratory method for a remoulded specimen
AS 2350 Various	Methods of testing Portland and blended cements
AS/NZS 2350.4: 2006	Setting time of Portland and blended cements
AS 2350.9-2006	Determination of residue on the 45 μm sieve
AS 3582	Supplementary cementitious materials for use with portland and blended cement
AS 3582.1-1998	Fly ash
AS 3582.2-2001	Slag - Ground granulated iron blast-furnace
AS 3583	Methods of test for supplementary cementitious materials for use with portland cement

AS 3583.3-1991	Determination of loss on ignition
AS 3583.6-1995	Determination of relative water requirement and relative strength
AS 3583.12-1991	Determination of available alkali
AS 3583.13-1991	Determination of chloride ion content
AS 3583.14-1991	Determination of insoluble residue content
AS 3972-2010	General purpose and blended cements

Other publications

AUSTROADS

AGPT04D-2006	Guide to pavement technology Part 4D - Stabilised materials.
AP-C87-2010	Austroads Glossary of terms

NSW RMS Test Methods

T432 – 2001	Rate of slaking of quicklime

1.4 STANDARDS

General

Standard: To AGPT04D.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- NATA: National Association of Testing Authorities.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Field Working Period: Time period from addition of mixing water until completion of compaction.
- Joints: Interfaces between work episodes delayed by more than the Field Working Period.
- Stabilising agent: Quicklime, hydrated lime, slag/lime blend, cement.

2 PRE-CONSTRUCTION PLANNING

2.1 SPECIFIED MATERIALS

Materials proposed for use in the work

Certificates of compliance: Provide a certificate from a NATA registered laboratory showing the following:

- The stabilisation mix(s) submitted and the mix constituents comply with the mix specified in **Annexure A.**
- The stabilised material meets the requirements of *1141 Flexible pavement base and subbase* if incorporated into the works as a pavement layer or
- *1112 Earthworks (Roadways)* or
- *1351 Stormwater drainage (Construction).*

This is a **HOLD POINT.**

Inspection, sampling and testing

Quality checks: Regular inspection, sampling and testing of pavement and subgrade materials to be undertaken by the Contractor while stabilisation is in progress in accordance with this worksection.

2.2 WORKS GENERALLY

Provision for traffic

Protection: Provide for traffic in accordance with *1101 Control of traffic* while undertaking the work and take all necessary precautions to protect the work from damage until such time as the new work has developed sufficient strength to carry normal traffic without damage.

Delays: Take all necessary steps to avoid or minimise delays and inconvenience to road users during the course of the work. Where adequate detours or side tracks are included in the contract or are otherwise available, traffic to be temporarily diverted while the work is in progress.

Proposals for construction
Program: Plan program of works to address time and access constraints. Develop equipment selection and material sources to suit the sequence of operations. Address the interaction with the Superintendent on approvals and inspections. Generate the Work Plan for Submission.

2.3 FIELD WORKING PERIOD

Laboratory tests
Submit: Provide the nominated Field Working Period in **Annexure A** for the stabilising agent approved for the works. This is a **HOLD POINT**.

Method: The nominated Field Working Period to be based on laboratory tests determining the time from mixing until such time as the calculated Wet Density for modified compaction procedures decreases by more than 2% points.

Samples: This testing to be undertaken utilising AS 1289.5.7.1 and samples of the materials representative of those to be utilised in the works.

Type: The field working period may vary significantly with variations in the type of stabilising agent.

3 MATERIALS

3.1 GENERAL

Stabilisation types: The requirements for stabilisation of the types of pavement courses and subgrade zones or layers are shown in **Types of pavement courses, subgrade zones or layers and stabilising binder** Table. The pavement course or subgrade zone or layer for stabilisation is as specified in *1141 Flexible pavement base and subbase*.

Types of pavement courses, subgrade zones or layers and stabilising binder table

Pavement course or subgrade zone or layer	**Stabilising binder**
Pavement course	
Base and subbase	Cement Blended Stabilising Agent Hydrated Lime (pugmill) Quicklime (in situ)
Subgrade zone or layer	
Selected Material Zone	Cement Blended Stabilising Agent Quicklime (in situ) Hydrated Lime (pugmill)
Other Subgrade Layers	Cement Blended Stabilising Agent Quicklime (in situ) Hydrated Lime (pugmill)
Selected Backfill Zone	Cement Hydrated Lime (pugmill)

3.2 CEMENT

Standard
General: To AS 3972.

Testing: To AS 2350 (Various).

Proof of quality: Provide documentary evidence of the quality and source of the cement upon request at any stage of the work. This is a **WITNESS POINT**.

Storage
Storage period: Prior to use re-test and submit test results for cement that has been stored for a period in excess of three months from the time of manufacture to ensure the cement still complies with AS 3972. This is a **HOLD POINT**.

Transport: Transport cement in water tight packaging and protect from moisture until used. Do not use caked or lumpy cement.

3.3 QUICKLIME

Standard

Type:

- Available lime: To AS 3583.12.
- Temperature rise: To test method RMS T432.
- Particle size: To AS 1141.11.1.

Quality: Provide NATA laboratory test results to confirm that the quicklime supplied conforms with that specified. This is a **WITNESS POINT**.

Properties

Calcium oxide: Quicklime to consist of essentially calcium oxide in a highly reactive form. At the point of spread the content of calcium oxide > 85 %.

Slaking rate: The active slaking time ≤ twenty minutes. The temperature rise on slaking > 40℃ in 6 minutes (determined from the average of four samples tested in accordance with Test Method RMS T432).

Particle size: The particle size distribution of the quick lime to comply with the following requirements in Table 3.1.

Table 3.1 Particle size distribution of quicklime

AS Sieve	Per cent passing
13.2 mm	100
9.5 mm	96–100
4.75 mm	70–100
2.36 mm	0–90

3.4 HYDRATED LIME

Standard

Type:

- Available lime: To AS 3583.12.
- Fineness: To AS 2350.9.
- Particle size: To AS 3583.14.

Quality: Provide NATA laboratory test results to confirm that the hydrated lime supplied conforms with that specified. Details to include percentage of calcium hydroxide, fineness expressed by percentage by mass passing the 45 µm sieve and source. This is a **WITNESS POINT**.

Properties

Calcium hydroxide: Hydrated lime to consist essentially of calcium hydroxide > 80 %. Both when used as the sole stabilising agent or blended with other additives.

Form: The material to be in powder form and must be dry.

Residue on sieving (Particle Size): The residue on a 300 µm sieve < 2 %.

3.5 GROUND GRANULATED BLAST FURNACE SLAG

Standard

Type: To AS 3582.2.

- Fineness: To AS 2350.9.
- Relative strength: To AS 3583.6.

Quality: Provide NATA laboratory test results to confirm that the slag supplied conforms with that specified. Details to include fineness expressed by percentage by mass passing the 45 µm sieve, relative strength (28 days) and source. This is a **WITNESS POINT**.

Slag: Ground granulated blast furnace slag is known as ‘slag’.

3.6 FLYASH

Standard

Type: To AS 3582.1.

- Fineness: To AS 2350.9.
- Loss on ignition: To AS 3583.3.

Quality: Provide NATA laboratory test results to confirm that the flyash supplied conforms with that specified. Details to include fineness expressed by percentage by mass passing the 45 µm sieve, loss on ignition and source. This is a **WITNESS POINT**.

3.7 BLENDED STABILISING AGENTS

Standard

Type:

- Fineness: To AS 2350.9.
- Setting time: To AS/NZS 2350.4.

Quality: Provide NATA laboratory test results to confirm that the blended agent supplied is in accordance with that specified. Details to include fineness expressed by percentage by mass passing the 45 µm sieve, setting time and source of each component. This is a **WITNESS POINT**.

Batch information

Requirements: A blended stabilising agent may be used.

Blending mass: The mass of components of the nominated blended stabilising agent are not to vary by more than ± 3 % from the blend percentages nominated in the mix design described in **Annexure A**.

Handling and storage

Requirements: Comply with the supplier's handling and storage requirements. Also arrange for sampling of the agent as required. This is a **WITNESS POINT**.

3.8 WATER

Standard

Chloride ion: To AS 3583.13.

Sulphate ion: To AS 1289.4.2.1.

Quality

Water to be free from harmful amounts of materials such as oils, salts, acids, alkalis and vegetable substances. Water accepted as potable and fit for human consumption will not require testing to confirm suitability.

Tolerances: Water not to contain more than:

- 600 parts per million of chloride ion.
- 400 parts per million of sulphate ion.
- 1 % by mass of undissolved solids.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 STABILISATION PROCESSES

Proposed equipment and procedures

Work plan: Submit details of the proposed equipment (including the mixing plant) and stabilisation procedures to be used in the work. This submission will be known as the Work Plan and is to include the following:

- The sequence of operations.
- Widths of stabilisation passes.
- Provision for traffic if appropriate.
- Comply with Statutory requirements for WHS.
- Testing methods and frequency.

- Comply with this worksection.
- Survey control methods.
- Curing methods.

This is a **HOLD POINT**.

4.3 QUALITY REQUIREMENTS

Compaction

Compaction within Field Working Period: Complete the compaction process within the nominated Field Working Period unless specific approval is provided by the Superintendent to an adjustment for site and seasonal conditions. This is a **WITNESS POINT**.

Weather conditions

Moisture Content: Do not proceed with the stabilisation of pavement materials during wet weather or if rain is imminent and likely to occur during any stage of the stabilisation process so as to significantly influence the resultant moisture content and uniformity of moisture content in the mix.

Wind: Do not proceed with spreading during windy conditions which may cause loss of stabilising agent or cause nuisance or danger to people or property.

4.4 APPLICATION OF STABILISING AGENT

Stationary mixing plant

Application rate: Monitor the application rate of stabilising agent at the pug mill or equivalent approved plant. Record for every 100 tonnes of production in kg/tonne. This is a **WITNESS POINT**.

Accuracy: The achieved accuracy of application rate ± 10 % of the rate nominated in **Annexure A**.

Spillage: Remove any spillage of the stabilising agent on site or at any loading location related to the site as soon as possible and within the same work shift of such spillage. This is a **WITNESS POINT**.

Excessive application: Prevent excessive application so as not to exceed the nominated rate by more than 10 %.

In situ application

Application process: The incorporation of stabilising agent is to follow a process where it is spread on the pavement in advance of the specialist mixing equipment.

Special processes: Any processes nominated by the contractor involving supply of stabilising agent within the mixing bowl of equipment must be approved. A demonstration of the process at the Contractor's expense may be requested. This is a **HOLD POINT**.

Spreading out

Mechanical spreader: Carry out spreading using the approved mechanical spreader nominated in the Work Plan.

Spread rate: Nominated in **Annexure A**.

Tolerances: The actual spread rate to be within ±10 % of the nominated rate. Verify this by testing the spread rate for each lot or 500 m^2 of pavement treated (whichever is less) in each application of binder. This is a **WITNESS POINT**.

Testing: Spread rate testing to be performed by weighing 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).

Average spread rate: Where 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.

Record: Submit data for each run, however such action will not cancel the Contractor's obligation to undertake the prescribed testing of spread rate. This is a **WITNESS POINT**.

Construction traffic: Traffic or equipment not involved in spreading or mixing of the stabilising agent not to pass over the spread material until it has been mixed into the layer to be stabilised.

4.5 MIXING

Stationary mixing plant

Type: Purpose build the stationary mixing plant for the process of mixing road making materials.

Maintain equipment: Maintain and calibrate all equipment so as to provide a uniformly mixed product without segregation of the aggregate material.

Water addition: Control and meter the inclusion of water into the mix.

Stationary mixing equipment: Incorporate a delivery system for mix materials capable of producing a uniform mixture to design requirements.

Strength test: Confirm performance by monitoring the unconfined compressive strength of production, to conform with AS 1289.6.1.1. Test a pair of specimens for each 100 tonnes of production. This is a **WITNESS POINT**.

In situ mixing process

Equipment: Mixing equipment and procedure to comply with the following:

- Purpose built for the process of in situ mixing of road making materials.
- Capable of mixing to the depth specified for the layer to be stabilised.
- Distribute the stabilising agent uniformly through the full depth and over the whole area of the layer to be stabilised.
- A minimum of 2 passes of the mixing equipment is required.
- As mixing blades or tynes wear, replace to maintain mixing efficiency consistent with that demonstrated during the trial section.
- Mixing equipment capable of supplying a calibrated amount of water to the mixing bowl in a such manner as to provide a uniformly moist mix to a target moisture content.

Approval: Demonstrate the mixing efficiency. This is a **HOLD POINT**.

Uniform mixture: The resultant mix must be uniform over the full depth so that there are no lenses, pockets, lumps or granules of stabilising agent present in the layer or adjacent to it.

Work plan: The procedure nominated in the Work Plan is to minimise disturbance of the distribution of stabilising agent spread in advance of the mixing process.

Inspections: Carry out visual inspections during mixing to ensure uniform mixing is being achieved in the layer. Record inspection results to conform with *0161 Quality (Construction) or 0167 Integrated management*, as applicable. This is a **WITNESS POINT**.

Additional mixing: The Superintendent may direct that additional passes by the mixing equipment be carried out to improve the visual uniformity of the mix and/or the moisture content. This is a **WITNESS POINT**.

4.6 TRIMMING AND COMPACTION

Tolerances

Level tolerance: After mixing, trim and compact the layer to conform with *1141 Flexible pavement base and subbase* to produce a tight dense surface parallel with the finished wearing surface so that the levels do not vary from the design levels beyond the tolerance for primary trimming specified in **Limits and Tolerances**.

Trimming

Secondary trimming: Subsequent secondary trimming may be undertaken on one or more occasions in preparation for primer seal and with the objective of meeting shape and level requirements. Secondary trimming to involve cutting to waste. Work methods that lead to the development of laminations in the pavement will not be allowed and surface slurrying will not be accepted. This is a **HOLD POINT**.

Survey control methods

General: Provide adequate survey control methods as stated in the Work Plan to ensure that the pavement layer thickness is not reduced during secondary trimming to an extent that it fails to comply with the requirement for layer thickness in accordance with the tolerance specified.

Layer thickness after trimming: When required by the Superintendent provide survey results to confirm that the pavement layer thickness remains within tolerance after secondary trimming. This survey will be at no cost to the Principal. This is a **WITNESS POINT**.

Trimmed material: All trimmed material having been cut to waste is to be used as fill or spoil as directed. The material will be owned by the Principal. This is a **HOLD POINT**.

Straight edge test

General: Conform to the following:

- Measurements with a 3 metre straight edge to be taken at a minimum of 10 randomly selected stations so as to represent each 200 metre lane length or part thereof.
- Deviation of the surface from the bottom of a 3 metre straight edge placed in any direction not to exceed 12 mm.
- This testing will be undertaken immediately prior to sealing or prior to agreed practical completion of any work component. This is a **WITNESS POINT**.

Compaction

General: Compact the stabilised layer over the entire area and depth so that the relative compaction determined by AS 1289.5.7.1 is not less than as detailed in *1141 Flexible pavement base and subbase*, *1112 Earthworks (Roadways)* or *1351 Stormwater drainage (Construction),* as appropriate.

Test method: To provide true relative compaction assessments the lots will be sampled and tested within the nominated Field Working Period to conform with AS 1289.5.7.1.

Wet Density: The maximum wet density (modified compaction) will be determined by sampling immediately after the determination of field density and testing to be undertaken within 2 hours of sampling. A determination of maximum wet density (modified compaction) representing the full layer depth is required for each sampling location when calculation of relative compaction is undertaken.

In situ dry density: The field density may be determined by in situ sand replacement testing or by single probe Nuclear Density Meter in direct transmission mode to conform with AS 1289.5.8.1.

4.7 JOINTS

Joint type

General: Joints comprise interfaces between work episodes that are separated in time by more than the nominal Field Working Period for the nominated stabilisation mix design.

- A longitudinal joint is considered to be a joint generally parallel to the road centreline.
- A transverse joint occurs when a length of work is terminated and extended at a later time after a period which exceeds the nominated Field Working Period.

Cutting back

General: Conform to the following:

- All longitudinal and transverse joints to be formed by cutting back into the previously stabilised and fully compacted sections.
- A minimum longitudinal overlap of mixing runs to be 75 mm.
- Transverse joints to be overlapped by a minimum of 2 m.
- Remix the material disturbed during cutting back at full depth and incorporate into the new work.
- No longitudinal joints to be allowed within 0.5 m of the centreline of a typical wheelpath.

Finish: The level and shape of the joints to be within the limits specified in **Limits and Tolerances**.

4.8 DIMENSIONS

Levels and surface trim

Surface levels: Conform to the following:

- The surface level after primary trimming + 30 mm and + 10 mm of the levels shown on the drawings.
- The surface level after secondary trimming + 15 mm and - 15 mm of the levels shown on the drawings.
- The pavement surface after secondary trimming and immediately prior to sealing to be of a quality such that deviation under a 3 metre straight edge does not exceed 12 mm.
- Ensure the final surface level is within ± 15 mm of the design levels in the event only a single trim is carried out.

Layer thickness

Layer thickness: Conform to the following:

- The final thickness of the stabilised layer at any point tolerance of + 20 mm and - 10 mm of the nominated layer thickness.
- The average thickness of the layer in a lot is determined from measurements of six randomly selected locations over any 200 m length of a lot and not less than that required to meet the specified final thickness tolerances after trimming.

- The layer thickness is measured at the edges of the stabilising run before compaction commences and measured relative to the finished design level.

Width

General: Conform to the following:

- The minimum width measured at any point of the stabilised layer must not be less than the specified width as shown in the drawings by more than 50 mm.
- Average width of the layer determined from measurements at 3 sites selected at random by the Superintendent over any 200 m length of a lot and not less than the specified width. This is a **WITNESS POINT**.

4.9 CURING

Method statement

Requirement: Submit to the Superintendent details of the proposed method of curing as part of the Work Plan. This is a **HOLD POINT**.

Curing method

Water curing: Protect the stabilised work against rapid drying out by keeping it continuously wet or damp during the period prior to the provision of a subsequent layer or the application of a prime or primer-seal. Water curing to consist of frequent light uniform spraying that will not produce significant run off or flooding on sections of the area. Avoid slurrying of the surface or leaching of the stabilising agent.

Curing Period: Under this Worksection provision for curing up to the period indicated in **Annexure A** is the responsibility of the Contractor at cost to the Contractor.

4.10 TRIAL SECTION OF STABILISED EARTHWORKS

General

Submit: Prior to the commencement of works submit a trial section of Stabilised earthworks to demonstrate the methods proposed to conform with this worksection. This is a **HOLD POINT**.

Trial section: This section is constructed so that it may be incorporated in the finished work. The length approximately 100 m.

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 base works. Demonstrate the methods proposed to be used for the construction of joints.

Deficient trial section: In the event of deficiencies in the stabilisation the trial section may not be approved. The method, equipment, materials and personnel will require to be reviewed and an explanation submitted. A further length of stabilisation may be requested. This is a **HOLD POINT**.

Requirement: Remove rejected works and make good any damage.

Removal: Remove the non conforming trial stabilised earthworks ensuring to prevent damage to the remaining stabilised earthworks and underlying materials.

Dispose: Dispose of the removed materials at an approved location.

Payment: Payment made for the stabilisation at the schedule rates for appropriate pay items, if it has been constructed without deficiencies and is incorporated into the work.

4.11 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause**
Quicklime		
- Available lime	> 85% Calcium Oxide content	**Quicklime**
- Slaking rate	Active Slaking time < twenty minutes, and temperature rise on slaking > 40^{o}C in 6 minutes (for an average of four samples).	**Quicklime**

Activity	**Limits/Tolerances**				**Worksection Clause**
- Particle distribution	Fraction passing AS Sieve:				**Quicklime**
	100%	for	13.2 mm	Sieve	
	96-100%	for	9.5 mm	Sieve	
	70-100%	for	4.75 mm	Sieve	
	0-90%	for	2.36 mm	Sieve	
Hydrated lime					
- Available lime	> 80% Calcium Hydroxide				**Hydrated lime**
- Particle size	< 2% residue on a 300 µm Sieve				**Hydrated lime**
Blended stabilising agents	**Blend percentages to not vary by more than ± 3% from those nominated in Annexure A**				**Blended stabilising agents**
Water					
- Chloride ion content	< 600 PPM Chloride ion				**Water**
- Sulphate ion content	< 400 PPM Sulphate ion				**Water**
- Undissolved solids	< 1 percent by mass of undissolved solids				**Water**
Application of stabilising agent					
- Spread rate or incorporation rate for in situ plant.	Actual spread rate shall be within ± 10% of the nominated rate				**Application of stabilising agent**
Trimming and compaction					
- Surface level	After primary trimming be within + 30 mm and +10 mm of levels shown on drawings After secondary trimming be within ± 15 mm of levels shown on drawings Final surface level ± 15 mm of design levels				**Dimensions**
- Shape	Not to deviate more than 12 mm under a 3 m straight edge immediately prior to first sealing				**Dimensions**
- Layer thickness	Final thickness of layers not to vary more than + 20 mm and - 10 mm of required thickness				**Dimensions**
Width					
- Width of stabilised layer	At any point, the width to be not less than 50 mm short of the width shown on the drawings with an average width always greater than that shown on the drawings				**Dimensions**
Joints					
- Longitudinal joint overlap	> 75 mm overlap of mixing runs				**Joints**
- Transverse joint overlap	> 2 m overlap of transverse joints				**Joints**
- Longitudinal joints	Not within 0.5 m of the centreline of a typical wheelpath				**Joints**

1121 OPEN DRAINS INCLUDING KERB AND CHANNEL (GUTTER)

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Provide all types of open drains including unlined and lined open drains, kerb and/or channel (gutter) and rock filled wire mattresses and gabions , as documented.

Performance

Requirements: Construct open drains to the specification and dimensions shown on the drawings.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0257 Landscape – roadways and street trees.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1102 Control of erosion and sedimentation (Construction).*
- *1352 Pipe drainage.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

AS 1141	Methods for sampling and testing aggregates
AS 1141.22-2008	Wet/dry strength variation
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
AS 1289.5.6.1-1998	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
AS 2758	Aggregates and rock for engineering purposes
AS 2758.4-2000	Aggregate for gabion baskets and wire mattresses
AS 2876-2000	Concrete kerbs and channels (gutters)—Manually or machine placed
AS/NZS 4534: 2006	Zinc and zinc/aluminium-alloy coatings on steel wire
Other publications	
AUSTROADS	
AGPT04B	Guide to pavement technology Part 4B - Asphalt
AGPT04G/09-2009	Guide to Pavement Technology Part4G- Geotextiles and geogrids
ASTM A975 – 2011	Standard specification for double-twisted hexagonal mesh gabions and revet mattresses (metallic coated steel wire or metallic coated steel wire and PVC coatings)

1.4 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definition apply:

- Kerb and channel (gutter): Includes all forms of concrete channels (gutters), dish drains, grated drains, and mountable median and barrier kerbing.

- Open drains: All drains other than pipe and box culverts and include catch drains, channels (gutters) and kerbs and channels (gutters).

1.5 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Authority Approvals			
- **Provision for traffic**	Submit Traffic Guidance Scheme for approval	2 weeks prior to site commencement	Superintendent
- **Temporary drainage**	Submit details of procedures/devices for approval	2 weeks prior to site commencement	Superintendent
MATERIALS			
Concrete	NATA compliance certificates for concrete and constituents	7 days prior to commencement on site	Superintendent
Joint Fillers and sealants	NATA compliance certificates for proposed joint filler	7 days prior to commencement on site	Superintendent
Proprietary Products	Submit proprietary products and manufacturers instructions	7 days prior to commencement on site	Superintendent
Wire mattresses	NATA compliance certificates for proposed wire mattress	7 days prior to commencement on site	Superintendent
Gabions	NATA compliance certificates for proposed Gabions	7 days prior to commencement on site	Superintendent
Rock fill material	NATA compliance certificates for proposed rock fill material	7 days prior to commencement on site	Superintendent
Geotextile	NATA compliance certificates for proposed Geotextile material	7 days prior to commencement on site	Superintendent
EXECUTION			
Open drains			
- **Excavation**	Approval to divert drain to avoid trees and/or rocks.	1 working day before set-out.	Superintendent.
- **Excavation**	Location and construction of drains to prevent salination	1 working day before set-out.	Superintendent.
Kerb and channel (gutter)			
- **Foundation**	Approval for shape and compaction of foundation material.	1 working day before forming	Superintendent
- **Construction**	Submit details of proposed method	14 days prior to commencement on site	Superintendent

Clause title/Item	Requirement	Notice for inspection	Release by
- **Trial section**	Demonstrate the capability of forming equipment	3 working days prior to commencement on site	Superintendent
Backfilling and reinstatement			
- **Gully pits**	Submit details for fixing to existing works for approval	1 working day before demolition	Superintendent
- **Gully pits**	Hydraulic capacity changes	7 days prior to commencement on site	Superintendent

WITNESS POINTS table – On-site activities

Clause title/Item	Requirement	Notice for inspection
EXECUTION		
Open drains		
- **Excavation**	Unsuitable material removal and disposal	Progressive
- **Excavation**	Spoil site locations	Prior to placement
- **Embankment**	Embankment compaction and revegetation	Progressive
- **Construction**	Grade and compaction of open drains	Progressive
- **Construction**	Proprietary items installed to manufacturers recommendations	Progressive
- **Types**	Maintain catch drains	Progressive
- **Types**	Construct minor diversion and contour drains, table drains, swales and depressed medians	Progressive
- **Types**	Channels preserving the existing stream bed	Progressive
Lining		
- **Concrete lining**	Instruction on weephole location.	1 working day before concreting.
- **Concrete lining**	Joints and tolerances	1 working day before concreting.
- **Stone pitching**	Bedding material and placement	1 working day before concreting.
Kerb and channel (gutter)		
- **Stormwater outlets**	Direction for other than flexible pipework	1 week before ordering
- **Vehicular or pedestrian access**	Laybacks confirmation	3 working days prior to works
Backfilling and reinstatement		
- **Backfill behind kerbs**	Backfilling timing, material and compaction	1 working day prior to backfilling
- **Pavement backfill**	Backfill adjacent new gutter material and location	3 working days prior to works
Rock filled wire mattresses and gabions – Completion	Inspection of rockfill material and filling method	On completion of works

2 PRE-CONSTRUCTION PLANNING

2.1 AUTHORITY APPROVALS

Provision for traffic

Documentation: Submit a Traffic Guidance Scheme for control of vehicular and pedestrian traffic to conform with *1101 Control of traffic*. Construct the works with the least possible obstruction to traffic, both vehicular and pedestrian. This is a **HOLD POINT**.

Temporary drainage

Documentation: Submit details of procedures/devices to maintain effective drainage of the works area during construction. This is a **HOLD POINT**.

Road opening permit

Application: Submit application to the relevant council for approval to undertake works to road or footpath. This application includes but is not limited to the following information:

- Ascertain the location of services.
- Opening and compaction specifications.

2.2 ESTABLISHMENT

Documentation

Survey control: Required for the following:

- Mapping and pegging the drainage system.
- Locating components.

3 MATERIALS

3.1 CONCRETE

General

Standard: To AS 2876

Specification: Concrete properties and delivery, placing, compaction, finishing, curing and protection to conform with *0319 Minor concrete works*.

Documentation: Submit NATA registered Compliance Certificates for all constituents of the mix as verification of the mix suitability. This is a **HOLD POINT**.

3.2 JOINT FILLERS AND SEALANTS

General

Documentation: Submit preformed joint filler proposed for use at least 7 days prior to use in the works. Supply NATA registered compliance certificates. This is a **HOLD POINT**.

3.3 PROPRIETARY PRODUCTS

General

Approval: Use only proprietary products to conform with the manufacturers instructions. This is a **HOLD POINT**.

3.4 WIRE MATTRESSES

General

Standard: To ASTM A975.

Submit: For approval the type of mattress proposed and a schedule of locations. This is a **HOLD POINT**.

Dimension: Unless otherwise shown on the drawings. 6 m $\times$ 2 m $\times$ 230 mm. Cut to suit areas if required.

Diaphragms: Divide mattress into cells not exceeding 1 m centres.

Forming diaphragms: Folding the base layer of a mattress, provided that the bottom of each of the diaphragm halves is securely tied together so that the transmission of tensile forces in the mesh of the base layer is not impeded.

Mattress material: Flexible woven heavily galvanised wire to ASTM A975.

Mesh size: 60 x 80 mm.

Galvanizing: Coating mass for round wire Class W10 to AS/NZS 4534. 95% zinc 5% aluminium mischmetal alloy.

Body wire: 2.0 mm minimum core diameter.

PVC wire coating: 0.4 mm required as shown on the drawings.

Selvedge wire: 2.4 mm minimum core diameter for mattresses less then 350 mm thick. Mattresses between 350 mm and 550 mm minimum diameter of mesh must be 2.4 mm and minimum galvanized wire 3.0 mm.

Selvedge properties: Ensure the mesh does not unravel and that the strength of the connection between the selvedge wire and the mesh ≥ the breaking strength of the mesh.

Lacing wire: 2.2 mm minimum core diameter.

3.5 GABIONS

General

Standard: To ASTM A975.

Submit: For approval the type of mattress proposed and a schedule of locations. This is a **HOLD POINT**.

Dimension: As shown on the drawings.

Diaphragms: Divide gabion into cells not greater than the width of the gabion plus 100 mm.

Material: Flexible woven heavily galvanised wire to ASTM A975.

Mesh size: 80 x 100 mm nominal.

Galvanizing: Coating mass for round wire Class W10 to AS/NZS 4534. 95% zinc 5% aluminium mischmetal alloy.

Body wire: 2.7 mm minimum core diameter.

PVC wire coating: 0.4 mm required as shown on the drawings.

Selvedge wire: 3.4 mm minimum core diameter.

Selvedge properties: Ensure the mesh does not unravel and that the strength of the connection between the selvedge wire and the mesh ≥ the breaking strength of the mesh.

Lacing wire: 2.2 mm minimum core diameter.

3.6 LACING AND CONNECTING WIRE

General

Standard: To ASTM A975.

Minimum diameter: 2.2 mm

Alternative fasteners: ‘C’ clips conforming with ASTM A975 may be used if approved.

3.7 ROCK FILL MATERIAL

General

Standard: To AS 2758.4.

Rock quality: Clean, dense, durable hard rock.

Wet strength: > 100 kN to AS 1141.22.

Wet / dry strength variation: < 35% to AS 1141.22.

Submit: For approval rock material and NATA certificates of compliance of the proposed rock fill material. This is a **HOLD POINT**.

Particle sizes for wire mattresses: Between 75 mm and two-thirds of the mattress thickness, or 250 mm, whichever is the lesser.

Particle size for gabions: Between 100 mm and 250 mm and preferably not greater than 200 mm.

3.8 GEOTEXTILE

General

Submit: For approval the proposed geotextile material and NATA certificates of compliance. Submit a sample of the fabric, the manufacturer information and installation instructions. This is a **HOLD POINT**.

Type: As shown on the drawings.

Properties

Classification: Properties, functions, design and construction requirements to AUSTROADS AGPT04B/09.

Specification: Material type and minimum mass requirements as shown on the drawings.

Quality: Free of any flaws, stabilised against UV radiation, rot proof, chemically stable, low water absorbency. Filaments must resist delamination and maintain their relative dimensional stability.

Geotextile strength and filtration: Require a knowledge of the site soils including gradings, plasticity and strength, protection of the layers supporting the drains.

Robustness and strength: Conform to the following:

- Conform to the classifications for robustness and strength cited in AGPT04G/09.
- Select material based on tests and subgrade conditions for the relevant location/function.

Delivery and storage

Delivery: At least 14 days prior to commencement of installation.

Storage: Under protective cover or wrapped with a waterproof, opaque UV protective sheeting to avoid any damage prior to installation. Store to conform to manufacturers recommendations.

Damage: Must not be stored directly on the ground or in any manner that adversely effect the material by heat, dirt or damage.

Label: Ensure the geotextile material is clearly labelled showing manufacturer, type and batch number.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 OPEN DRAINS

Excavation

Clear: To *1111 Clearing and grubbing*, strip topsoil and any unsuitable material.

Trees and rock outcrops: Approval to divert the drain where trees marked for preservation or rock outcrops occur. This is a **HOLD POINT**.

Control of erosion: Conform to *1102 Control of erosion and sedimentation (Construction).*

Salinity prevention: Locate and construct open drains to avoid recharging groundwater, a shallow water table and salinity degradation of adjacent land. This is a **HOLD POINT**.

Excavate: To the dimensions shown on the drawings or where not shown to minimum depth of 300 mm and minimum waterway area 0.2 m^2.

Cross section: V-shaped or trapezoidal unless otherwise shown on drawings.

Batter slope: Not steeper than 2H:1V.

Unsuitable material: Notify the Superintendent of any unsuitable material and seek a direction for removal. Dispose of the unsuitable material as approved or directed. Replace unsuitable material with acceptable cut or other material. This is a **WITNESS POINT**.

Surplus material: Use the excavated material in the works or remove to spoil stockpiles as directed. This is a **WITNESS POINT**.

Waterways outside the site: Do not disturb with activities associated with the work.

Embankment

Construct: In layers maximum 200 mm in depth and compact in layers of maximum depth 150 mm.

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 0257 *Landscape – roadways and street trees.*

Backfill: To excavation below the level of the natural channel with suitable material. Compact to a density equal to and compatible with that existing naturally. This is a **WITNESS POINT**.

Construction

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.

Trimming: To a uniform surface free of irregularities and compact any surface to be lined to 90% relative compaction.

Open drains: Grade to ensure free flow of water and minimum grade of 0.5%. This is a **WITNESS POINT**.

Types

Provide catch drains: Before construction of the adjacent roadway.

Location of catch drains: > 2 m above the tops of cuttings or > 2 m along the toes of embankments.

Maintain: The fall of the catch drains unless otherwise approved. This is a **WITNESS POINT**.

Minor diversion and contour drains: Provide the same capacity as the nearest pipe culvert on the line of the drain.

Table drains, swales and depressed medians: Construct as part of earthworks, with the line and level as shown on the drawings or from calculations. This is a **WITNESS POINT**.

Channels: Excavate inlet, outlet and diversion channels as shown on the drawings and, unless noted otherwise, extend to join the existing stream bed, avoiding disturbance in stream flow. Preserve the existing stream bed as far as possible outside the limits of the excavation. This is a **WITNESS POINT**.

4.3 LINING

General

Lining choice: Unless otherwise shown on the drawings use the following linings:

- Organic fibre mat and vegetation where the longitudinal grade of the completed drain lies between 1% and 5% inclusive; or
- Concrete where the longitudinal grade of the completed drain is less than 1% or greater than 5%.

Timing: Within 7 days of shaping and compacting the foundation.

Proprietary Items: Install approval proprietary items to conform to the manufacturer's instructions. This is a **WITNESS POINT**.

Organic fibre mat and vegetation

Conform to: *0257 Landscape – roadways and street trees.*

Concrete lining

Concrete: Minimum compacted thickness 100 mm measured at right angles to the surface of the lining.

Colour: To match that of the surrounding materials or as directed.

Method: Cast-in-situ or sprayed concrete to conform with *0319 Minor concrete works*.

Weepholes: Provide weepholes in locations shown on the drawings or at 2 m spacing in non-horizontal elements or as directed. This is a **WITNESS POINT**.

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: Within ± 10 mm of design levels.
- Surface deviation: Not more that 5 mm from a 3 m straight edge parallel to the direction of flow, except at kerb laybacks, grade changes or curves, or at gully pits requiring channel depression.

Contraction joints: Conform to the following:

- Width: 5 mm minimum.
- Depth: 20 mm minimum.
- Intervals: Every 3 m of lining.

Expansion joints: Conform to the following:

- Width: 15 mm.

- Depth: Full thickness of the concrete lining.
- Intervals: 15 m maximum.
- Material: Approved preformed jointing material. This is a **WITNESS POINT**.

Stone pitching

Material: Sound durable rock not less than 100 mm thick, properly bedded on approved loam or sand and mortared to present a uniform surface.

The exposed surface of each stone: Approximately flat and not less than 0.05 m^2 in area.

Spaces between adjacent stones or blocks: 20 mm maximum width. This is a **WITNESS POINT**.

Batter drains

Material: Half round steel pipes or precast nestable concrete units as shown on the drawings.

Install: The units in a carefully excavated and template controlled trench to form an even top edge +0 mm to –50 mm from the batter line at the underside of topsoil.

Backfill and compact: Backfill over-excavation and undulations in the batter line. Compact both sides of the drain over the full length to form a firm shoulder against the top edge of the batter drain.

Taper topsoil: Over a width of 1 m to zero thickness at the rim of the drain.

Turf: Both sides of the drain for a minimum width of 600 mm to conform with *0257 Landscape – roadways and street trees*.

4.4 KERB AND CHANNEL (GUTTER)

Foundation

Shape and compaction: Before placing any kerb and/or channel (gutter), shape and compact the foundation material to an approved firm base.

Relative compaction: To AS 2876 except where placed on pavement courses, then to the requirements of the respective pavement course. This is a **HOLD POINT**.

Construction

Construct: Kerb and/or channel (gutters) in fixed forms, by extrusion or by slip forming to AS 2876.
Submit: Details of method proposed including type of extrusion or slipform, concrete properties, equipment and finish. This is a **HOLD POINT**.

Trial section

Trial section: Provide a trial section to demonstrate the Contractors capability of forming equipment. This is a **HOLD POINT**.

Finish

Finish true to line: The top and face of the finished kerb and channel.

Top surface: Uniform width, free from humps, sags and other irregularities.

Type: Steel float finish or as otherwise shown on drawings.

Tolerances

Finished levels of channel / gutter surface: Within ± 10 mm of design levels.

Surface deviation of kerb face and channel (gutter) surface: ± 5 mm from the edge of a 3 m straight edge, except at kerb laybacks, grade changes or curves, or at gully pits requiring channel/gutter depression.

Joints

Contraction joints: Unless shown otherwise on the drawings, conform to the following:

- Width: 5 mm minimum.
- Depth: 20 mm.
- Intervals: Every 3 m of channel / gutter length for a minimum of 50% of cross sectional area of concrete.
- Tooling: 20 mm in depth to form a neat groove of 5 mm minimum width.

Expansion joints: Provide where the channel/gutter abuts against pits, retaining walls, overbridges and at both sides of kerb laybacks for vehicular or pedestrian access. Unless shown otherwise on the drawings, conform to the following:

- Width: 15 mm.
- Depth: Full depth of kerb and channel (gutter).

- Maximum intervals: 15 m.

Joints adjacent to concrete pavement: If kerbs and/or channel / gutters are cast adjacent to a concrete pavement, continue the contraction, construction and expansion joints documented for the concrete base across the kerb and/or channel (gutter).

Stormwater outlets

General: Reconnect and extend all existing house stormwater outlets through the kerb to match the existing type and size of pipe as shown on the drawings.

Pipes: Conform to *1352 Pipe drainage*. This is a **WITNESS POINT**.

Vehicular or pedestrian access

Barrier kerb: Discontinue opposite all driveways as shown on the drawings or as directed.

Kerb laybacks: As shown on the drawings where the barrier kerb is discontinued.

Footpath crossovers: Meet the laybacks as shown on the drawings or reinstate to match existing materials. This is a **WITNESS POINT**.

4.5 BACKFILLING AND REINSTATEMENT

Backfill behind kerbs

Timing: Not earlier than 3 days after concreting, backfill and reinstate the spaces on both sides of the kerb and/or channel (gutter) to conform with the drawings, or as directed.

Material: Granular material, free of organic material, clay and rock in excess of 50 mm diameter, or approved material.

Layers: Compact in layers not greater than 150 mm thick.

Relative compaction: 95% when tested in conformance with AS 1289.5.4.1 for standard compactive effort or density index 70 if non-cohesive material to AS 1289.5.6.1.

Surface treatment: Free draining and free from undulations and trip hazards. This is a **WITNESS POINT**.

Pavement backfill

Backfill: Material adjacent to the new channel (gutter) as shown on the drawings or as directed. This is a **WITNESS POINT**.

Gully pits

Reconstruct: The top of gully pits or adjust precast units to suit new kerb and channel (gutter) profile to conform with *0319 Minor concrete works*.

Adjustment: Demolish and reconstruct gully pits to suit new line or level of the kerb and channel (gutter) to match the design standard of the existing gully pit.

Fixing to existing works: Fix new wall sections in concrete or brick securely to the retained wall section. Submit details of the proposed procedure for approval. This is a **HOLD POINT**.

Hydraulic capacity: Retain or improve the capacity of the original gully pit. Cavity shapes to be regular and oriented so as not to impede flow into and out of the pit.

Submit: Provide sketches and/or calculations relevant to such hydraulic capacity. This is a **HOLD POINT**.

4.6 ROCK FILLED WIRE MATTRESSES AND GABIONS

General

Location: As shown on the drawings.

Foundations

Finished level of excavation: Prior to installation of rock filled wire mattress or gabion excavate so the mattresses finish flush with the surrounding ground.

Shape and compaction: Not less than 95 % for standard compactive effort to AS 1289.5.4.1. to form a uniform channel cross-section prior to installation of mattresses.

Geotextile: Before laying out the wire mattresses or gabions, place geotextile between the wire cage and the material being protected as shown on the drawings.

Assembly

Prior to assembly: Open the wire mesh out flat on the ground and stretch it to remove all kinks and bends.

Gabion boxes: Individually assemble by raising the sides, ends and diaphragms, ensure all creases are in the correct position and that all four sides and the diaphragms are even.

Lace: The four corners first and then the edges of internal diaphragms to the sides.

Lacing and twisting: Commence the lacing by twisting the end of the lacing wire around the selvedge(s) then pass it around the two edges being joined using alternate single and double loops through each mesh in turn and tie it off securely at the bottom.

Ends: Turn the ends of all lacing wires to the inside of the box on completion of each lacing operation.

Erection

Conform to the following:

- Only assembled boxes, or groups of boxes must be positioned in the structure.
- Secure the end to either the completed work or by galvanised star pickets driven into the ground at 1 m spacing.
- Firmly embed the star pickets into the ground by minimum 900 mm.
- Star pickets to be at lest the height of the box.
- Place boxes in the structure lacing securely the proceeding one along all common corners and diaphragms.

Stretching for gabion boxes: Using a pull lift of at least 1 tonne capacity, firmly secured to the free end of the assembled gabion boxes. Whilst under tension, securely lace the gabion boxes along all edges and at diaphragm points to al adjacent boxes.

Mattresses: Adjust the position of the diaphragms so that the sides hinge up on the thicker wire woven in the mesh.

Filling

Gabion boxes: Conform to the following:

- Fill whilst the gabion boxes are under tension.
- Place the rocks at the front face and other exposed faces by hand to produce a neat face free of excessive bulges, depressions and voids.
- Internal bracing wires 4 per m^3 at 330 mm centres to prevent distortion.
- Face bracing wires 4 per m^2 of face.
- Mechanical filling equipment may be used with caution to protect any PVC or galvanized coatings from abrasion.
- Release the tension on the gabion boxes only when fully laced so as to prevent any slackening.

Mattresses:

- Mechanical filling equipment may be used with caution to protect any PVC or galvanized coatings from abrasion.
- Redistribute the filling materials by hand to ensure that all diaphragm compartments are fully filled to produce a neat and level top surface.
- Overfill by 25 to 50 mm to allow for subsequent settlement.

Final lacing

Close and lace lids: As soon as practicable after filling particularly if there is a storm or flood expected.

Stretch lids tightly over the filling and lace down securely.

Completion

Inspection: Inspection of rock fill material and filling method. This is a **WITNESS POINT**.

4.7 LIMITS AND TOLERANCES

The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause/subclause**
Materials		
Wire mattresses	Diaphragm cells at 1 m centres Mesh size 60 x 80 mm	**Wire mattresses**

Activity	Limits/Tolerances	Worksection Clause/subclause
	Galvanising 95% zinc, 5% aluminium	
Gabions	Diaphragms < width plus 100 mm Mesh size 80 x 100 mm Galvanising 95% zinc, 5% aluminium	**Gabions**
Rock fill material	Wet strength > 10 kN Wet/dry strength < 35% Particle size for mattresses between 75 mm and 150 mm Particle size for gabions > 100 mm < 250 mm	**Rock fill material**
Unlined open drains		
Design	Grade > 0.5% Depth > 300 mm Waterway Area > 0.2 m^2	**Open drains – Construction**
Catch Drain Location	> 2 m from top of cuttings or toes of embankments	**Open drains - Types**
	Compaction > 95% (standard compaction)	**Open drains - Embankment**
Lining		
	1% to 5% use organic mat or vegetation Less 1% greater than 5% use concrete lining	**Lining**
	Concrete 100 mm thick measured at right angles	**Concrete lining**
Contraction joints	Width: 5 mm minimum Depth: 20 mm minimum Intervals: every 3 m of lining Tooling: 20 mm in depth groove 5 mm minimum width	**Concrete lining**
Expansion joints	Width: 15 mm minimum Depth: full thickness of the concrete lining Intervals: 15 m maximum	**Concrete lining**
Stone pitching	Rock > 100 mm thick Exposed surface > 0.05 m^2 Spaces < 20 mm maximum width	**Stone pitching**
Batter drains	Install 0 to 50 mm below batter line Top soil: thickness 1 m to 1 at rim of drain	**Batter drains**
- Compaction of Foundation	> 95% (standard compaction)	**Lined open drains**
- Level of lining surface	Level ± 10 mm of design level	**Concrete lining**
- Surface uniformity	Deviation lining surface from 3 m straight edge ≤ 5 mm	**Concrete lining**
Kerb and channel		
Kerb and channel (gutter)		**Execution**
- Relative compaction of foundation	To AS 2876	**Foundation**
- Finished levels of channel (gutter) surface	Level ± 10 mm of design level	**Kerb and channel (gutter) -Tolerances**
- Surface deviation of kerb face and channel (gutter) surface	± 5 mm from 3 m straight edge	**Kerb and channel (gutter) -Tolerances**
- Contraction joints	Width: ≥ 5 mm Depth: 20 mm	**Kerb and channel (gutter) - Joints**

Activity	**Limits/Tolerances**	**Worksection Clause/subclause**
	Intervals every 3 m of channel/gutter length for a minimum of 50% of CS area of concrete	
- Expansion joint interval	≤ 15 m Width: 15 mm Depth: Full depth of kerb and channel (gutter)	**Kerb and channel (gutter) - Joints**
Backfill behind kerb		
- Layer thickness	≤ 150 mm	**Backfilling and reinstatement**
- Relative compaction	95% (standard compaction)	**Backfilling and reinstatement**
Rock filled wire mattresses and gabions		
- Star pickets for ties	Depth in ground > 900 mm Spacing < 1 m	**Rock filled wire mattresses and gabions - Erection**
Bracing wires	Internal: 4 per m^3 at 330 mm centres Face: 4 per m^2 of face	**Rock filled wire mattresses and gabions - Filling**
Wire mattress filling	Over fill mattresses by 25 to 50 mm	**Rock filled wire mattresses and gabions - Filling**

1122 KERB AND CHANNEL (GUTTER) REPLACEMENT

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Remove and dispose of existing kerb and channel (gutter) and provide new kerb and channel (gutter) and associated works, as documented.
Existing works: Conform to the position of existing works.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1352 Pipe drainage.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

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
AS 2876-2000	Concrete kerbs and channels (gutters)—Manually or machine placed

1.4 STANDARDS

General
Standard: To AS 2876.

1.5 INTERPRETATION

Definitions
General: For the purposes of this worksection the following definition apply:
Kerb and channel (gutter): Includes all forms of concrete channels (gutters), dish drains and mountable median and barrier kerbing.

1.6 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.
Documents
Submit the following for approval:
- Design:
  - . Temporary works.
  - . Traffic guidance scheme
  - . Temporary drainage plan
  - . Road opening permit

- Drawings:
  . Location of driveways and laybacks
  . Gully pit hydraulic capacity.
- Execution details: Trial section.

Technical data:

  . Components: Concrete, material for backfill, pipes as specified, precast products.
  . Compaction data on earth materials.
  . Calculations: Proposals for temporary drainage and changed hydraulic capacity.
  . Technical data: Survey data for construction to tolerances.

- Type test results: Data on extrusion/slip forming performance as required.

1.7 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title / Item	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Authority Approvals			
- **Provision for traffic**	Submit Traffic Guidance Scheme for approval	2 weeks prior to site commencement	Superintendent
- **Temporary drainage**	Submit details of procedures/devices for approval	2 weeks prior to site commencement	Superintendent
MATERIALS			
Concrete	NATA compliance certificates for concrete and constituents	7 days prior to commencement on site	Superintendent
Joint Fillers and sealants	NATA compliance certificates for proposed joint filler	7 days prior to commencement on site	Superintendent
Proprietary Products	Submit proprietary products and manufacturers instructions	7 days prior to commencement on site	Superintendent
EXECUTION			
Removal and disposal, Disposal	Approval for disposal site for excavated material	2 working days prior to excavation	Superintendent
Foundation	Approval for shape and compaction of foundation material.	1 working day before forming	Superintendent
Kerb and channel (gutter)			
- **Method**	Submit details of proposed method	14 days prior to commencement on site	Superintendent
- **Trial section**	Demonstrate the capability of forming equipment	3 working days prior to commencement on site	Superintendent
Backfilling and reinstatement			
- **Gully pits**	Submit details for fixing to existing works for approval	1 working day before demolition	Superintendent

Clause title / Item	Requirement	Notice for inspection	Release by
- **Gully pits**	Hydraulic capacity changes	7 days prior to commencement on site	Superintendent

WITNESS POINTS table – On-site activities

Clause title / Item	Requirement	Notice for inspection
EXECUTION		
Removal and disposal		
- **Footpath and road pavement**	Assess preconstruction condition of footpath and road pavement	3 working days prior
- **Footpath and road pavement**	Location of saw-cutting of existing redundant kerb and gutter	1 working day before setting out
- **Footpath and road pavement**	Restoration of footpath to pre-construction condition	Prior to completion of works
- **Services**	Reinstate pipes and services	1 working day before completing reinstatement
Kerb and channel (gutter)		
- **Stormwater outlets**	Direction for other than flexible pipework	1 week before ordering
- **Vehicular or pedestrian access**	Laybacks confirmation	3 working days prior to works
Backfilling and reinstatement		
- **Backfill behind kerbs**	Backfilling timing, material and compaction	1 working day prior to backfilling
- **Pavement backfill**	Backfill adjacent new gutter material and location	3 working days prior to works

2 PRE-CONSTRUCTION PLANNING

2.1 AUTHORITY APPROVALS

Provision for traffic

Documentation: Submit a Traffic Guidance Scheme for control of vehicular and pedestrian traffic to conform with *1101 Control of traffic*. Construct the works with the least possible obstruction to traffic, both vehicular and pedestrian. This is a **HOLD POINT**.

Temporary drainage

Documentation: Submit details of procedures/devices to maintain effective drainage of the works area during construction. This is a **HOLD POINT**.

Road opening permit

Application: Submit application to the relevant council for approval to undertake works to road or footpath. This application includes but is not limited to the following information:

- Ascertain the location of services.
- Opening and compaction specifications.

3 MATERIALS

3.1 CONCRETE

General

Standard: To AS 2876.

Specification: Concrete properties and delivery, placing, compaction, finishing, curing and protection to conform with *0319 Minor concrete works*.

Documentation: Submit NATA registered Compliance Certificates for all constituents of the mix as verification of the mix suitability. This is a **HOLD POINT**.

3.2 JOINT FILLERS AND SEALANTS

General

Documentation: Submit preformed joint filler proposed for use at least 7 days prior to use in the works. Supply NATA registered compliance certificates. This is a **HOLD POINT**.

3.3 PROPRIETARY PRODUCTS

General

Approval: Use only proprietary products to conform with the manufacturers instructions. This is a **HOLD POINT**.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 REMOVAL AND DISPOSAL

Footpath and road pavement

Pre-construction Inspection: Assess the condition of the footpath, driveways and road pavement surrounding the area of kerb and channel (gutter) involved in the works. This is a **WITNESS POINT**.

Saw-cut: Along the footpath, driveways and road pavement where shown on the drawings or as directed. Minimise damage and disturbance to the remainder of the footpath and road pavement. This is a **WITNESS POINT**.

Damage to footpath: Reinstate footpath, driveways and/or road pavement damaged or disturbed by the work to their approved pre-construction condition. This is a **WITNESS POINT**.

Excavation

Extent: Demolish and remove the existing redundant kerb and channel (gutter) and excavate to the level shown on the drawings.

Method: Conform to *0319 Minor concrete works*.

Services

Existing services: Carefully remove kerb and channel (gutter) so as to prevent damage to existing services, including existing stormwater drainage pipes which discharge into the channel / gutter.

Damaged services: Restore stormwater drainage pipes and/or other services damaged by the works to their pre-construction condition. This is a **WITNESS POINT**.

Disposal

General: Remove excavated material and demolished kerb and channel (gutter) from site and legally dispose of to an approved site. This is a **HOLD POINT**.

4.3 FOUNDATION

General

Shape and Compaction: Before placing any kerb and/or channel (gutter), shape and compact the foundation material to an approved firm base.

Relative compaction: To AS 2876 except where placed on pavement courses, then to the requirements of the respective pavement course. This is a **HOLD POINT**.

4.4 KERB AND CHANNEL (GUTTER)

Method

Construct: Kerb and/or channel (gutters) in fixed forms, by extrusion or by slip forming to AS 2876.
Submit: Details of method proposed including type of extrusion or slipform, concrete properties, equipment and finish. This is a **HOLD POINT**.

Trial section

Trial section: Provide a trial section to demonstrate the Contractors capability of forming equipment. This is a **HOLD POINT**.

Finish

Finish true to line: The top and face of the finished kerb and channel.

Top surface: Uniform width, free from humps, sags and other irregularities.

Type: Steel float finish or as otherwise shown on drawings.

Tolerances

Finished levels of channel/gutter surface: Within ± 10 mm of design levels.

Surface deviation of kerb face and channel (gutter) surface: ± 5 mm from the edge of a 3 m straight edge, except at kerb laybacks, grade changes or curves, or at gully pits requiring channel/gutter depression.

Joints

Contraction joints: Unless shown otherwise on the drawings, conform to the following:

- Width: 5 mm minimum.
- Depth: 20 mm.
- Intervals: Every 3 m of channel/gutter length for a minimum of 50% of cross sectional area of concrete.
- Tooling: 20 mm in depth to form a neat groove of 5 mm minimum width.

Expansion joints: Provide where the channel/gutter abuts against pits, retaining walls, overbridges and at both sides of kerb laybacks for vehicular or pedestrian access. Unless shown otherwise on the drawings, conform to the following:

- Width: 15 mm.
- Depth: Full depth of kerb and channel (gutter).
- Maximum intervals: 15 m.

Joints adjacent to concrete pavement: If kerbs and/or channel / gutters are cast adjacent to a concrete pavement, continue the contraction, construction and expansion joints documented for the concrete base across the kerb and/or channel (gutter).

Stormwater outlets

General: Reconnect and extend all existing house stormwater outlets through the kerb to match the existing type and size of pipe as shown on the drawings.

Pipes: Conform to *1352 Pipe drainage*. This is a **WITNESS POINT**.

Vehicular or pedestrian access

Barrier kerb: Discontinue opposite all driveways as shown on the drawings or as directed.

Kerb laybacks: As shown on the drawings where the barrier kerb is discontinued.

Footpath crossovers: Meet the laybacks as shown on the drawings or reinstate to match existing materials. This is a **WITNESS POINT**.

4.5 BACKFILLING AND REINSTATEMENT

Backfill behind kerbs

Timing: Not earlier than 3 days after concreting, backfill and reinstate the spaces on both sides of the kerb and/or channel (gutter) to conform with the drawings, or as directed.

Material: Granular material, free of organic material, clay and rock in excess of 50 mm diameter, or approved material.

Layers: Compact in layers not greater than 150 mm thick.

Relative compaction: 95% when tested to conform with AS 1289.5.4.1 for standard compactive effort.

Surface treatment: Free draining and free from undulations and trip hazards. This is a **WITNESS POINT**.

Pavement backfill

Backfill: Material adjacent to the new channel (gutter) as shown on the drawings or as directed. This is a **WITNESS POINT**.

Gully pits

Reconstruct: The top of gully pits or adjust precast units to suit new kerb and channel (gutter) profile to conform with *0319 Minor concrete works*.

Adjustment: Demolish and reconstruct gully pits to suit new line or level of the kerb and channel (gutter) to match the design standard of the existing gully pit.

Fixing to existing works: Fix new wall sections in concrete or brick securely to the retained wall section. Submit details of the proposed procedure for approval. This is a **HOLD POINT**.

Hydraulic capacity: Retain or improve the capacity of the original gully pit. Cavity shapes to be regular and oriented so as not to impede flow into and out of the pit.

Submit: Provide sketches and/or calculations relevant to such hydraulic capacity. This is a **HOLD POINT**.

4.6 LIMITS AND TOLERANCES

The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause/ subclause**
Kerb and channel (gutter)		**Execution**
- Relative compaction of foundation	To AS 2876	**Foundation**
- Finished levels of channel (gutter) surface	Level ± 10 mm of design level	**Kerb and channel (gutter) - Tolerances**
- Surface deviation of kerb face and channel (gutter) surface	± 5 mm from 3 m straight edge	**Kerb and channel (gutter) - Tolerances**
- Contraction joints	Width: ≥ 5 mm Depth: 20 mm Intervals every 3 m of channel / gutter length for a minimum of 50% of CS area of concrete Tooling: 20 mm in depth to form a neat groove of 5 mm minimum width.	**Kerb and channel (gutter) - Joints**
- Expansion joint interval	≤ 15 m Width: 15 mm Depth: full depth of kerb and channel (gutter)	**Kerb and channel (gutter) - Joints**
Backfill behind kerb		
- Layer thickness	≤ 150 mm	**Backfilling and reinstatement**
- Relative compaction	95% (standard compaction)	**Backfilling and reinstatement**

1141 FLEXIBLE PAVEMENT BASE AND SUBBASE

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Provide flexible pavement base and subbase, including supply, spreading, compaction and trimming as documented.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*
- *1113 Stabilisation.*
- *1143 Sprayed bituminous surfacing.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

AS 1141	Methods for sampling and testing aggregates
AS 1141.3.1-2012	Sampling - aggregates
AS 1141.14-2007	Particle shape, by proportional calliper
AS 1141.22-2008	Wet/dry strength variation
AS 1141.23-2009	Los Angeles value
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 1289.5.1.1-2003	Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort
AS 1289.5.2.1-2003	Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using modified compactive effort
AS 1289.5.3.2-2004	Soil compaction and density tests - Determination of the field dry density of a soil - Sand replacement method using a sand pouring can, with or without a volume displacer
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 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 1289.6.1.1-1998	Soil strength and consolidation tests - Determination of the California Bearing Ratio of a soil - Standard laboratory method for a remoulded specimen
AS 5101.4-2008	Methods for preparation and testing of stabilized materials – Unconfined compressive strength of compacted materials

Other publications

ARRB

ARRB Group-2005	Sealed local roads manual – Guidelines to good practice: Design, construction, maintenance and rehabilitation of pavements.

AUSTROADS

AGPT04A-2008	Guide to pavement technology Part 4A: Granular base and subbase materials
AGPT04D-2006	Guide to pavement technology Part 4D: Stabilised materials

RMS Test Methods

T130-2010	Dry density/moisture relationship of road construction materials (blended in the laboratory with cementitious binders).
T171-2010	Modified Texas triaxial compression test pavement materials

1.4 INTERPRETATIONS

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- CBR: California bearing ratio.
- CRB: Crushed rock base.
- CRS: Crushed rock subbase.
- NATA: National Association of Testing Authorities.
- NGB: Natural gravel base.
- NGS: Natural gravel subbase.
- RCCB: Recycled crushed concrete base.
- RCCS: Recycled crushed concrete subbase.
- UCS: Unconfined compressive strength.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Base: Layer(s) of material forming the uppermost structural element of a pavement and on which the surfacing may be placed.
- 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 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.
- Subbase: Material laid on the subgrade (or selected material), below the base, either for the purpose of making up additional pavement thickness, to prevent intrusion of the subgrade into the base, or to provide a working platform.
- Unbound material: A granular material with no significant capacity to resist tensile stresses.

1.5 HOLD POINTS AND WITNESS POINTS

Approval

Submissions: To the Superintendent's approval.

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINTS table** and the **WITNESS POINTS table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Activity plan			
Pavement plan	Prepare and submit pavement plan	4 weeks before commencing site work	Superintendent
Design and control of base and subbase materials			
Proposed materials	Prepare and submit schedule detailing material properties including NATA test results	2 weeks before ordering materials	Superintendent
Bound or modified materials	Complete and submit Annexure A of *1113 Stabilisation*	2 weeks before ordering materials	Superintendent
Variations to approved materials	Submit details of changes to approved materials	1 week before use in works	Superintendent
Inspection, sampling and testing			
Notification	Written notice for testing times and provide test results	3 working days prior to testing or inspection	Superintendent
MATERIALS			
Modified Texas triaxial classification			
Alternative materials	Submit details of alternative material including test results	2 weeks before ordering materials	Superintendent
Lime modified base and subbase materials			
Lime modification	Submit proposals to modify materials	2 weeks before placing	Superintendent
In-situ lime modification	Submit proposals for the in-situ use of hydrated lime or quicklime	2 weeks before activity	Superintendent
EXECUTION			
Spreading			
Underlying layer	Inspection to determine suitability of underlying layer	1 working day before placing next layer	Superintendent
Temperature	Submit proposal to proceed outside allowable conditions	1 working day before placement	Superintendent
Trimming, compaction and curing			
Plant	Submit details of proposed hand operated plant	1 week before use	Superintendent
Subsequent layers	Submit completed test results of previous layer	1 working day before placing next layer	Superintendent
Acceptance of compaction			
Lots for acceptance	Submit compaction test results	1 working day after testing	Superintendent
Compaction	Submit evidence that	1 working day after test	Superintendent

Clause title/Item	Requirement	Notice for inspection	Release by
requirements and acceptance	compaction is within tolerances	results	
Acceptance of dimensions and levels			
General	Submit lot survey reports	1 working day before next activity	Superintendent
Corrective action - rejected unbound layers	Submit proposal for corrective action	1 working day before next activity	Superintendent
Corrective action - rejected bound layers	Submit proposal for corrective action	3 working days before next activity	Superintendent
Removal and replacement of rejected courses			
Extent of removal	Submit proposal to remove less than full width	1 working day before next activity	Superintendent
Prior to replacement	Give notice for inspection of underlying material	1 working day before next activity	Superintendent
Replacement	Submit proposed methods to make good	1 working day before next activity	Superintendent
Maintenance before completion of wearing surface			
Pavement condition before primerseal	Dry-back, re-prepare and give notice for inspection	3 working days before next activity	Superintendent
Opening bound pavement to traffic	Give notice of proposed opening to traffic	3 working days before proposed opening	Superintendent

WITNESS POINTS table

Clause title/Item	Requirement	Notice for inspection
MATERIALS		
Bound base and subbase materials		
In-situ stabilisation	Give notice of proposal to use mobile plant for in-situ stabilisation at site	2 weeks before activity
EXECUTION		
Delivery		
Delivered materials	Give notice for inspection	Progressive
Delivery of modified or bound materials	Give notice of use of vehicles without covers	3 working days before use
Delivery dockets bound material	Provide delivery dockets at point of delivery	Progressive
Stockpiling unbound material		
Location	Give notice of proposed alternative locations	2 weeks before stockpiling
Trimming, compaction and curing		
Compaction	Give notice of proposal to use alternative layer thickness	2 weeks before activity
Rework	Give notice for inspection of reworked wetted up layer	Progressive
Curing of bound materials	Give notice of water curing activities	Progressive
Acceptance of compaction		
Nuclear density Meter testing	Give notice of proposal to use	1 working day before use

Clause title/Item	Requirement	Notice for inspection
	Nuclear density meter	
Acceptance of dimensions and levels		
Layer width	Give notice of completion of layer width	Progressive
Subbase surface deviation	Give notice of completed subbase surface	Progressive
Base surface deviation	Give notice of completed base surface	Progressive
Base adjacent to kerb and gutter	Give notice of completed base surface	Progressive
Maintenance before completion of wearing surface		
Primerseal	Give notice of alternative procedure	At time of lot acceptance
Restrictions on movement	Give notice if vehicles are to use unbound pavement before application of primerseal	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 ACTIVITY PLAN

General

Program: Plan the following activities:

- Allocation of plant and personnel for the contract period.
- Work programming to meet the constraints of **HOLD POINTS** and **WITNESS POINTS**.

Pavement construction plan

Requirements: Prepare and submit a Pavement construction plan for the flexible base and subbase construction consistent with the drawings and subject to direction by the Superintendent. Include the following:

- A time based program to conform with Contract constraints.
- A drawn sectional plan showing lots and sequence.
- Site availability, assumptions on weather, plant and materials.
- A list of activities requiring approvals or notification of local authorities, statutory bodies, and local residents.
- Off-site storage of plant, personnel and maintenance facilities.
- On-site accommodation of personnel and communication facilities.

Submission: **HOLD POINT**.

2.2 DESIGN AND CONTROL OF BASE AND SUBBASE MATERIALS

Proposed materials

Schedule: Submit a schedule detailing the material properties of the proposed base and subbase, including sources of supply and the proposed type and proportion of any binder. Include test results from a NATA registered laboratory as evidence that material properties conform to the requirements of this worksection.

Submission: **HOLD POINT**.

Bound or modified materials

Stabilisation: If the proposed base or subbase is a bound or modified material, submit a completed Annexure A of *1113 Stabilisation.*

Submission: **HOLD POINT**.

Approved base and subbase

General: Once the proposed materials have been approved, they are known as the approved base and subbase.

Pre-approval: Proposed base or subbase may be pre-approved under the following conditions:

- If the base or subbase was used in a separate contract within 12 months of proposed works date.
- If full approved details have been previously used.
- If the material properties remain unchanged from that previously approved.
- If the in-service performance of the base or subbase incorporating the nominated materials is acceptable.

Variations to approved materials

Written approval: Submit details of any changes to the approved base and subbase or source of supply.

Submission: **HOLD POINT**.

Non-conformance: Any change to the approved base and subbase, without approval will be considered a non-conforming material and may be rejected.

2.3 INSPECTION, SAMPLING AND TESTING

General

Extent: Inspect, sample and test the base and subbase material before, on delivery, during and after construction, for conformance with this worksection.

Accreditation: Testing by a NATA registered laboratory with appropriate accreditation and suitably qualified personnel.

Notification

Notice: Give notice of when testing is to be carried out and submit copies of all test results.

Submission: **HOLD POINT**.

3 MATERIALS

3.1 UNBOUND BASE AND SUBBASE MATERIALS

General

Standard: To AGPT04A and ARRB - *Sealed local roads manual*.

Sampling and testing: To AS 1289 and AS 1141.

Requirement: Provide unbound granular materials, including blends of two or more different materials, which when compacted develop structural stability and are uniform in grading and physical characteristics.

Production: Materials may be produced by crushing plant or naturally occurring granular materials. Methods and properties to conform to this worksection and additional requirements of Austroads AGPT04A.

Crushed rock and recycled material class

Requirement: Provide crushed rock and recycled material as documented, 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 require a very high standard of surface preparation.
- Class 3: Not applicable.
- Class 4: Subbase material for unbound flexible pavements.

Crushed rock

Designation: Unbound crushed rock materials are designated as follows:

- CRB20-1: 20 mm nominal sized class 1 crushed rock base.
- CRB20-2: 20 mm nominal sized class 2 crushed rock base.
- CRS20: 20 mm nominal sized crushed rock subbase.
- CRS40: 40 mm nominal sized crushed rock subbase.

Recycled crushed concrete

Designation: Recycled crushed concrete materials are designated as follows:

- RCCB20-1: 20 mm nominal sized class 1 recycled crushed concrete base.
- RCCB20-2: 20 mm nominal sized class 2 recycled crushed concrete base.
- RCCS20: 20 mm nominal sized recycled crushed concrete subbase.

Natural gravel

Designation: Unbound natural gravel materials are designated as follows:

- NGB20: 20 mm nominal sized natural gravel base.
- NGS20: 20 mm nominal sized natural gravel subbase.
- NGS40: 40 mm nominal sized natural gravel subbase.

Base material properties

Base materials: Conform to the **Base material properties table**.

Base material properties table

Test method	Description	CRB20-1	CRB20-2	RCCB20-1	RCCB20-2	NGB20
AS 1289.3.6.1	Particle size distribution					
	% passing 26.5 mm sieve	100	100	100	100	100
	% passing 19.0 mm sieve	95–100	95–100	95–100	95–100	93–100
	% passing 13.2 mm sieve	77–93	77–93	78–92	78–92	—
	% passing 9.5 mm sieve	63–83	63–83	63–83	63–83	71–87
	% passing 4.75 mm sieve	44–64	44–64	44–64	44–64	47–70
	% passing 2.36 mm sieve	29–49	29–49	30–48	30–48	35–56
	% passing 0.425 mm sieve	13–23	13–23	13–21	13–21	14–32
	% passing 0.075 mm sieve	5–11	5–11	5–9	5–9	6–20
AS 1289.3.1.1	Liquid limit	max 30	max 30	max 35	max 35	max 25
AS 1289.3.3.1	Plasticity index:					
	All areas	min 2	—	min 2	—	—
	Areas with annual rainfall > 500 mm	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
AS 1289.3.4.1	Linear shrinkage:					
	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
	Areas with annual rainfall < 500 mm	max 4.0	max 4.0	max 4.0	max 4.0	max 4.0
Direct measurement	Foreign materials in that fraction of RCCB retained on 4.75 mm sieve - % by mass:					
	High density (brick, etc)	—	—	max 2.0	max 2.0	—
	Low density (plaster, etc)	—	—	max 0.5	max 0.5	—
	Organic matter (wood, etc)	—	—	max 0.1	max 0.1	—
	Asbestos and hazardous	—	—	0	0	—
AS 1141.52	Maximum dry compressive strength on fraction passing 19 mm sieve (only applies if plasticity index is less than 1)	min 1.7 MPa	min 1.7 MPa	min 1.7 MPa	min 1.7 MPa	min 1.7 MPa
AS 1141.14	Particle shape by proportional calliper - % misshapen (2:1)	max 35%	max 35%	max 35%	max 35%	—
AS 1141.22	Aggregate wet strength*	min 100 kN	min 80 kN	min 100 kN	min 80 kN	—
AS 1141.22	Wet/dry strength variation*	max 35%	max 35%	max 35%	max 35%	—

Test method	Description	CRB20-1	CRB20-2	RCCB20-1	RCCB20-2	NGB20
	(dry - wet)/dry					
AS 1141.23	Los Angeles value	max 35%	max 35%	max 40%	max 40%	—
AS 1289.6.1.1	4 day soaked CBR (98% modified compaction)	min 80%	min 80%	min 80%	min 80%	min 80%
AS 5101.4	Unconfined compressive strength (UCS)	max 1.0 MPa	max 1.0 MPa	max 1.0 MPa	max 1.0 MPa	—

NOTES:
* All fractions of the proposed mix must satisfy this requirement. Use the fraction with the highest wet/dry strength variation as the value for determining conformance. Test the fraction 19.0 mm to 9.5 mm. In the case of blended materials, also test the fraction 9.5 mm to 4.75 mm. Test any other fraction which is at risk of failing, in the opinion of the Superintendent.

Subbase material properties

Subbase materials: Conform to the **Subbase material properties table**.

Subbase material properties table

Test method	Description	CRS20	CRS40	RCCS20	NGS20	NGS40
AS 1289.3.6.1	Particle size distribution					
	% passing 53.0 mm sieve	—	100	—	—	100
	% passing 37.5 mm sieve	—	90–100	—	—	95-100
	% passing 26.5 mm sieve	100	74–96	100	100	80-97
	% passing 19.0 mm sieve	90–100	62–86	95–100	96–100	—
	% passing 13.2 mm sieve	74–96	—	75–95	—	—
	% passing 9.5 mm sieve	61–85	42–66	60–90	65-89	48-85
	% passing 4.75 mm sieve	42–66	28–50	42–76	47–80	35–73
	% passing 2.36 mm sieve	28–50	20–39	28–60	32–67	25–58
	% passing 0.425 mm sieve	11–27	8–21	10–28	14–42	10–33
	% passing 0.075 mm sieve	4–14	3–11	2–10	6–26	3–21
AS 1289.3.1.1	Liquid limit	max 35	max 35	max 40	max 35	max 35
AS 1289.3.3.1	Plasticity index:					
	Areas with annual rainfall > 500 mm	max 12	max 12	max 12	max 12	max 12
	Areas with annual rainfall < 500 mm	max 15	max 15	max 15	max 15	max 15
AS 1289.3.4.1	Linear shrinkage:					
	Areas with annual rainfall > 500 mm	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
Direct measurement	Foreign materials in that fraction of RCCS retained on 4.75 mm sieve - % by mass:					
	High density (brick, glass, etc)	—	—	max 3.0	—	—
	Low density (plaster, clay, etc)	—	—	max 1.0	—	—
	Organic matter (wood, etc)	—	—	max 0.2	—	—
	Asbestos and hazardous	—	—	0	—	—
AS 1141.52	Maximum dry compressive strength on fraction passing 19 mm sieve (only applies if plasticity index is less than 1)	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa
AS 1141.14	Particle shape by proportional calliper - % misshapen (2:1)	max 35%	max 35%	max 35%	—	—
AS 1141.22	Aggregate wet strength*	min 50 kN	min 50 kN	min 50 kN	—	—
AS 1141.22	Wet/dry strength variation* (dry - wet)/dry	max 40%	max 40%	max 40%	—	—

Test method	Description	CRS20	CRS40	RCCS20	NGS20	NGS40
AS 1141.23	Los Angeles value	max 40%	max 40%	max 40%	—	—
AS 1289.6.1.1	4 day soaked CBR (94% modified compaction)	min 30%	min 30%	min 30%	min 30%	min 30%
NOTES: * All fractions of the proposed mix must satisfy this requirement. Use the fraction with the highest wet/dry strength variation as the value for determining conformance. Test the fraction 19.0 mm to 9.5 mm. In the case of blended materials, also test the fraction 9.5 mm to 4.75 mm. Test any other fraction which is at risk of failing, in the opinion of the Superintendent.						

3.2 MODIFIED TEXAS TRIAXIAL CLASSIFICATION

Alternative materials

Requirement: Submit proposal for the use of any unbound base or subbase material that conforms to the requirements of the **Base material properties table** or **Subbase material properties table**, except for the particle size distribution grading to AS 1289.3.6.1.

Proposed material: Submit details of the proposed material including evidence of modified Texas triaxial classification and associated tests.

Submission: **HOLD POINT**.

Test

Method: RMS T171.

Requirements: To the **Modified Texas triaxial classification number requirements table**.

RMS T171 tested: At 83 - 87% of Optimum Moisture Content and 99 - 101% of Maximum Dry Density as determined by AS 1289.5.1.1.

Modified Texas triaxial classification number requirements table

Material class	Modified Texas triaxial classification number (RMS Test Method T171)
Base	max 2.5
Subbase	max 3.2

3.3 LIME MODIFIED BASE AND SUBBASE MATERIALS

Lime modification

Proposal: Submit details of any proposed addition of hydrated lime, including details of any initial consumption of lime test, to modify unbound base and subbase materials to meet the requirements of **UNBOUND BASE AND SUBBASE MATERIALS**.

Submission: **HOLD POINT**.

Modification: Uniformly mix with hydrated lime, in a stationary mixing plant, at the supplier's quarry.

In-situ lime modification

Alternative: Submit details of any proposed in-situ addition of hydrated lime or quicklime.

Submission: **HOLD POINT**.

Method: To *1113 Stabilisation.*

Material requirements

Before lime treatment: Provide material with no added pozzolanic material.

Lime: Hydrated lime and quicklime to *1113 Stabilisation*.

Proportion of lime: Not less than 1.5% nor more than 4%, by mass, after initial consumption of lime requirements have been met.

CRB20 before treatment with lime: Material to conform to the requirements of CRS20 in the **Subbase material properties table** and the following:

- Aggregate wet strength > 80 kN.

CRB20 material after lime treatment: CBR ≥ 80, when tested to AS 1289.6.1.1. Perform sampling within 24 hours of adding the lime and test after 7 days accelerated curing.

Unconfined compressive strength
Testing: UCS < 1.0 MPa, when tested to AS 5101.4. Perform sampling within 24 hours of adding the lime and test after 7 days accelerated curing.

3.4 BOUND BASE AND SUBBASE MATERIALS

General
Requirement: Supply bound material as a crushed rock product with stabilising agent incorporated in a pugmill.

Stabilising agent: Materials and process to Austroads AGPT04D and *1113 Stabilisation*.

Bound base
Base material requirements before stabilisation: To the **Subbase material properties table**.

In situ stabilisation
Alternative: Give notice if in-situ stabilisation of natural or blended gravel by mobile plant at site is proposed.

Proposal: **WITNESS POINT**.

Unconfined compressive strength
Testing: UCS > 3 MPa when tested to AS 5101.4. Perform sampling within 1 hour of adding the stabilising agent and test after 7 days accelerated curing.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General
Requirement: Conform to *1101 Control of traffic.*

4.2 DELIVERY

Transport of materials
Delivery vehicles: Provide enclosure to avoid loss of material during transit.

Condition: Provide materials sufficiently damp to avoid segregation and loss of fines during transit.

Moisture content: Uniformly distributed so that the moisture content is less than the optimum moisture content to AS 1289.5.1.1, AS 1289.5.2.1 or AS 1289.5.7.1. Alternatively, the moisture content may be specified by the Superintendent ± 0.5%.

Delivered materials
Notice: Give notice of arrival of materials for inspection.

Inspection: **WITNESS POINT**.

Delivery of modified or bound materials
Time period: Program the delay between mixing and delivery, to allow incorporation into the works, including trimming and compaction, within the nominated field working period.

Vehicle covers: Use delivery vehicles fitted with fabric covers to prevent loss of moisture during transport.

Alternative: Give notice of the proposed use of any vehicles not fitted with fabric covers.

Proposal: **WITNESS POINT**.

Delivery dockets for bound material
Identification: Identify each truck load of bound material by delivery dockets, indicating the time and date of mixing and registration or fleet number of the delivery truck. Provide delivery dockets for inspection at the point of delivery.

Inspection: **WITNESS POINT**.

4.3 STOCKPILING UNBOUND MATERIAL

Location
Stockpile sites: Locate stockpile sites as shown on the drawings or give notice of proposed alternative locations.

Proposal: **WITNESS POINT**.

Preparation
Condition: Clear stockpile sites of all vegetation and extraneous matter, and shape to form a crown to allow area to drain freely. Compact the area to a relative compaction ≥ 95%, to AS 1289.5.4.1 for standard compactive effort.

Stockpile maintenance
Stockpile height: < 3 m.

Side slopes: Uniform shape with side slopes not steeper than 1.5H:1V or flatter than 3H:1V.

Moisture content: Maintain stockpiled material at a moisture content sufficient to avoid loss of fines.

Contamination of materials: Maintain stockpiles and stockpile sites to make sure materials do not become intermixed, segregated or contaminated with foreign material.

Restoration
Surplus material: Upon completion of the works, clear stockpile sites of all surplus material and leave in a clean and tidy condition.

Sampling
Test: Sample and test stockpiles within 3 days of delivery to AS 1141.3.1 and as directed by the Superintendent.

4.4 SPREADING

General
Joints: At all work boundaries in bound materials, provide vertical faces for transverse and longitudinal joints.

Transverse joints: Locate at a minimum offset of 2 m from any joint in layer below.

Longitudinal joints: Locate along lane marking line or mid-way between lane marking lines. Offset a minimum of 100 mm from any joint in layer below.

Moisture content when spreading: > 85% of the laboratory optimum moisture content, to achieve specified compaction to AS 1289.5.2.1.

Underlying layer
Requirement: Moisture content < 80% of the laboratory optimum moisture content, to AS 1289.5.2.1, and free from rutting or foreign matter.

Quality: Before spreading of base and subbase material, give notice so that inspection may be made of the underlying layer quality including the assessment of required moisture content.

Inspection: **HOLD POINT**.

Non-conforming underlying layer
Correction: If Contractor activities cause the underlying layer to become non-conforming, correct the underlying layer to conform to this worksection.

Alternative: If the underlying layer becomes non-conforming, due to no fault of the Contractor, the Superintendent may require correction of the underlying layer as a variation to the contract.

Temperature
Requirement: Spread material when ambient air temperature is between 5°C and 35°C in the shade.

Outside temperature range: Submit proposals to spread bound materials when temperatures are outside the required ambient air temperature range.

Submission: **HOLD POINT**.

4.5 TRIMMING, COMPACTION AND CURING

Compaction

Process: Spread, shape and compact each layer in uniform thicknesses. Trim layer to conform to the documented thickness.

Compacted layer thickness: 200 mm maximum and 100 mm minimum. Provide layers of equal thickness in multilayer courses. Give notice of the proposed use of any layer thickness outside of this range.

Proposal: **WITNESS POINT**.

Compaction procedure
Conformance: Uniformly compact each layer of the base and subbase courses over their entire area and depth conforming to **ACCEPTANCE OF COMPACTION**.

Moisture content: Maintain at > 85% of the laboratory optimum moisture content during compaction.

One-way crossfall sections: Compact from the low side to the high side.

Crowned sections: Compact from edge to crown on each side of the pavement.

Rollers: Pass parallel to the centreline of the pavement and uniformly overlap each preceding pass.

Sides: Minimum 2 additional passes of roller, for outer 1 m width of pavement on both sides.

Plant

Protection: Do not stand watering and compaction plant on the pavement being compacted.

Self propelled plant: Use self propelled compaction plant, where practical.

Hand operated plant: Submit details of any hand operated compaction plant proposed for use.

Submission: **HOLD POINT**.

Subsequent layers

Tests: Do not place subsequent layers until all required testing has been completed and the test results for each layer have been submitted.

Submission: **HOLD POINT**.

Rework

Wetted up layers: If an unbound layer becomes wetted up after compaction is complete, dry out and give notice for inspection. If necessary, uniformly re-compact and trim to the documented density requirements and level tolerances.

Inspection: **WITNESS POINT**.

Unstable areas

Rejection criteria: Any unstable areas that develop during rolling or are identified by proof rolling.

Dry back and replacement: Open up, dry back and re-compact, to the requirements of this worksection. If dry back is not possible, remove the full depth of layer, dispose of and replace with fresh material to conform with **REMOVAL AND REPLACEMENT OF REJECTED COURSES.**

Curing of bound materials

Timing: Commence curing of the surface layer of a lot immediately after compaction is completed.

Requirement: Keep stabilised work continuously wet or damp to prevent rapid drying out before placement of the subsequent layer or the application of a prime or primerseal.

Procedure: Provide frequent light uniform water spray without significant run off or flooding. Avoid slurrying of the surface or leaching of the stabilising agent. Give notice of water curing activities for inspection.

Inspection: **WITNESS POINT**.

4.6 ACCEPTANCE OF COMPACTION

Lots for acceptance

Acceptance of work: Based on density testing of the work in lots.

Lots: Nominate lots as follows:

- Extent: A single layer of work, constructed under uniform conditions in a continuous operation, not crossing any transverse construction joints.
- Unbound materials: Equal to a day's output using the same material.

Density testing: Submit results verifying the required relative compaction has been achieved.

Submission: **HOLD POINT**.

Compaction requirements and acceptance

Lot compaction acceptance: Minimum relative compaction for modified compactive effort is ≥ 97%.

Alternative compaction acceptance: For bound layers any zones with relative compaction < 97% (modified compactive effort) but ≥ 92% may be accepted provided evidence is submitted to show that such zones constitute less than 5% of the lot.

Submission: HOLD POINT.

Relative compaction using in-situ dry density

Sampling frequency: Ten tests per 5000 sq m with a minimum of 3 tests per lot or as directed.

Method: Calculate the relative compaction of pavement material, at each location tested for in-situ dry density, to AS 1289.5.4.1 as follows:

- Relative Compaction % = [(In-situ dry density)/(Comparative dry density)]×100

Comparative dry density: Equal to the following:

- Unbound layers: The maximum dry density (modified compactive effort) determined in the laboratory by testing samples to AS 1289.5.2.1.
- Bound layers: The maximum dry density (modified compactive effort) determined by testing samples to RMS T130 within two hours of the addition of the stabilising agent to the mix.

In-situ dry density: Test the compacted material to AS 1289.5.3.2.

Nuclear density meter testing

Alternative: A single probe Nuclear Density Meter may be used in the direct transmission mode, to AS 1289.5.8.1, for some or all of the in-situ dry density testing. Give notice of proposal to use Nuclear Density Meter.

Proposal: **WITNESS POINT**.

Corrective action – rejected layers

Unbound layers: Rework lots that have been rejected in regard to compaction and resubmit for compaction assessment.

Bound layers: Remove rejected bound layers.

Removal

Replacement: Remove rejected bound layers and any unbound material which in the opinion of the Superintendent, has become degraded, segregated or otherwise reduced in quality by reworking. Dispose of and replace with fresh material to conform with **REMOVAL AND REPLACEMENT OF REJECTED COURSES**.

4.7 ACCEPTANCE OF DIMENSIONS AND LEVELS

General

Acceptable limits: Documented tolerances are acceptable limits of departure from the dimensions shown on the drawings, which may occur during construction.

Lots: Conform to the maximum lot size and minimum test frequencies in *0161 Quality (Construction)*.

Survey reports: Submit survey reports covering line and level for each lot.

Submission: **HOLD POINT**.

Layer width

Tolerance: Zero to + 100 mm of the design widths for both base and subbase, measured from the design centre line to the edge of the constructed pavement base/subbase layer but limited to 50 mm per side and as shown on the drawings. Give notice for inspection of completed layer width.

Inspection: **WITNESS POINT**.

Surface level

Surface: Parallel to the proposed finished wearing surface after final compaction and trimming of both base and subbase layers.

Subbase surface deviation

Tolerance: + 10 mm, - 25 mm from design level, after trimming. Give notice for inspection of completed subbase surface.

Inspection: **WITNESS POINT**.

Base surface deviation

Tolerance: + 10 mm, - 5 mm from design level or ± 5 mm from a 3 m long straightedge laid in any direction, after trimming and immediately prior to sealing. Give notice for inspection of completed base surface.

Inspection: **WITNESS POINT**.

Base adjacent to kerb and gutter

Tolerance: ± 5 mm of the level of the lip of the gutter, minus the design thickness of the wearing surface. Give notice for inspection of completed base surface.

Inspection: **WITNESS POINT**.

Corrective action – rejected unbound layers

Trimming: Submit proposal to correct surface by trimming without filling, to produce a uniform, hard surface.

Submission: **HOLD POINT**.

Corrective action – rejected bound layers

Design level: Corrective action may be approved where:

- The subbase course is lower than the design level with tolerances. Submit proposal to increase the thickness of the base course to make up such deficiency in thickness.
- The subbase course is above the design level with tolerances. Submit proposal to regrade the design level of the base course, to allow for laying of its design thickness, up to a maximum of 20 mm above the original design level.
- The base course is above the design level with tolerances. Submit proposal to regrade the design level of the base course.

Submission: **HOLD POINT**.

Approved corrective regrading: Conform to the following:

- A rate of change of grade from the original finished design surface level of less than 3 mm per metre.
- The proper design function of the drainage system.
- Existing levels at property boundaries, without increasing or decreasing footpath or footpath crossover levels or grades beyond Council's allowable design limits.
- Clearances.

Removal

Replacement: If corrective action is unachievable, remove and dispose of material and replace with fresh material to conform with **REMOVAL AND REPLACEMENT OF REJECTED COURSES**.

4.8 REMOVAL AND REPLACEMENT OF REJECTED COURSES

Extent of removal

Requirement: Remove rejected material over full length of rejected lot.

Exception: Submit proposal to remove less than the full width, as constructed, if the cause of rejection can be isolated. Form a new longitudinal cold joint located along the centreline of the road pavement.
Submission: **HOLD POINT**.

Prior to replacement

Inspection: Give notice of completion of removal of rejected base or subbase, for inspection before commencement of replacement works.

Inspection: **HOLD POINT**.

Replacement

Materials: Provide materials for replacement works, including spreading, compaction, trimming, curing and test the replacement materials, to conform to the requirements of this worksection.

Damage: Submit proposed methods to make good any damage to underlying or abutting layers or structures due to the removal or replacement of rejected courses.

Submission: **HOLD POINT**.

4.9 MAINTENANCE BEFORE COMPLETION OF WEARING SURFACE

Dry back

General: Allow material to dry back to 60% to 80% of the optimum moisture content before applying the primerseal or wearing surface

Primerseal

Prepared surface: Maintain the accepted condition of the base course until the wearing surface is completed.

Extent: Within 7 days of acceptance of a lot, cover the base course with a primerseal, over the full width, to *1143 Sprayed bituminous surfacing*. Give notice of any alternative procedure proposed.

Proposal: **WITNESS POINT**.

Pavement condition before primerseal

Restore condition: If the base condition deteriorates before primerseal application and approval to proceed with bitumen surfacing work is withdrawn, dry-back and re-prepare the base. Submit evidence of dry-back being achieved and give notice for inspection.

Inspection: **HOLD POINT**.

Surface drainage

Ponded water: Maintain adequate drainage of the pavement before completion of the wearing surface and remove any ponded water within 12 hours if free drainage is not achievable.

Restrictions on movement

Limits: Only vehicles registered for road use and loaded within legal limits are permitted to use the pavement.

Bound pavements: Prevent construction plant and vehicles not involved in current construction or testing activities from using the pavement within 7 days of placement of the base course and before the application of primerseal.

Unbound pavements: Prevent construction plant and vehicles not involved in current construction or testing activities from using the pavement before the application of primerseal. Give notice if this requirement is impractical.

Notification: **WITNESS POINT**.

Opening bound pavement to traffic

Timing: Traffic not permitted to use pavement within 7 days of completion of full pavement depth and application of primerseal. Give notice of proposed opening to traffic.

Notification: **HOLD POINT**.

4.10 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	Limits/Tolerances	Clause - subclause
Stockpile sites: Relative compaction	> 95%.	**Stockpiling unbound materials - Preparation**
Stockpile height	< 3 m.	**Stockpiling unbound materials - Stockpile maintenance**
Stockpile batter	1.5H:1V max. 3H:1V min.	**Stockpiling unbound materials - Stockpile maintenance**
Compacted layer thickness	200 mm max. 100 mm min.	**Trimming, compaction and curing - Compaction**
Compaction acceptance: Minimum value of all calculated relative compaction results	≥ 97% (modified compactive effort). For bound pavements, the Superintendent may accept between 92% and 97% provided it represents less than 5% of the area.	**Acceptance of compaction - Compaction requirements and acceptance**
Layer width	Zero to + 100 mm of dimensions on drawings. Limited to 50 mm per side.	**Acceptance of dimensions and levels - Layer width**
Subbase surface deviation	+ 10 mm, - 25 mm from design level.	**Acceptance of dimensions and levels - Subbase surface deviation**
Base surface deviation	+ 10 mm, - 5 mm from design level or ± 5 mm from a 3 m long straightedge placed on surface, immediately prior to sealing.	**Acceptance of dimensions and levels - Base surface deviation**
Base adjacent to kerb and gutter	± 5 mm from the level of the lip of adjacent gutter minus design thickness of wearing surface.	**Acceptance of dimensions and levels - Base adjacent to kerb and gutter**

1142 BITUMINOUS COLD MIX

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide bituminous cold mix, as documented.

Performance
Requirements: Conform with this worksection, Standards and *0161 Quality (Construction)*.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1141	Methods for sampling and testing aggregates
AS 1141.11.1.1-2009	Particle size distribution by sieving
AS 1141.15-1999	Flakiness index
AS 1141.18-1996	Crushed particles in coarse aggregate derived from gravel
AS 1141.22-2008	Wet/dry strength variation
AS 2008-1997	Residual bitumen for pavements
AS 2150-2005	Hot mix asphalt – a guide to good practice
AS 2157-1997	Cutback bitumen
AS 2758	Aggregates and rock for engineering purposes
AS 2758.5-2009	Coarse asphalt aggregates
AS 2891	Methods of sampling and testing asphalt
AS 2891.1.1-2008	Sampling - loose asphalt
AS 2891.1.2-2008	Sampling - Coring method
AS/NZS 2891.3.1-1997	Bitumen content and aggregate grading—Reflux method
AS 3568-1999	Oils for reducing the viscosity of residual bitumen for pavements
AS 4283-1995	Cold mix asphalt for maintenance patching.

Other publications

AUSTROADS	
AGPT04F – 2008	Guide to Pavement Technology Part 4F: Bituminous Binders
AGPT04J – 2008	Guide to Pavement Technology Part 4J: Aggregate and source rock

1.4 INTERPRETATION

Definitions
General: For the purposes of this worksection the definition given below applies.

Bituminous cold mix: Hot mixed-cold laid plant mix.

1.5 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Documents
Submit the following for approval:

- Design:
  . Design and control of bituminous mixes to achieve approval of the nominated mix.
  . Proposed changes to the nominated mix
- Test results: Submit for approval of Superintendent the test results and NATA Certification for the constituent materials as specified in materials details of the nominated mix.
- Technical data: Refer to Mix Design and Materials clauses.
- Materials: Technical data of materials as specified for the following:
  . Aggregates.
  . Mineral filler.
  . Binder.
  . Flux oil and cutter oil.
  . Bitumen adhesion agent.
- Execution details:
  . Plant location.
  . Stockpile locations.

1.6 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Design and control of bituminous mixes – Nominated mixes	Nominated mix including NATA Certification	21 days before first delivery of cold mix	Superintendent
EXECUTION			
Requirements of production mix – Non-complying production cold mix	Approval for use or rejection	Progressive	Superintendent
Mixing procedure - Plant	Plant location and specifics to be approved	At tender acceptance	Superintendent
Transport and delivery – Cancellation of deliveries by Principle	Notice for cancellation of delivery	Progressive	Superintendent
Transport and delivery – Delivery dockets	Submit all delivery dockets	Within 1 working day of delivery	Superintendent
Traffic Control - Provision	Traffic control for safety and stockpile locations to be approved	3 working days prior to starting on site	Superintendent

WITNESS POINTS table – Off-site activities

Clause title/Item	Requirement	Notice for inspection
MATERIALS		
Aggregate – Coarse aggregate	Submit NATA certificates	At time of nominated mix
Aggregate – Fine aggregate	Submit NATA certificates	At time of nominated mix
Mineral filler – General	Submit NATA certificates	At time of nominated mix
Binder - General	Submit NATA certificates	At time of nominated mix

Flux oil and cutter oil - General	Submit NATA certificates	At time of nominated mix
Bitumen adhesion agent - General	Submit NATA certificates	At time of nominated mix
EXECUTION		
Requirements of production mix - General	Submit NATA certificates	With in 7 days of the delivery
Requirements of production mix – Adjusting for weather	Variation of added oil for seasonal conditions	Progressive
Mixing Procedure – Storage of mix	Rectify / reject stockpiles with visible segregation, contamination or weathering	Progressive
Sampling and testing -General	Conformance reports from NATA laboratory near mixing plant	Progressive
Transport and delivery – Haulage trucks	Release agent for trucks to be approved	Prior to use
Transport and delivery – Load measurement	Alternatives to registered weighbridge	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 DESIGN AND CONTROL OF BITUMINOUS MIXES

Design limits

Design mix: The contractor is to design a mix within the limits set out in the Limits for design of nominated mix table and submit for approval as a nominated mix.

Limits for design of nominated mix table

Property	**Requirement for nominal mix size**			**Test method**
	Aggregate % by mass passing			
	7 mm	**10 mm**	**14 mm**	
AS Sieve grading:				AS 1141.11.1
19.0 mm	100	100	100	
13.2 mm	100	100	95–100	
9.50 mm	100	90–100	70–85	
6.70 mm	90–100	70–85	57–74	
4.75 mm	70–90	55–70	45–65	
2.36 mm	45–60	35–50	28–45	
1.18 mm	26–45	22–38	15–30	
600 µm	15–30	12–27	10–23	
300 µm	10–20	6–16	5–17	
150 µm	4–14	4–11	3–11	
75 µm	3–8	2–6	2–5	
Filler	0.5–1.0	0.5–1.0	0.5–1.0	
Binder content (% by mass of total mix)*	4.5–6.0	4.0-5.5	4.0–5.0	AS/NZS 2891.3.1
Medium flux oil (%) in binder	10–20	10–20	10–20	
* Some increase beyond these ranges of binder may be permitted for aggregates having unusually high absorption characteristic. Such departures will require Superintendent's approval.				

Nominated mixes

Approval: Submit details of the proposed cold mix design including details for the mix and the constituent materials. Approval of the nominated mix will be in consideration of AS 4283. The Contractor must produce the cold mix to conform with all specifications. This is a **HOLD POINT**.

Details for submission:

- Combined aggregate grading and binder content.
- Proportions of constituent materials used (including adhesion agent).
- Grading of aggregate and filler.
- Type and sources of aggregates, filler, binder and adhesion agent.
- All relevant compliance certificates.

Definition: When a nominated mix has been approved it is to be known as the 'Approved Mix'.

Non-conformance: Revise and retest nominated mixes that do not conform with specified requirements.

Prior approval

Conditions: A mix may be approved due to 'prior approval' in the following conditions:

- If the mix was used in a separate contract within 12 months of proposed works date.
- If full approved details have been previously used.
- If the constituent materials and quality remain unchanged from that previously approved.
- If the in-service performance of the concrete incorporating the nominated mix is acceptable.

Variations to approved mixes

Written approval required: Any changes to the approved mix, its method of production or source of supply of constituents require written approval 21 days prior to proposed implementation.

Certificates of compliance

Submission: Submit NATA Certificates of compliance for each constituent and nominated mix.

Requirements: All phases of any particular test to be performed at one laboratory. All relevant test results to accompany the Certificate and be within twelve months of the submission date.

2.2 SCHEDULING

Program for the works

Planning: Conform to the following:

- Provide planning resources to allocate plant and personnel for the contract period.
- Program the work to meet the constraints of **HOLD POINTS**, **WITNESS POINTS**.

3 MATERIALS

3.1 AGGREGATES

General

Standard: To AS 2758.5 and AS 1141 and Austroads AGPT04J.

Quality: Uniform quality and grading.

Coarse aggregate

Standard: To AS 2758.5.

Size: All mineral matter retained on the 4.75 mm AS sieve.

Quality: Clean, dry, hard, tough and sound crushed rock, metallurgical slag or gravel, be of uniform quality and be free from dust, clay, dirt or other matter deleterious to asphalt.

Grading: Determine grading to AS 1141.11.1.

Proposed grading: The grading is to be known as the 'Proposed Grading'.

Compliance certificates: When submitting details of the nominated mix submit test reports on the quality and grading of the coarse aggregate proposed to be used. Include source, geological type and particle size distribution. For blended aggregates submit results for each constituent coarse aggregate and the proportions of the various sizes proposed. Certificate to include Wet strength, Wet / dry strength variation, flakiness index, fractured faces. This is a **WITNESS POINT**.

Currency: Test results must be less than 12 months old and representative of current aggregate supply.

Property requirements for coarse aggregates

Property	Limit	Standard
Wet Strength	≥ 100 kN for any mix except for any fraction of open graded asphalt ≥ 150 kN	AS 1141.22
Wet/Dry strength variation	≤ 35% for any fraction or constituent	AS 1141.22
Flakiness index	≤ 35	AS 1141.15
Fractured faces	≥ 75% by weight of particles with at least two fractured faces.	AS 1141.18

Fine aggregate

Size: All mineral matter (other than filler) passing the 4.75 mm AS sieve.

Quality: Clean, hard, tough and sound grains, free of coatings or loose particles of clay, silt or other matter deleterious to asphalt.

Material: Natural sand or a mixture of natural sand and material derived from the crushing of sound stone or gravel.

Grading: Determine grading to AS 1141.11.1.

Compliance certificates: When submitting details of the nominated mix submit test report on the quality and grading of the fine aggregate proposed to be used. For blended aggregates submit results for each constituent coarse aggregate and the proportions of the various sizes proposed. This is a **WITNESS POINT**.

Currency: Such test results must be less than 12 months old and representative of current aggregate supply.

3.2 MINERAL FILLER

General

Standard: To AS 2150.

Size: Mineral matter passing a 0.075 mm sieve including rock dust derived from coarse and fine aggregates.

Composition: Consistent in mineral composition and dry compacted air voids.

Quality: Dry and free from lumps, clay, organic matter or other material deleterious to asphalt.

Materials: Added mineral filler to comply with table 3 of AS 2150. May consist of hydrated lime, fly ash, portland cement, flue dust from the manufacture of portland cement, asphalt plant baghouse fines or other approved material.

Submit: Submit compliance certificates for added mineral fillers at time of **nominated mix** submission. This is a **WITNESS POINT**.

3.3 BINDER

General

Standard: Conform to AGPT04F and the following:

- Binder: To AS 2008 and AS 2157.
- Bitumen: To AS 2008.

Classification: On the basis of consistency expressed in terms of viscosity at 60°C Class 170 or Class 320 bitumen.

Consistency: The residual bitumen must be homogeneous, contain no inorganic mineral matter other than that naturally occurring.

Oils: Add flux oil or cutter oil to AS 3568 to reduce the viscosity. All cutback bitumen to conform with AS 2157.

Submit: Compliance certificates for binders for approval at time of **nominated mix** submission. This is a **WITNESS POINT**.

3.4 FLUX OIL AND CUTTER OIL

General

Standard: To AS 3568.

Oils: Use for reducing the viscosity of the binder and retaining the cold mix in a workable condition to AS 3568.

Quality: Clean and free from water.

Mixing: When one part by volume of oil is mixed with four parts by volume of bitumen at a temperature of 177°C the mixture must be homogeneous and not foam.

Submit: Compliance certificates for Flux oil and cutter oil for approval at time of **nominated mix** submission. Test results must be less than 3 years old. This is a **WITNESS POINT**.

3.5 BITUMEN ADHESION AGENT

General

Standard: To AS 2150 and manufacturer recommendation.

Criteria: Add a bitumen adhesion agent, if required, to the binder at 1% by mass when directed by the Superintendent based on experience with asphalts incorporating aggregates from the same source.

Bitumen adhesion agent: A substance for promoting adhesion between binder and aggregates, normally in the presence of water.

Submit: Compliance certificates for bitumen adhesion agent for approval at time of **nominated mix** submission. This is a **WITNESS POINT**.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 REQUIREMENTS OF PRODUCTION MIX

General

Production mix: The cold mix produced in the plant and delivered to the site is to be known as the 'production mix'.

Submit: NATA test results from the refinery batch from which the bitumen was taken, sampling within 7 days of the delivery of the bitumen. This is a **WITNESS POINT**.

Fluxing: Carried out prior to the addition of the binder to the mix by adding the required amount of cold flux oil and cutter oil to the hot bitumen.

Adjusting for weather

Quantities: The amount of flux oil and cutter oil added to be varied according to the season as agreed between the Contractor and the Superintendent based on local experience. This is a **WITNESS POINT**.

Grading variations

Tolerance: The grading of the total mineral aggregate in the mix produced must not vary from the approved mix design figures by more than the amounts given in AS 2758.5 clause 1.7.

Binder variation

Tolerance: The binder content not to vary from the approved mix by more than ± 0.3%.

Non-complying production cold mix

Criteria: Mixes not complying with this worksection will be rejected. This is a **HOLD POINT**.

4.3 MIXING PROCEDURE

Plant

Submit: Undertake mixing in a suitable plant nominated and approved at tender. This plant must be capable of uniformly mixing the coarse and fine aggregate and binder to meet the specified requirements. This is a **HOLD POINT**.

Requirements: Mixing time and temperature to be such that all particles of the mineral aggregate are uniformly coated with binder.

Storage of mix

Protect: From weather and store on a concrete or asphalt slab.

Locate the stockpile site: In a free draining area not susceptible to ponding of water due to precipitation.

Construct stockpiles: To ensure no compaction, other than by the weight of the material itself, will result. Do not run equipment of any kind over the surface of the stockpile.

Cover: All stockpiles are to remain covered and protected from precipitation and excess evaporation of incorporated oils.

Rectify or reject: Stockpiles that exhibit visible segregation, contamination or weathering must be rectified or replaced. This is a **WITNESS POINT**.

Prior to delivery: Storage of the mix by the Contractor prior to delivery is limited to a period of 2 weeks.

4.4 SAMPLING AND TESTING

General

Standard: To AS 2891.1.1 or AS 2891.1.2.

Supply: All facilities, equipment and labour for sampling.

Frequency: Take one sample for each production lot or days production whichever is the lesser.

NATA laboratory: Maintain a NATA registered testing laboratory at, or near, the mixing plant so as to ensure complete control over the mixture produced.

Submit: Provide certificates of compliance reports for the production mix verifying at the point of manufacture that every batch of the bitumen complies for viscosity and temperature range. This is a **WITNESS POINT**.

Performance properties of the mix

Cohesiveness: The manufactured material must be cohesive and capable of being compacted readily into a semi-dense mass which is resistant to the destructive action of traffic.

Interlock: When compacted, visual examination of the compacted material is to indicate good mechanical interlock of particles which are fully coated with binder.

4.5 TRANSPORT AND DELIVERY

Haulage trucks

Release agent: Keep the bodies of haulage trucks clean and coated with a thin film of an approved release agent to prevent asphalt sticking to the body of the truck. Remove any surplus release agent before loading. This is a **WITNESS POINT**.

Load measurement

Means of measurement: Measure the mass of all truck-loads of cold mix on a registered weighbridge unless other means of measurement are approved. This is a **WITNESS POINT**.

Delivery times

Arrivals: Unless otherwise specially requested, deliveries are to reach the site of the work between the hours of 7.30 am and 3.30 pm Mondays to Fridays inclusive.

Advice of delivery: As much preliminary notice as possible will be given before the first deliveries are required, and thereafter advice of delivery requirements for particular locations will be given not later than 10.00 a.m. on the day preceding the delivery. Conform to all reasonable delivery instructions meeting these guidelines.

Cancellation of deliveries by Principal

Criteria: The Principal reserves the right to cancel deliveries other than premixed loads actually being mixed or in transit. This is a **HOLD POINT**.

Delivery dockets

Submit: Each delivery docket must be submitted with in 24 hours of delivery. Docket details to include:

- Manufacturer's name, product name and class.
- Refinery batch number.
- Date of loading at refinery.

- Any intermediate delivery site.
- Loading temperature.
- Delivery temperature for bitumen delivered by road tanker or sprayer.
- Weighbridge tickets showing gross mass of the delivery, the mass of the empty vehicle or container and the net mass of bitumen. This is a **HOLD POINT**.

Stockpiling

Safety: Set up traffic control for safe delivery and stockpile sites to conform with *1101 Control of traffic*.

Stockpile locations: Set up stockpile locations as directed by the Superintendent and make sure sufficient sign positing is in place. This is a **HOLD POINT**.

1143 SPRAYED BITUMINOUS SURFACING

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Provide sprayed bituminous surfacing for roads and related applications, as documented, comprising:

- Prime.
- Primerseal.
- Seal:
  - . With conventional bitumen, cutback bitumen or bitumen emulsion binder.
  - . With modified binder, e.g. multigrade binder, polymer modified binder.
  - . Incorporating geotextile fabric, with or without modified binder.

Performance

Design

Designer: Design the composition of the seal materials.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *0136 General requirements (Construction).*
- *0152 Schedule of rates – supply projects.*
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*

Precedence

General: The locations and required types of sprayed bituminous surfacings, including types of binders and aggregate sizes, as detailed in the **Schedule of Job Details**. For multiple treatments, the binder and aggregate may be required to be laid in one or more separate applications. Read this section in conjunction with the **Schedule of Job Details**. If there is conflict between the requirements of this section and **Selections**, the requirements of the **Selections** apply.

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

AS 1160-1996	Bituminous Emulsions for Construction and Maintenance of Pavements
AS 1742	Manual of uniform traffic control devices,
AS 1742.3-2009	Traffic control devices for works on roads
AS 2008-1997	Residual bitumen for pavements
AS 2124-1992	General conditions of contract
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
AS/NZS ISO 9001-2008	Quality Management Systems – Requirements

Other publications

AAPA	
AAPA-2004	National asphalt specification. 2nd edition
AAPA HS&E Guide No 8	Guide for Environmental Management when Spraying Bituminous Materials
AAPA-2003	Guide to the Selection, Heating and Storage of Binders for Sprayed Sealing and Hot Mixed Asphalt

ASTM D6140-2009	Standard test method to determine asphalt retention of paving fabrics used in asphalt paving for full width applications
AUSTROADS	
Manual of Test Procedures	(www.austroads.com.au/tm/testmethods.htm)
AGPT03-2009	Guide to Pavement Technology Part 3 – Pavement surfacings
AGPT04F-2008	Guide to Pavement Technology Part 4F - Bituminous binders
AGPT04K-2009	Guide to pavement technology Part 4K - Seals
AP-C87-2010	Austroads glossary of terms
AP-G41-2008	Bituminous materials sealing safety guide
AP-T37-2005	Geotextile reinforced seals
AP-T40-2005	Audit and surveillance of sprayed sealing contract works
AP–T42-2006	Guide to the selection and use of Polymer Modified Binders and multigrade bitumens
AP-T68-2006	Update of the Austroads sprayed seal design method
AGPT-T190-2010	Specification framework for polymer modified binders and multigrade bitumens
AGPT-T252-2006	Commentary to AG: PT/T252-2006 - Penetration of road bases by bituminous primers or primebinders

1.4 INTERPRETATION

Definitions

General: For the purposes of this worksection the definitions in AP-C87 and those given below apply.

- Binder: A material used in the mix to improve temperature susceptibility, response to transient loads and cohesive strength.
- Cutter oil: A light petroleum distillate (e.g. kerosene) added to bitumen to temporarily reduce its viscosity.
- Double/double seal: 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.
- Prime: An application of a primer to a prepared base, without cover aggregate.
- Primer: A bituminous material of low viscosity and low surface tension used in priming.
- Primerseal: An application of a primerbinder with a cover aggregate to a prepared base.
- Primerbinder: A material, more viscous than a primer, and required to act both as a primer and binder, and used in primersealing.
- Seal: A sprayed application 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.
- Reseal: A seal applied to an existing sealed, or asphalt surface.
- Residual Binder: The volume of bituminous binder at 15°C including the volume of any polymer, crumb rubber and flux oil but not including the volume of any cutter oil, water, emulsifier or adhesion agent.
- Single/double seal: A seal consisting of a single application of binder followed by a double application of aggregate.
- Single/single seal: A seal consisting of a single application of binder followed by a single application of aggregate.
- High Stress Seal or Reseal (HSS): The application of a polymer modified binder into which aggregate is incorporated to provide a durable wearing surface.
- Strain Alleviating Membrane (SAM): The application of polymer modified binder into which aggregate is incorporated to provide a durable wearing surface with strain alleviating or other desirable properties.
- 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.

- Geotextile Reinforced Seal (GRS): The applications of C170 tack coat, geotextile or polymer modified binder into which aggregate is incorporated to provide a durable wearing surface with strain alleviating or other desirable properties.

1.5 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Documents
Submit the following for approval:

- Materials: Refer to material clauses.
- Drawings: Prepare drawings or other documentation to record extent and constitution of final works.
- Execution details: In conformance with worksection requirements.

Design of sprayed seals
Submit the design of sprayed seals as follows:

- The types of sprayed seal treatment as listed in the schedule of job requirements, or as shown on drawings.
- Determine rates of application of binder and aggregate for the nominated sprayed seal treatment types based on Austroads *Sprayed sealing guide.* If specified, submit the seal design for assessment by the Superintendent for compliance with the requirements of this worksection. This is a **WITNESS POINT**.

Materials and application rates: The selection of materials and application rates for surfacing treatments not covered by the Austroads *Seal Design Method*, such as priming, primersealing and special treatments, to be in conformance with guidelines for accepted good practice.

1.6 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Sampling and testing	Quality plan to nominate testing frequency	2 weeks before testing materials	Superintendent
Traffic management	Submit a traffic management plan for approval	3 weeks before commencing site work	Superintendent
Plant	Evidence that plant is registered and insured	2 weeks before using plant	Superintendent

WITNESS POINTS table – On-site activities

Clause title/Item	Requirement	Notice for inspection
GENERAL		
Submissions, Design	Submit the sprayed seal design for approval	2 weeks before commencing work
MATERIALS		
Aggregate	Source of materials submit for approval	3 weeks before commencing work
Removal of loose aggregate, Loose aggregate particles	Completion within specified time	Various to allow inspection of performance in conformance with Tables of time limits
Removal of surplus and waste material	Demonstrate that materials are properly disposed	Progressive

Clause title/Item	Requirement	Notice for inspection
Protection, New work	Demonstrate that line marking and warning signs are in place to protect new work	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 GENERAL

Proposed testing frequency

Quality plan: Nominate in the Quality plan the proposed testing frequency including, but not limited to:

- Specification compliance of bituminous materials.
- Specification compliance of aggregates.
- Measurement of loose aggregate on completed work. This is a **HOLD POINT**.

Traffic management

Plan: Submit a Traffic Management Plan for approval. Provide for traffic in conformance with *1101 Control of traffic* while undertaking the work and include the following:

- Supply of labour and materials to *1101 Control of traffic*.
- Avoid or minimise delays and inconvenience to road users during the course of the work but without compromise to the safety of the employees and the road users. This is a **HOLD POINT**.

Plant

Registration and insurance: Provide for all plant as appropriate to its use on a public road.

Operation: Conform to statutory environmental regulations. This is a **HOLD POINT**.

3 MATERIALS

3.1 BITUMINOUS MATERIALS

Bitumen

Standard Classes of bitumen: To AS 2008.

Bituminous binders: To AGPT04F.

Multigrade bitumen: To AGPT/T190 available from www.austroads.com.au.

Polymer modified binders

Polymer modified binder: To AGPT/T190 available from www.austroads.com.au.

Bitumen emulsion

Bitumen emulsion: To AS 1160.

Cutback bitumen

Cutback bitumen: To AS 2157 or may be prepared by the Contractor, in the field, by blending bitumen and cutter oil in proportions documented or selected as appropriate to the particular application.

Proprietary grades of cutback bitumen: To the manufacturer's specification.

Adhesion agent

Type and proportion: Add the type and proportion of adhesion agent to bituminous binder or aggregate precoating material subject to either of the following:

- Evidence provided of previous satisfactory performance with the proposed combination of binder, aggregate source and precoating material.
- Selection from materials listed as approved by the relevant state road authority (if applicable).

Cutter oil and flux oil

Cutter oil and flux oil: To AS 3568.

Aggregate precoating materials

Aggregate precoating materials: Flux oil, flux oil and bitumen mixture, cutback bitumen, proprietary bitumen emulsion or other proprietary product are subject to evidence of previous satisfactory field

performance as an aggregate precoating material. All precoating material to contain a minimum of 1% of an approved adhesion agent.

3.2 AGGREGATE

General

Source: The source of all materials is subject to inspection and approval by the Superintendent. Only use material from a nominated quarry face or location. This is a **WITNESS POINT**.

Aggregate: To AS 2758.2 with the following additional requirements:

- Specify the class of aggregate, resistance to polishing, method of determination of aggregate shape, and combination of hardness and durability test measures in the **Schedule of Job Details**.
- Apply only one method of determination of aggregate shape and one combination of hardness and durability.
- If no aggregate details are specified in the **Schedule of Job Details**, select the particular aggregate class, polishing resistance and combination of test methods based on the service conditions and customary test procedures used in the State in which the works are located.

3.3 OTHER MATERIALS

Protective paper

Heavy duty protective paper: Use a heavy-duty protective paper, weighing not less than 120 gm/m^2, for all start, finish and taper operations. Ensure that the paper is of sufficient width to prevent overspray and of sufficient strength to prevent spillage during removal.

Geotextile

Properties: Geotextile fabric used in geotextile reinforced seals:

- Non-woven.
- Needle punched fabric:
  - . Minimum melting point 190ºC.
  - . Minimum mass 130 g/m^2.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 APPLICATION

General

Application: Adopt **Annexure A** for procedure.

Scope: Provide the following:

- Supply and delivery of materials.
- Storage and handling of raw materials.
- Precoating of aggregate (if aggregates are not purchased suitably precoated).
- Preparation of bituminous materials, including selection and incorporation of appropriate proportions of cutter oil, adhesion agent and any other additives. To Austroads AP-T42/06.
- Control of traffic through the works, including recording of traffic control measures.
- Removal and disposal, or protection, of existing raised pavement markers.
- Sweeping and cleaning pavement surfaces prior to spraying.
- Protection of road furniture from spray.
- Supply and placing of geotextile, as documented.
- Application of primer, primerbinder and/or binder, uniformly to the target application rate.
- Spreading of aggregate, uniformly to the target application rate.
- Rolling of aggregate.
- Removal of loose aggregate

- Removal and disposal of all surplus and waste materials.
- Installation of temporary pavement markers.
- Care of completed work.

Performance: In conformance with recognised industry standards, AGPT04K, including the following:

- Completed and cured primes to have a uniform appearance.
- Completed primerseals and single/single seals with aggregates of 7 mm size, or less, to have a uniform surface retaining a matrix of aggregate.
- Completed single/single seals with aggregates of 10 mm size, or greater, to have a uniform, single retained layer of aggregate.
- Completed single/double seals to have a uniform layer of retained aggregate with both sizes fitting together to produce a uniform surface texture.
- Completed double/double seals to have uniform double retained layers of aggregate with the second aggregate fitting inside the texture of the aggregate used in the first layer.
- Finished work to have clean straight edges and no obvious defects related to poorly constructed longitudinal or transverse joins, blocked spray nozzles or any other construction fault.

4.3 TESTING

Laboratory testing

Requirements: Test the properties required by the worksection as follows:

- Perform in a laboratory registered by the National Association of Testing Authorities (NATA) or International Accreditation New Zealand (IANZ) for the appropriate tests. Perform in conformance with procedures contained in the relevant Australian or New Zealand Standard or Austroads Manual of Test Procedures.
- If there is no applicable Australian Standard or Austroads Test Method or if the Standard/Manual provides a choice of procedures, adopt a procedure endorsed by the relevant state road authority in the State in which the work is being undertaken.

Exceptions: Requirements for NATA or IANZ registration do not apply to field tests such as surface texture measurements or aggregate spreader calibration undertaken by competent and trained personnel.

4.4 REMOVAL OF LOOSE AGGREGATE

Loose aggregate particles

Extent: After final sweeping, and prior to removal of speed restriction and warning signs, the number of loose aggregate particles remaining on the surface of seals constructed with 10 mm, or larger, aggregates not to exceed the values specified in **Loose stone particles remaining after sweeping table**.

Windrow aggregate: Remove any windrow of aggregate on either the sealed surface or shoulder that could constitute a traffic hazard. If documented, uplift and remove from the works all surplus aggregate.

Timing: Complete the removal of loose aggregate from the trafficked pavement within the time specified in **Time limit for removal of loose aggregate table**. This is a **WITNESS POINT**.

Loose stone particles remaining after sweeping table

Road type	**Loose stones (particles/m^2) max**
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 aggregate table

Traffic volume (vehicles/lane/day)	**Maximum time limits**
> 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

4.5 REMOVAL OF SURPLUS AND WASTE MATERIAL

Cleaning
Completion: Prior to leaving the work site, ensure that all services are uncovered and cleaned, if necessary. Remove from site all waste paper and rubbish arising from the sprayed sealing operations. Clean the stockpile site and store any excess material in a tidy heap or remove, depending on the requirements of the Superintendent. This is a **WITNESS POINT**.

4.6 PROTECTION

New work
Warning signs: Protect the new work by providing signage as follows:

- Provide signs to warn public of loose stones and absence of line marking including provision of temporary raised pavement markers.
- Maintain signs until loose aggregate has been removed and linemarking reinstated.
- If linemarking is to be undertaken by others, erect warning signs indicating the absence of linemarking to be maintained by the organisation responsible for linemarking. These activities are a **WITNESS POINT**.

Services and road Fixtures
Protection: Take all necessary precautions to prevent primer, primerbinder, binder, aggregate or other material used on the work from entering or adhering to gratings, hydrants or valve boxes, manhole covers, bridge or culvert decks and other road fixtures.

Cleaning: Immediately after aggregate has been spread, clean off or remove any sprayed material and leave the services and road fixtures in a condition equivalent to that existing when the sprayed surfacing work commenced.

5 MEASUREMENT AND PAYMENT

5.1 MEASUREMENT BY AREA OR LENGTH

Pay Items	Unit of measurement	Schedule rate scope
1143.1 Priming, primer sealing or sealing	m² -Area	No deductions for openings each not exceeding 1 m². All costs associated with priming, primer sealing or sealing.
1143.2 Removal and disposal of existing raised pavement markers	Measured by length in kilometres	

5.2 MEASUREMENT BY QUANTITY OF MATERIAL SUPPLIED

Pay items	Unit of measurement	Schedule rate scope
1143.3 Supply and spray primer or primer binder (including preparation of surface) @ 15ºC	Litres Determine the quantities (in litres) by either: - Multiplying the target application rate of the combined mixture of primer or primerbinder (including any cutter or flux oil) at 15ºC (in litres/m^2) by the area of road surface sprayed for each sprayer run (in m².); or - Measurement of actual volume (at 15ºC) of materials used.	All costs associated with the preparartion of surface and supply and spray primer or primebinder

Pay items	Unit of measurement	Schedule rate scope
1143.4 Supply and spray binder (including adhesion agent where required, and preparation of surface) @ 15ºC	Litres Determine the quantities (in litres) by either: - Multiplying the target application rate of the residual (excluding any cutter oil or flux oil) at 15ºC (in litres/m^2) by the area of road surface sprayed for each sprayer run (in m^2); or - Measurement of actual volume (at 15ºC) of materials used.	All costs associated with the supply and spray binder.
1143.5 Supply, incorporate and spray cutter oil, flux oil and adhesion agent in binder at ambient temperature or 15ºC	Litre Determine the quantities from either: - The target proportion of cutter, oil flux oil, or adhesion agent added to the binder; or - Measurement of actual volume of materials used.	All costs associated with the supply of cutter oil, flux oil and adhesion agent in the binder.
1143.6 Supply, precoat, apply aggregate	m^3 - Volume. - Determine the quantity of aggregate (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 aggregate
1143.7 Roll and incorporate aggregate	m^2	All costs associated with the rolling of aggregate
1143.8 Supply and place geotextile	m^2 - Pavement area covered	All costs associated with the supply and placement of geotextile to exclude laps and application of binder and aggregate.
1143.9 Sweeping	m^2	All costs associated sweeping prior to seal and post seal

5.3 NON COMPLYING MATERIALS

Non compliance

General: If the work or materials supplied is not within the standards defined for supply and application of sprayed bituminous surfacing, the Superintendent may direct:

- That the reduced service life arising from the non compliance is offset by reducing payment for the non complying portion of work or material by the method defined in **Schedule of Job Details**; or,
- With the consent of the Contractor, any other remedial treatment that is expected to provide the required level of service.

6 SELECTIONS

6.1 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 (1)
		Map ref. (1)	Chainage	Distance markers or ref. points				Type (2)	Desc (3)	Apps (4)	Size (s)	Class min (5)	PSV/ PAFV min (6)	veh/lane/day (7)	heavy eh. % (8)	Binder L/m^2 (9)	Agg. m^2/m^3 (10)	

1. Map references should nominate directory used
2. Treatment type: Prime only (PO), Primerseal (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 (D/D)
5. Aggregate Class: A, B or C (AS 2758.2)
6. Aggregate PSV or PAFV: 48 for Class A aggregates unless otherwise specified.
7. Veh/lane/day (v/l/d): Annual Average Daily (24 hr) Traffic / Number of traffic lanes.
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 measurement of surface and aggregate properties.
10. Estimated aggregate spread rate for tendering purposes only. Actual rates to be determined after measurement of aggregate ALD.
11. Other requirements may include job specific requirements such as binder type or surface pretreatment.

7 ANNEXURE A: PROCEDURE FOR PERFORMING SPRAYED SEALING WORKS

7.1 GENERAL

This section details the procedure, based on good practice, to achieve satisfactory outcomes and durable performance from sprayed sealing work. The following procedures may be incorporated in the Contractor's Quality Plan or provide a benchmark for assessing the effectiveness of the process standards adopted by the Contractor.

7.2 STORAGE AND HANDLING OF RAW MATERIALS

Aggregates

Requirement: Arrange and manage aggregate stockpiles in conformance with the following requirements:

- The maximum lot size limited to 250 m^3 (approximately 300 tonnes).
- Stockpiles each located on a firm level ground and effectively separated to prevent cross-contamination and interfere with the loading and/or precoating operations.
- Siting of stockpiles ensure adequate clearance between machinery and overhead power lines.
- Stockpiles managed to avoid environmental damage from dust or run-off of bituminous materials.
- The quantity and type of each stockpile clearly signposted on the stockpile at all times.
- Stockpiles covered, if necessary, to reduce contamination by dust or water.
- Recovery from stockpiles is to avoid contamination of aggregates.
- Contamination, weathering or reduction in effectiveness of precoating of aggregates in stockpiles to be rectified or the stockpile replaced.

Binder

Heating of binder: Heat binder in conformance with the manufacturer's written recommendations but never exceed 200°C. Do not use any bituminous material that has been overheated unless tested for compliance with the relevant specification. If no specific recommendation is provided, adopt the temperature guidelines set out in AAPA-2003.

Storage: Store binder in conformance with the temperature and time combinations specified in the manufacturer's written recommendation. Implement procedures for storage and handling of binder that ensure prevention of segregation and contamination of the binder by flushing liquids or other materials. Use straining devices at all times when transferring binders into sprayers to avoid particles of hardened bituminous material or other contaminants that could cause blockages in spraying jets.

7.3 CONDITION FOR COMMENCEMENT

Acceptance of surface condition

Inspection: Prior to commencing sprayed sealing work, make an inspection to determine any pavement defects that could adversely affect the quality of the finished work. Sprayed sealing work is not to proceed until defects have been corrected or agreement reached with the Superintendent's Representative on responsibility for consequences of any recorded defects.

Defects requiring correction may include, but are not limited to:

- Excessive moisture in unbound granular base to be primed or primersealed.
- Loose, poorly bonded, or inadequately compacted materials in the surface of unbound granular base to be primed or primersealed.
- Poorly shaped unbound granular base to be primed or primersealed.
- Presence of soft, fatty or bleeding patches in pavements to be resealed.
- Presence of uncured patching materials, crack sealing, etc.
- Presence of porous patches in surface to be resealed.
- Significant variations in surface texture requiring corrective treatment before resealing.
- Inadequate repair of weak or cracked pavements.
- Inadequate curing of primed surfaces prior to sealing.
- Inadequate curing of primersealed pavements (generally a minimum of 12 months for cutback bitumen primerbinders) prior to resealing.

Preparation of pavement surface

Surface preparation: Before the application of primer, primerbinder or binder, sweep pavement surface by the use of a rotary road broom or suction broom to provide a uniformly clean surface. If necessary, do additional sweeping by hand, using stiff brooms. Extend sweeping at least 300 mm beyond each edge of the area to be sprayed. If sealing work is carried out on localised areas and/or half pavement widths, remove from the pavement surface any remaining loose material immediately adjacent to the swept areas.

Remove adherent patches of foreign material from the surface of the pavement. Remove raised pavement markers.

Pavement temperature and weather conditions

Record of weather conditions: Conform to the following:

- Measure and record pavement temperatures at regular intervals during the course of the work using appropriate equipment and measurement procedures.
- If the pavement is partly in sun and partly in shade, record the temperatures for both conditions. The lower recorded temperature to be used as a basis for decisions on suitability for spraying and selection of cutter oil proportions.
- Spraying primers, primerbinders and binders only if the pavement temperature has been at or above for the temperature shown in **Table A1** at least one hour before commencement of spraying and does not fall below the recommended minimum pavement temperature during the period of spraying.
- Spray at temperatures below that recommended only if 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.

Table A1 Minimum pavement temperature

Type of work	**Minimum pavement temperature**
Priming	10°C
Primersealing	10°C
Sealing: - Class 170, Class 320 bitumen, Multigrade binder or bitumen emulsion - PMB binder (hot)	 15°C 20°C

Surface condition

General: Conform to the following:

- 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 primersealing: Damp, but not wet. If necessary, the pavement surface may be lightly watered shortly before applying the primerbinder.
- Surfaces for sealing: Dry and clean.

Environmental Risk

Risk assessment: The risk of environmental damage due to primer or primerbinder being washed off into adjacent drains and open watercourses as a result of rain on uncured materials must be considered as an element of an overall risk management plan. A guide to the risk of primer or primerbinder wash-off as a result of rain within stipulated periods after spraying is shown in **Table A2**.

Table A2 Priming Primersealing Risk Assessment

(From: *Guide for Environmental Management when Spraying Bituminous Materials, AAPA HS&E Guide No 8*)

(a) Cutback bitumen				
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	Moderate	Low	Low

(a) Cutback bitumen				
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, 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

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 shown.
2. Typical temperatures associated with different weather conditions are: Hot = 25ºC, Warm = 15–25ºC, Cool = 15ºC.
3. If risk is classified as unacceptable, application should be delayed until conditions improve.
4. If risk is classified as high, application should be delayed or the application and curing supervised 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 ensure prompt response to rain events.

7.4 PREPARATION OF AGGREGATES

Precoating of aggregate

Aggregate: Conform to either of the following:

- Precoated at the quarry, or on site, and stockpiled for later use, or
- Precoated on site, immediately prior to use.

Advance precoating is preferred to be done with a bitumen-based material that leaves a thin film of bitumen adhering to the aggregate. Bitumen based materials may be a mixture of bitumen, flux oil/cutter oil and adhesion agent or bitumen emulsion specifically formulated for use as aggregate precoating material. Bitumen/flux oil mixtures to be cured for a minimum of one week before use. Precoated aggregates that have been stockpiled for more than one month to be re-assessed for effectiveness of precoating and possible rejuvenation before use.

Precoating on site, for immediate use, to be done with either 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 to be added to oil based precoating materials at the rate of 1% by volume when aggregates are damp or the weather conditions are unfavourable with rain threatening or humid conditions.

Apply the aggregate precoating agent to the aggregate in a manner and at a rate and time which will provide a complete, light, uniform, effective cover of all aggregate particles at the time of spreading.

A guide to rates of application on clean, dry aggregates is given in **Table A3**. Dusty or dirty aggregates require a heavier rate of precoating than clean dry aggregates of the same type and size. For porous aggregates, rates may need to be increased by up to 2 L/m^3, and for smooth, hard aggregates, reduced by up to 2 L/m^3, from the values shown in **Table A3**. Generally, bitumen based materials and emulsions require heavier rates of application than oil based precoating materials.

Field precoating of aggregate for immediate use is not to be carried out when rain is imminent. If aggregate has been precoated and rain appears imminent, adequately cover the aggregate to prevent the fresh precoating material being washed from the aggregate particles.

Take precautions, such as covering stockpiles, to prevent settlement of dust, penetration of moisture or drying out of the precoating material on the stockpiled aggregate.

Table A3 Typical precoating rates (L/m^3)

Aggregate condition	**Precoating material**	
	Bitumen based, including bitumen emulsions	**Oil based**
Clean	6 to 12	4 to 10
Dirty	8 to 14	6 to 12

7.5 PREPARATION OF BITUMEN BINDER

Proportion of cutter oil

Determine and record the proportion of cutter oil required for each sprayer load. **Tables A4** and **A5** provide a guide to the proportions of cutter oil for Class 170 or 320 bitumen, multigrade binder and polymer modified binders, respectively.

Adding cutter oil: Binder to be within the temperature range shown in **Table A6** when cutter oil is incorporated. The sprayer load of cutback bitumen to be circulated at a rate of at least 700litres/min (approximately 350 rpm) for a minimum of twenty minutes before spraying.

Take care to ensure that any material that is to be added to hot binder is free of moisture. Materials considered at risk from moisture contamination, for example drummed materials stored in the open, should be checked with a water-finding paste before use. When adding cutter oil to standard bitumen binders, risks associated with moisture can be reduced by placing the cutter oil into a sprayer that has not been previously heated, followed by the hot bitumen.

When adding cutter oil to polymer modified bitumen binders, including crumb rubber binder, the cutter oil is to be added to the hot binder.

If a part sprayer load of field prepared cutback bitumen is unused on the day of mixing, and needs to be returned to the heater tanks, place it in a tank reserved for that purpose. No bitumen or cutter oil to be added to the returned cutback bitumen unless the tank is fitted with an effective circulation system. When the returned cutback bitumen is subsequently used as part of a sprayer load, make allowance for the cutter oil contained in the returned cutback bitumen.

Cutback bitumen to be within the temperature range shown in **Table A7** at the time of spraying. Spraying temperatures for proportions of cutter oil between those shown in the table may be established by interpolation.

Adding flux oil

If flux oil is to be included, it is to be added to the bitumen in the sprayer and the mixture circulated at a rate of at least 700 litres/min for 20 minutes before spraying. Take care to ensure that flux oil that is to be added to hot binder is free of moisture.

Adding bitumen adhesion agent

If bitumen adhesion agent is to be included, add it to the bitumen in the sprayer and the entire mixture circulated at a rate of at least 700 litres/min for 20 minutes, after addition of the last component, before spraying.

If bitumen containing adhesion agent is not used within 8 hours of mixing with hot bitumen, the active contribution of adhesion agent is to be ignored in subsequent use of the bitumen material. However, make allowance for the oil component of the adhesion agent in the returned bitumen.

Table A4 Basic Cutting Practice for Class 170 Bitumen and Multigrade Binder

(Parts by volume of cutter oil to be added to bitumen measured at 15ºC).

Aggregates of 10 mm nominal size or larger	**Aggregates of 7 mm nominal size or smaller**

Pavement temperature (ºC)	Traffic (vehicles/lane/day)			Pavement temperature (ºC)	Traffic (vehicles/lane/day)		
	< 100	100–1500	> 1500		< 100	100–1500	> 1500
15-19	10	8	6	15-19	12	10	8
20–25	8	6	4	20–25	10	8	6
26–32	6	4	2	26–32	8	6	4
33–38	4	2	0	33–38	6	4	2
39–45	2	0	0	39–45	4	2	0
>45	0	0	0	>45	2	0	0

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 15ºC, provided that sprayed sealing work should not be carried out at temperatures below 10ºC.
6. Subtract 5ºC 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.

Table A5 Guide to Cutting Practice for PMBs used in SAM and HSS Applications 1, 2
(Parts by volume of cutter oil to be added to 100 parts by volume of PMB-measured at 15°C) (Note 3)

Pavement Temperature4 (°C)	Traffic (veh/lane/day)	Class of PMB				
		S15E	S20E	S35E	S45R	
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	
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	

1. In SAMI applications, if the seal is to be covered by asphalt within a short period, it is undesirable to include any cutter oil at all. If cutter oil is considered necessary, it should be 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.
2. In aggregate retention applications using lower levels of polymer modification i.e. S10E, and some proprietary blends of PBD, the binder should be cut back as per normal Class 170 bitumen
3. If cutter proportions are added as percentage of total binder, the proportions shown here as parts per 100 parts of PMB may be taken as a reasonable approximation of percentage by volume.
4. Pavement temperature should generally be based on the worst condition, i.e., shaded areas.
5. Pre-blended crumb rubber grades may contain process oil used in their manufacture. This oil will most likely reduce the viscosity compared to field blended grades, and may allow a small reduction, say 2 parts, in added cutter oil compared to field produced grades.

6. At high rates of application of binder (greater than say 2 L/m^2) the proportion of cutter oil may be reduced by 2 parts.

Table A6 Binder Temperature

Binder	Temperature range (°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

Table A7 Cutback Bitumen Spraying Temperature

AS Grade (if applicable)	Equivalent Cutter Oil (%)	Temperature Range (°C)
AMC 00	56	ambient
AMC 0	44	35–55
AMC 1	34	60–80
AMC 2	27	75–100
AMC 3	21	95–115
AMC 4	16	110–135
AMC 5	11	120–150
	9	130–155
AMC 6	7	135–160
	5	145–170
AMC 7	3	150–175
	2	155–180

7.6 APPLICATION OF PRIMER, PRIMERBINDER AND BINDER

General

The area to be sprayed with primerbinder or binder is to be limited to the area that can be covered with aggregate within fifteen minutes of spraying.

Primer and primerbinder

The class and grade of primer and primerbinder to be as specified in **Schedule of job details**.

Application rates and quantities of primer and primerbinder applied to the mixture, including cutter oil or the water content of bitumen emulsion, are measured at 15°C.

After application of a primer, a period of at least seventy-two hours, or such longer period as determined to be necessary for the primer to become completely dry, is to elapse before the binder for a seal is applied. All traffic to be kept off the primed surface.

If it is necessary to give traffic limited access to the primed surface, the surface is to have a light layer of grit applied to avoid pickup. Gritting is not to be applied until a substantial proportion of the primer has been absorbed into the pavement.

Binder

The class or type of bitumen, modified bitumen, cutback bitumen, or bitumen emulsion is to be as specified in the **Schedule of job details**.

Nominated and target application rates and quantities of binder to be based on the volumes of bitumen measured at a temperature of 15°C and not include any adhesion agent and/or cutter oil or the water content of emulsions. If flux oil has been added to the bitumen, the quantity of flux oil is to be included as part of the binder.

If adhesion agent and/or cutter oil have been added to the binder, adjust the application rate of the total binder at 15°C to allow for the quantities of adhesion agent and/or cutter oil in the mixture.

Determine the forward speed of the bitumen sprayer based on either:

- the hot application rate of total binder, including adhesion agent and/or cutter oil, or
- allowances for temperature and proportion of adhesion agent and cutter oil, measured at 15°C.

Volume correction factors for converting volume of bituminous binders from 15ºC to elevated temperature, or from elevated temperature back to 15ºC are shown in **Tables A8** and **A9**.

Table A8 Volume Conversion Table – Bitumen (Including cutback bitumen)

MULTIPLY BY "A" TO REDUCE VOLUME AT T° TO VOLUME AT 15° MULTIPLY BY "B" TO INCREASE VOLUME AT 15°C TO VOLUME AT T°					
Multiplier A	**Temp. °C T**	**Multiplier B**	**Multiplier A**	**Temp. °C T**	**Multiplier B**
.9856	38	1.0146	.9189	148	1.0883
.9844	40	1.0158	.9178	150	1.0896
.9831	42	1.0172	.9166	152	1.0910
.9819	44	1.0184	.9154	154	1.0924
.9806	46	1.0198	.9142	156	1.0939
.9794	48	1.0210	.9130	158	1.0953
.9782	50	1.0223	.9119	160	1.0966
.9769	52	1.0236	.9107	162	1.0981
.9757	54	1.0249	.9095	164	1.0995
.9745	56	1.0262	.9084	166	1.1009
.9732	58	1.0275	.9072	168	1.1023
.9720	60	1.0288	.9060	170	1.1038
.9708	62	1.0301	.9049	172	1.1051
.9695	64	1.0315	.9037	174	1.1066
.9683	66	1.0327	.9025	176	1.1080
.9671	68	1.0340	.9014	178	1.1094
.9659	70	1.0353	.9002	180	1.1109
.9646	72	1.0367	.8990	182	1.1123
.9634	74	1.0380	.8979	184	1.1137
.9622	76	1.0393	.8967	186	1.1152
.9610	78	1.0406	.8956	188	1.1166
.9597	80	1.0420	.8944	190	1.1181
.9585	82	1.0433	.8933	192	1.1195
.9573	84	1.0446	.8921	194	1.1209
.9561	86	1.0459	.8909	196	1.1224
.9549	88	1.0472	.8898	198	1.1239
.9537	90	1.0486	.8886	200	1.1253
.9524	92	1.0500			
.9512	94	1.0513			
.9500	96	1.0526			
.9488	98	1.0540			
.9476	100	1.0553			
.9464	102	1.0566			
.9452	104	1.0580			
.9440	106	1.0593			
.9428	108	1.0607			
.9416	110	1.0620			
.9404	112	1.0634			
.9392	114	1.0647			
.9380	116	1.0661			
.9368	118	1.0675			
.9356	120	1.0688			
.9344	122	1.0702			
.9332	124	1.0716			
.9320	126	1.0730			
.9308	128	1.0743			
.9296	130	1.0757			
.9284	132	1.0771			
.9272	134	1.0785			
.9260	136	1.0799			
.9249	138	1.0812			
.9237	140	1.0826			
.9225	142	1.0840			
.9213	144	1.0854			
.9201	146	1.0868			

Table A9 Volume Conversion Table – Bitumen Emulsion

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**
1.0000	15	1.0000	1.0000	15	1.0000	1.0000	15	1.0000
.9998	16	1.0002	.9977	20	1.0023	.9974	20	1.0026
.9989	18	1.0011	.9951	25	1.0049	.9948	25	1.0052
.9980	20	1.0020	.9924	30	1.0076	.9921	30	1.0079
.9971	22	1.0029	.9899	35	1.0102	.9895	35	1.0106
.9962	24	1.0038	.9872	40	1.0129	.9868	40	1.0134
.9953	26	1.0047	.9840	46	1.0162	.9837	46	1.0166
.9944	28	1.0056	.9830	48	1.0172	.9826	48	1.0177
.9935	30	1.0065	.9819	50	1.0184	.9816	50	1.0187
.9926	32	1.0074	.9809	52	1.0194	.9805	52	1.0199
.9917	34	1.0083	.9798	54	1.0206	.9794	54	1.0210
.9908	36	1.0092	.9788	56	1.0216	.9783	56	1.0222
.9899	38	1.0102	.9777	58	1.0228	.9773	58	1.0232
.9890	40	1.0111	.9767	60	1.0238	.9762	60	1.0244
.9881	42	1.0120	.9752	62	1.0254	.9751	62	1.0255
.9872	44	1.0129	.9746	64	1.0260	.9740	64	1.0267
.9863	46	1.0138	.9736	66	1.0271	.9730	66	1.0277
.9854	48	1.0148	.9725	68	1.0282	.9719	68	1.0289
.9845	50	1.0157	.9715	70	1.0293	.9709	70	1.0300
.9836	52	1.0166	.9704	72	1.0305	.9698	72	1.0311
.9827	54	1.0176	.9693	74	1.0316	.9687	74	1.0323
.9818	56	1.0185	.9683	76	1.0327	.9677	76	1.0334
.9809	58	1.0194	.9672	78	1.0339	.9667	78	1.0344
.9800	60	1.0204	.9662	80	1.0349	.9656	80	1.0356
.9791	62	1.0213	.9651	82	1.0361	.9643	82	1.0370
.9782	64	1.0222	.9640	84	1.0373	.9630	84	1.0384
.9773	66	1.0232	.9630	86	1.0384	.9616	86	1.0399
.9764	68	1.0241	.9619	88	1.0396	.9603	88	1.0413
.9755	70	1.0251	.9608	90	1.0407	.9590	90	1.0427

7.7 APPLICATION OF SPRAYED BITUMINOUS SURFACING

Plant

Use a mechanical sprayer to apply primer, primerbinder and binder. The sprayer is to have a current Sprayer Certificate issued by a NATA accredited testing authority. Keep a copy of the test certificate with the sprayer.

A register of accredited sprayers is maintained by AAPA and available on the AAPA Web Site (www.aapa.asn.au).

The spray nozzles are to be of the make and type endorsed on the Sprayer Certificate. Any nozzles that may be damaged or become unduly worn or defective are to be replaced.

Use mechanical spreading equipment to spread aggregate which is capable of achieving a uniform spread rate.

Rollers to be pneumatic tyred multi-wheel rollers with a minimum mass of 7 tonnes, smooth tyres and a minimum tyre pressure of 550 kPa, or combination rollers having a rubber coated, vibratory drum on one axle and pneumatic tyres on the other. Rollers must be capable of achieving effective incorporation of aggregate into the binder without breakdown or crushing of the cover aggregate.

Remove from the work any plant or equipment not fully operational or not in a satisfactory condition for carrying out work in conformance with this worksection.

Operation of the sprayer

The type of spray nozzles to be used on the spray bar of the sprayer is to be compatible with the nature of the binder to be sprayed and its application rate.

Where the longitudinal edges of spray runs are not required to overlap, either special type end nozzles or intermediate nozzles set with a jig as end nozzles may be used. Where an overlap is required, the overlap of spray between adjacent longitudinal runs to be 50 mm for special type end nozzles or jig set intermediate nozzles. If intermediate nozzles, set in the normal manner, are to be used to overlap adjacent longitudinal sprays, the overlap is to be 300 mm.

The spraying of primer, primerbinder or binder for each run of the sprayer is to commence on a protective strip of heavy paper laid across, and held securely to, the pavement surface beforehand. The sprayer is to commence moving at a sufficient distance in advance of the protective strip to ensure that the road speed for correct application is attained at the commencement of spraying.

The sprayer to maintain a constant road speed throughout the length of each sprayer run.

The spraying for each run to terminate on protective paper laid across, and held securely, to the pavement surface beforehand.

Cease spraying immediately any defect develops in the spraying equipment and the fault rectified before further spraying.

If any blockage or partial blockage of nozzles occurs, cease spraying immediately. Spraying is not to recommence until the cause of the blockage is identified and rectified.

Areas not within 5% of the target application rate of primer, primerbinder or binder shall constitute a 'Non-conformance' under the contract.

If a mechanical sprayer is not able to satisfactorily spray small areas or areas of irregular shape, spray such areas by means of the hand spray equipment attached to the sprayer.

After each sprayer run, check the quantity of binder sprayed against the area covered. If the actual application rate is not within specified limits, make adjustments to ensure that the target application rate is achieved in subsequent runs.

Temperature

Measure and record the temperature of the binder.

If the temperature of the bituminous material is below the applicable lower limit from **Tables A6** or **A7**, the bituminous material may be heated provided that safe heating practices are adopted. All heating activities to conform to the Austroads AP-G41 *Bitumen Sealing Safety Guide*.

Do not use burners unless the level of the material in the heating tank is at least 150 mm above the tops of the heating tubes, or as indicated by the manufacturer of the equipment. Two or more suitable fully charged pressurised chemical fire extinguishers to be placed conveniently to the heaters at all times while heating is in progress.

During heating, the temperature of the bituminous material not to exceed the applicable upper limit from **Tables A6** or **A7**. The rate of heating is not to exceed the rate shown in **Table A10**. Materials to be circulated at all times while heating and for a further minimum of 15 minutes after burners are turned off.

Table A10: Maximum Heating Rate for Bituminous Materials

Material	**Maximum Heating Rate (°C/hr)**
Bitumen & Multigrade binder	40
Cutback Bitumen: - Priming grades - Primersealing grades - Sealing grades	 30 30 30
Crumb rubber bitumen	40
Polymer modified binder	Refer manufacturer's recommendations
Bitumen emulsion	15

Geotextile

Apply geotextile if nominated in the **Schedule of details**. 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. The rate of application of tack coat is 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).

Joins to be butt joined or overlapped by a minimum of 200 mm as specified in the **Schedule of details.** Longitudinal joins not to be placed in wheel paths.

Work records

Record details of the work performed. Details of primer, primerbinder, binder and aggregate applied to be recorded immediately after every sprayer run. Each form is to be signed by the Contractor's representative as a true record of the work performed. Supply to the Superintendent a copy of each completed form.

Control of traffic

Provide for traffic in conformance with the requirements of AS 1742.3 while undertaking the work and take all necessary precautions to protect the work from damage until such time as the new seal coat has developed sufficient strength to carry normal traffic without disturbance of the aggregate. Where early use of the new seal is needed to facilitate the movement of traffic, vehicles may be allowed to run on the work after initial rolling has taken place provided that vehicles are controlled to such slow speeds that no displacement of aggregate occurs. Where necessary, use patrol vehicles to ensure that traffic travels at an acceptable speed.

Take all necessary steps to avoid or minimise delays and inconvenience to road users during the course of the work. Where adequate detours or sidetracks are included in the Contract or are otherwise available, direct traffic temporarily while the work is in progress.

If facilities for the diversion of traffic are not available, spray part width of the pavement in the one operation and make available to traffic the adjacent strip of roadway or schedule spraying operations in such a manner so as to restrict traffic delays to a maximum of 15 minutes. All traffic movement through the work are to cease during the actual spraying operation.

Detailed records of traffic control including control device type, precise location of device and the time at which such device was installed and removed, to be maintained throughout the works and then kept on file.

7.8 SPREADING AND ROLLING OF AGGREGATE

Proceed with spreading of aggregate as soon as practical after spraying of the binder has commenced and complete within fifteen minutes of spraying.

Apply the aggregate of the specified nominal size and at the target aggregate application rate. The method to determine the actual aggregate spread rate is to be detailed in the Quality Plan. Ensure that sufficient loaded and measured trucks of aggregate are at the site to provide full cover for the area sprayed.

Spread the aggregate uniformly over the sprayed surface by means of suitable mechanical spreading equipment.

Calibrate spreaders with aggregate from the stockpile to be used for the work. Calibration is best done off-road. A calibration site needs to be of sufficient length to allow the aggregate spreading unit to reach normal operational speed before applying the aggregate. Calibration can be done with standard calibration mats or by painting 1 m^2 areas on the test site. The total width of the aggregate spreader must be calibrated.

Any bare or insufficiently covered areas to be re-run by the mechanical spreader or covered by hand as necessary to give a uniform and complete coverage. Remove any local excess of aggregate before rolling is commenced.

Supply sufficient rollers to ensure that total area sprayed receives the minimum coverage (roller hours) derived from **Table A11**. Allow adequate time at the end of the day's work to ensure that the last materials spread receive the same amount of rolling as that placed earlier in the day.

After the aggregate has been applied to each section of the work, carry out initial rolling with one or more rollers complying with Application of primer, primerbinder and binder.

Continue initial rolling until the aggregate is firmly adhered to the primerbinder or binder.

Reduce the amount of rolling while the aggregate is wet, but resume normal rolling as soon as aggregate dries. Trafficking during this period to be avoided, or kept to a minimum speed, until aggregate has dried sufficiently for adhesion to be established.

Table A11 Area that can be effectively rolled, per hour, with each pneumatic tyred multi-wheel roller

Aggregate size (mm)	**Traffic Volume (vehicles per lane per day)**		
	< 300	**300–1200**	**> 1200**
	Area – m^2 per roller hour		
7 or smaller	4500–5000	5000–5500	5500–6000
10	3000–3500	3500–4000	4500–5000
14	2500–3000	3000–3500	3500–4000

If the aggregate is not evenly distributed over the surface of the pavement, traverse the surface with a light drag broom after the initial rolling. If the broom has any tendency to dislodge aggregate particles bedded in the primerbinder or binder, defer or eliminate the drag brooming. Where drag brooming is eliminated, the Contractor may substitute light hand brooming.

Then carry out backrolling until the effective amount of rolling in terms of roller hours for the total area sprayed achieves that shown in **Table A11**.

When the aggregate has been evenly distributed and adhered to the binder, remove any remaining loose particles of aggregate from the pavement.

Variations to spreading and rolling procedures are to be applied to different types of seals as follows:

- Single/single seals A single application of aggregate is to be applied on a single application of binder and then the seal is rolled and, where necessary, brooming carried out as described above.
- Single/double seals In a single/double seal, the second application of aggregate is applied after initial rolling of the first application, and before final rolling and trafficking.
- Double/double seals Where both applications of binder and aggregate are to be applied on the same day, the first application of binder and aggregate to be completed as described above, except that the aggregate application is reduced by approximately 10% compared to that required for a single/single seal. The second application of aggregate, following the second application of binder, is to be applied at a rate that is just sufficient to fill the voids in the first application, and rolling and removal of any remaining loose aggregate completed as described above. Where the binder in the first application is a bitumen emulsion, the second application must not be applied until the binder in the first coat is completely broken to form a stable seal.

Where the first application of a double/double seal is to be trafficked for a short period of time, generally not exceeding several weeks, the first application is to be completed as a single/single seal and the aggregate in the second application reduced by about 30% to occupy the voids in the first application.

Where the second application is applied after a significant period of trafficking, both applications are to be completed as single/single seals.

8 ANNEXURE B: NOTES FOR IMPLEMENTATION AND USE OF SPECIFICATION CLAUSES

HEADINGS BELOW RELATE TO THE CLAUSE TITLES USED IN THE MAIN BODY OF THE WORKSECTION

8.1 GENERAL

Applicability

General: The worksection covers the supply of materials and application of sprayed sealing. It is applicable to contract works where the Principal defines the type of treatment required and the Contractor undertakes those activities associated with supply of materials, determination of application rates of binder and aggregate, preparation and spraying of binder, preparation and application of aggregates, rolling of aggregates and clean-up of completed work. Where some of the activities described in this worksection are undertaken by others, responsibility for the relevant items must be clearly defined in the **Responsibilities**.

This worksection will normally be used as contract documentation in conjunction with a standard General Conditions of Contract such as AS 2124. Contract documentation may also include other works. The terms used in the worksection guidelines are consistent with AS 2124, and include Principal, Superintendent, and Superintendent's Representative. Where these terms are in conflict

with those otherwise used, a general interpretation clause should be inserted in the contract documents.

Schedule of Details: The type of seal, class and nominal size of aggregate and any special binder requirements should be specified in the **Schedule of Job Details**.

Careful consideration of the Schedule of Job Details is required to ensure that the sprayed seal is of the appropriate type and quality, and provided in a cost effective manner.

Surface preparation: Preparation of surfaces under this worksection is limited to preliminary sweeping and cleaning of surfaces immediately prior to spraying of bituminous material. The scope of work does not include preparation of granular pavements for priming or primersealing, rectification or maintenance of surfacings prior to resealing or the reinstatement of linemarking, raised pavement markers, etc.

Surface preparation is extremely important to the success of sprayed sealing work. Granular pavements should be prepared to a smooth dense surface and dried back to a suitable moisture content (typically 70% of saturation level) to avoid weakening of the granular pavement with trapped moisture. Preliminary work for retreatment of existing surfacings should be carried out well in advance of sealing work (typically six weeks or more). Embedment of aggregate and variable texture of patches is a major cause of blemishes in finished work. Effective application of sprayed seals requires an underlying surface of uniform texture. Corrective treatments may be required for variable surfaces prior to, or in conjunction with sprayed sealing treatments.

Notes on the preparation of pavements are provided in **Annexures A** and **B**. Further detailed guidance for the selection of sprayed seal treatments and preparation of surfaces is provided in the Austroads AGPT03 *Pavement Surfacings*, AGPT04K *Seals*, AGPT/T190 *Specification framework for polymer modified binders and multigrade bitumens* (www.austroads.com.au/pavements), AP-T42/06 *Guidelines for the Selection and Use of Modified Binders.*

Quality systems

The quality requirements of *0161 Quality (Construction)* are designed to apply the AUS-SPEC quality system requirements.

The following paragraphs may be substituted if desired:

'The Contractor shall establish, implement and maintain a Quality System in conformance with this worksection and the requirements of AS/NZS ISO 9001, or a recognised equivalent.'

'Where required in the contract general clauses, the Contractor shall submit a Quality Plan prior to commencement of any works. The Quality Plan shall take into account the specific requirements for inspection and testing, acceptance/rejection criteria, details of proposed methods and other quality requirements that are contained in the Contract Documents. Appendix B provides Guidelines for process items which may be included in the Quality Plan. No part of the Quality System shall be used to pre-empt or otherwise negate the technical requirements of the contract documents.'

Depending on project type and performance risk, the Principal may undertake an audit of a Contractor's Quality System and/or Quality Plan as part of prequalification or contract acceptance procedures. The Principal may also establish additional procedures for surveillance of contract activity and audit/verification of quality of materials and testing.

8.2 MATERIALS

Bituminous materials: The type and/or grade of primer, primerbinder or binder should be specified in **Schedule of Job Details.**

Cutback bitumen for priming and primersealing (and occasionally for sealing) may be specified in terms of the following alternatives:

- Standard grades of cutback bitumen manufactured conforming to AS 2157;
- Cutback bitumen produced in the field by blending Class 170 bitumen with an appropriate type and proportion of cutter oil in a bitumen sprayer, tanker, etc.;
- Proprietary grades of cutback bitumen;
- Standard grades of bitumen emulsion conforming to AS 1160;
- Proprietary grades of bitumen emulsion.

Suppliers of proprietary products should be required to submit their own product specifications for use as a basis for quality control.

Depending on their viscosity, standard grades of cutback bitumen are classified as follows:

- Priming classes (AMC00, AMC0, AMC1);
- Primersealing classes (AMC2, AMC3, AMC4);
- Sealing classes (AMC5, AMC6, AMC7).

When used for primersealing, an adhesion agent (usually 1%) should be added to cutback bitumen primerbinders. Adhesion agents may also be added to priming classes, although this is not mentioned in AS 2157.

A guide to the properties of cutback bitumen is provided in **Tables B1** and **B2**. **Table B1** provides a guide to the proportions of cutter oil required for field preparation of cutback bitumen. **Table B2** provides a guide to practical grades of cutback bitumen primer and primerbinder for various applications based on the viscosity of the binder.

The selection of particular priming and/or primersealing products should be based on field trials or experience. Guidance on the selection of grade and application rate of primer and primerbinder is given in **Design of spray seals**.

Generally, Class 170 (also Class 320) bitumen is used as the binder for sprayed sealing work with the addition of cutter oil as required, depending on ambient conditions. Modified binders, as well as bitumen emulsion, may also be used. Guidance on the selection of modified binders and other binders for special application is provided in the references outlined in GENERAL, above.

The use of standard grades of cutback bitumen for sealing is uncommon, as sealing binders are generally prepared at the time of application with the proportion of cutter oil adjusted to the ambient conditions at that time.

Table B1 Field preparation of medium curing cutback bitumen

Class (AS 2157 designation)		**Approx. parts kerosene per 100 parts bitumen (vol. at 15°C)**	**Equivalent percent of kerosene (vol. at 15°C)**	**Viscosity at 60°C (Pa.s)**
Precoating and priming classes	AMC00	127	56	0.008–0.016
	AMC0	78	44	0.025–0.05
	AMC1	51	34	0.06–0.12
Primersealing classes	AMC2	37	27	0.22–0.44
	AMC3	27	21	0.55–1.10
	AMC4	19	16	2.0–4.0
Sealing classes	AMC5	12	11	5.5–11.0
	AMC6	7	7	13.0–16.0
	AMC7	3	3	43.0–86.0

Table B2 Grades of primers and primerbinders

Grade	**Viscosity Range Pa.s @ 60°C**
Primer:	
– Very light	0.010–0.020
– Light	0.025–0.050
– Medium	0.050–0.080
– Heavy	0.080–0.200
– Very Heavy	0.200–0.400
Primerbinder:	
– Light / Medium	1.0–3.0
– Heavy	4.0–7.0

Aggregate: The worksection refers to AS 2758.2, which requires the user to select from a number of options for determination of aggregate hardness and soundness. These options tend to have been developed around the tests considered to provide the most suitable characterisation of the various stone types found in different localities. As a general rule, the standards are applied on a state by state basis as follows:

- Soundness based on Los Angeles Abrasion and Unsound Stone Content: Victoria and Western Australia.
- Soundness based on Ten Percent Fines Value and Wet/Dry Strength Variation: All other States.

AS 2758.2 provides for three classes of aggregate based on the following pavement classifications:

- Class A – premium quality aggregates suitable for freeways, highly trafficked highways or pavements carrying a high volume of heavy vehicles.
- Class B – aggregates suitable for highways or main roads carrying medium traffic volumes, medium to lightly trafficked pavements, general parking areas and similar.
- Class C – aggregates suitable for lightly trafficked roads.

The class of aggregate should be nominated in the **Schedule of job details** as well as the minimum value of polishing resistance (PSV or PAFV), if required. For general application, a minimum value of 48 should be specified for applications where Class A aggregates are required. No minimum value of PSV or PAFV is usually required for Class B or Class C applications. Surface friction requirements will vary according to the risks associated with operating environment or particular sites, which will also influence design factors associated with surface texture. This may lead to the adoption of higher or lower minimum polishing resistance values for some applications.

8.3 DESIGN OF SPRAY SEALS

General: A distinction is made between selection of treatment type and determination of application rates of binder and aggregate for a selected sprayed seal treatment type. The worksection requires the Contractor to determine rates of application using Austroads AP-T68/06 *Sprayed Seal Design Method.*

In the context of this worksection, the Principal is required to nominate the treatment type as well as provide sufficient information for an accurate assessment of traffic volume for determination of binder application rates.

The traffic volume should be based on actual traffic counts, including the proportion and distribution of heavy vehicles. Where actual traffic counts are not available, or difficult or impractical to measure, a reasonable estimate should be made based on expected usage. Estimates of traffic should only be used for low volume roads. Actual measurement of traffic volumes is particularly important at high traffic volumes or where there is a large proportion of heavy vehicles. Traffic counts should also take into account seasonal variation such as local events, crop harvesting or seasonal tourist traffic. Generally, summer traffic volumes are more critical to design of application rates than winter traffic volumes.

Further critical inputs to determination of application rates using the AP-T68 Method include condition and texture of the existing surface and measurement of aggregate properties.

Estimates of existing surface conditions and aggregate average least dimension (ALD) may be made by the Principal as a basis for determining nominal rates of application for tendering purposes. Before commencing spraying operations, nominal rates of application must be checked by the Contractor, and adjusted as necessary, based on actual measurement of surface texture and aggregate grading, shape and ALD determined from testing of materials sampled from stockpiles of the aggregates to be used on the work. Variations to texture within the job and use of corrective treatments must be noted. Aggregate properties must be determined on current materials and not be based on assigned values or estimates from previous work.

Geotextile Reinforced Seals: Binder application rates for geotextile reinforced seals should be determined in conformance with standard procedures (AP-T68 Method). The binder retention allowance will depend on the grade or thickness (mass) of the fabric and may vary between different manufacturers. Typical allowances are shown in **Table B3**, however, guidance on the selection of a binder retention allowance should be sought from the geotextile supplier or may be determined using test method ASTM D6140.

A minimum fabric mass of 130 g/m^2 is used for general sealing applications. On soft substrates, such as initial treatment on low quality granular base materials, heavier grades of fabric (175 g/m^2 to 200 g/m^2) should be used to minimise the potential for aggregate to puncture the fabric, particularly when using aggregates of 14 mm nominal size, or greater.

Austroads AP-T37/05 *Geotextile Reinforced Seals* should be consulted for guidance on field procedures.

Priming: A guide to selection of grade of cutback bitumen primer and primer application rates is shown in the **Table B4**.

Standard grades of bitumen emulsion are generally not suitable for priming but proprietary grades have been developed that should be used in conformance with manufacturer's guidelines.

Primersealing: A guide to the selection of type and grade of primerbinder is shown in **Table B5**.

The aggregate size will depend on traffic and climatic conditions. For less than 1200 vehicles/lane/day, 5 mm or 7 mm size aggregate is appropriate, and for higher traffic situations use 7 mm or 10 mm size aggregate. However, if the conditions are either very hot or wet and the traffic is in excess of 600 v/l/d, a 10 mm size aggregate may be used. The use of 10 mm aggregate may, however, result in a coarse texture that requires extra consideration in the placing of the subsequent seal.

There are no formal design procedures for primerbinder application rates for primerseals. **Table B6** offers some practical guidelines. The basic primerbinder application rates shown may need to be adjusted in line with allowances for absorption, existing surface condition and embedment. Austroads Commentary to AG:PT/T252 – Penetration of road bases by bituminous primers or primerbinders, may also provide assistance in estimating pavement absorption (www.austroads.com.au/pavements).

The primerbinder application rates shown refer to the total volumes of the mixtures (i.e., including cutter oils and/or water content) expressed at 15°C.

Aggregate spread rates should be:

- For 5 mm and 7 mm aggregates: 130 m^2/m^3 - 150 m^2/m^3
- For 10 mm aggregates: 110 m^2/m^3 - 130 m^2/m^3.

Table B3 Typical Geotextile Retention Allowances

Geotextile grade	**Retention allowance (L/m^2)**
130 - 140g/m^2	0.9 to 1.0
175 - 200g/m^2	1.1 to 1.3

Table B4 Guide to grade and rates of application of primer

Pavement	**Primer**	
	Grade	**Rate of Application L/m^2**
Tightly bonded	Light	0.6–1.1
Medium porosity	Medium	0.8–1.1
Porous	Heavy to Very heavy	0.9–1.3
Limestone	Heavy to Very heavy	2 applications: -1st @ 0.7–0.9 -2nd @ 0.5–0.7
Sandstone	Heavy to Very heavy	2 applications: -1st @ 0.7–0.9 -2nd @ 0.5–0.7
Hill gravels, granitic sands	Light	0.8–1.1
Stabilised	Very light to Light	0.5–0.8
Concrete	Very light	0.2–0.4

Table B5 Selection of type and grade of primerbinder

Primerbinder	**Recommended use**
Light-medium grade of cutback bitumen	- Cool and/or damp conditions. - Tightly bonded or medium porosity type pavements.
Heavy grade of cutback bitumen	- Warmer and/or dry conditions - Porous type pavements.
Bitumen Emulsion (60% and 67% bitumen content)	- All year, but more suited to cool and/or damp conditions - Porous type pavements - When final surfacing is to be applied immediately or within 3 months.

Table B6 Basic primerbinder application rates

Traffic (v/l/d)	Aggregate Size	Total Primerbinder Application Rate (L/m^2 @ 15°C)		
		Cutback Bitumen	Bitumen Emulsion	
			60%	67%
≤ 150	7 or 5 10	1.3 1.4	1.6 1.8	1.4 1.6
151–1200	7 or 5 10	1.2 1.3	1.5 1.6	1.3 1.4
> 1200	7 or 5 10	1.1 1.2	1.4 1.5	1.2 1.3

8.4 APPLICATION OF SPRAYED SEALING

The worksection does not include detailed procedures for carrying out sprayed sealing work. A general guide to good practice is provided in the Appendix to the worksection. The detailed provisions of are not mandatory but it is expected that the Contractor will adhere to the principles described and incorporate relevant procedures in his own Quality Plan. A guide to evaluating and auditing of quality plans and surveillance of contract activity is provided in a separate document prepared jointly by Austroads and AAPA (AP-T40/05).

8.5 REMOVAL OF LOOSE AGGREGATE

Removal of loose aggregate can generally commence when initial aggregate adhesion and interlock has been completed by rolling and traffic, the binder has hardened to a state where no more aggregate can be pressed into it, and the seal is less prone to damage by sweeping.

Factors that influence the timing of aggregate removal include:

- Traffic volume/road class.
- Type of binder.
- Aggregate size.
- Ambient temperature/pavement temperature.

High traffic volumes will rapidly fix aggregates into the binder so that removal of surplus stones may commence within a few hours of spreading. High traffic volumes are also often associated with roads in urban areas and other situations where it is important to minimise risks associated with loose aggregate, so that removal is often undertaken within about 12 hours of spreading.

On lighter trafficked roads, a period of up to 48 hours may be allowed to elapse before completing the removal of excess aggregate, provided the safety of the travelling public is appropriately considered.

Polymer modified binders develop cohesion more rapidly, particularly at higher ambient temperatures, so that aggregate removal can often be undertaken on the same day.

Emulsion binders develop cohesion more slowly. Up to 48 hours curing may be necessary, in some circumstances, before sweeping can be undertaken without a high risk of damage to the seal.

Extra care is required at higher temperatures, particularly in sunny conditions and air temperatures of 30°C or more. In such circumstances it is preferable to undertake aggregate removal at night or early morning, when air and pavement temperatures are lower.

In urban areas, the use of a vacuum broom or suction sweeper to uplift and remove aggregate from site as well as removal from kerb and channel, adjoining paved areas, etc. should be specified. In rural areas, where loose aggregate can be safely swept onto unpaved verges, uplifting and removal of aggregate from site is generally not necessary.

8.6 REMOVAL OF SURPLUS AND WASTE MATERIAL

Special requirements for disposal of surplus aggregate at stockpile sites should be specified in additional clauses or included in the schedule of job details.

8.7 PROTECTION AND CARE OF NEW WORK

Generally the Contractor is responsible for protecting the new work and correction of 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.

8.8 SAMPLING AND TESTING

The worksection requires the Contractor to prepare a schedule for the nominated items. The Principal may, however, choose to specify test methods and minimum frequency of sampling and testing.

8.9 MEASUREMENT AND PAYMENT

The worksection provides for two alternatives, measurement by area only, or measurement of actual quantities used.

Measurement and payment by area may be used for straightforward works where conditions are readily identifiable at the time of tender.

Measurement by quantity of material supplied allows for variation in the design rates of application of binder and aggregate and compensation for actual amounts of cutter oil based on the conditions at the time of spraying. In such cases, the schedule may nominate provisional rates of application or quantities for tendering purposes, but incorporate schedule items for actual quantities or variations to rates of application. This type of payment schedule is particularly applicable to contracts incorporating a range of types or location of works.

Schedule items may also be included for other special items such as geotextiles, and for additional works such as reinstatement of raised pavement markers and linemarking, if required.

A typical schedule of rates is shown in **Table B7**.

Table B7 Typical Schedule of Rates

Activity	**Unit**	**Rate**
Control traffic to worksite	m^2	
Sweep surface prior to seal: - Gravel pavements - Sealed pavements	 m^2 m^2	
Supply and spray binder @ 15ºC	Litre	
Supply, incorporate and spray cutter oil @ 15ºC	Litre	
Supply, incorporate & spray Adhesion agent @ 15ºC	Litre	
Remove existing raised pavement markers	each	
Protect existing raised pavement markers	each	
Supply and install temporary raised pavement markers	each	
Supply, load, haul and spread precoated aggregate	m^3	
Roll and incorporate aggregate	m^2	
Post-sweep of seal including stone counts: - With rotary broom - With suction broom as stipulated	 m^2 m^2	
Supply and place geotextile	m^2	
Load, haul and spread additional where closest available stockpile greater than 5 km from jobsite	m^3/km > 5 km	

8.10 SELECTIONS

The following actions should be taken in the preparation of the **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(s).
- 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 test methods and frequency of testing, if applicable.
- Prepare and insert special clauses for payment for non complying materials, 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.

1144 ASPHALTIC CONCRETE (ROADWAYS)

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Provide various categories of hot mixed asphalt for roads and related applications, as documented, comprising:

- Asphalt materials.
- Asphalt mix design requirements.
- Process control in manufacture and placement of asphalt.
- Acceptance criteria for asphalt.
- Quality systems, minimum process standards, plant requirements and sampling and testing frequencies.

Design

Designer: Design the asphalt mixes.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

AS 1141	Methods for sampling and testing aggregates
AS 1141.17-1995	Voids in dry compacted filler
AS 1141.25.3-2003	Degradation factor - Fine aggregate
AS 1160-1996	Bituminous emulsions for the construction and maintenance of pavements
AS 1672	Limes and Limestones
AS 1672.1-1997	Limes for Building
AS 2008-1997	Residual bitumen for pavements
AS 2124-1992	General conditions of contract
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 3582	Supplementary cementitious materials for use with portland cement,
AS 3582.1-1998	Fly Ash
AS 3582.2-2001	Slag – Ground Granulated Iron Blast-Furnace.
AS 3940-1990	Quality control - Guide to the use of control chart methods including Cusum techniques
AS 3942-1993	Quality control - Variables charts - Guide
AS 3972-2010	General purpose and Blended Cements
AS/NZS/ISO 9001:2008	Quality Management Systems – Requirements

Other publications

RMS

NSW RMS Test Methods

QA Specification 3253-2009 Bitumen for pavements.

AAPA

AAPA 2004	National asphalt specification 2004
AAPA Advisory note 7-2003	Guide to the selection, heating and storage of binders for sprayed sealing and hot mixed asphalt.
AAPA IG-3-2004	Asphalt plant process control guide (Implementation Guide series)

AUSTROADS

AP-T41-2006	Specification framework for polymer modified binders and multigrade bitumens
AGPT02-2012	Guide to Pavement Technology Part 2 – Pavement structural design.
AGPT03-2009	Guide to Pavement Technology Part 3 – Pavement surfacings
AGPT04B-2007	Guide to Pavement Technology Part 4B - Asphalt
AGPT04E-2009	Guide to Pavement Technology Part 4E – Recycled materials
AGPT04F-2008	Guide to Pavement Technology Part 4F - Bituminous binders
AGPT04J-2008	Guide to Pavement Technology Part 4J - Aggregate and source rock
AGPT04K-2009	Guide to Pavement Technology Part 4K - Seals

1.4 STANDARDS

General

Standards: To AAPA National asphalt specification, AGPT02, AGPT03 and AGPT04B.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the abbreviations given below apply.

- AC: Asphaltic concrete.
- FGGA: Fine gap graded asphalt.
- OGA: Open graded asphalt.
- RAP: Reclaimed asphalt pavement.
- SMA: Stone mastic asphalt.
- UTOGA: Ultra thin open graded asphalt.

Definitions

General: For the purposes of this worksection the definitions given below apply:

Asphalt mixes: Dense graded asphalt mixes have been classified:

- In terms of position in the pavement (wearing course or base course) and
- Traffic category (Light, Medium, Heavy and Very Heavy). Where relevant, the same traffic categories to apply to other mix types.

The particular mixes to be used to be nominated in the **Schedule of job details**. Dense graded hot mix asphalt is also known as asphaltic concrete and designated by the abbreviation 'AC'.

1.6 SUBMISSIONS

Planning requirements

Testing: Conform to the following:

- Testing: All testing of properties required by the worksection is to be undertaken in a laboratory registered by the National Association of Testing Authorities (NATA) for the appropriate tests and performed in accordance with procedures contained in the relevant Australian Standard or Austroads *Manual of Test Procedures.*
- Where there is no applicable Australian Standard or Austroads Test Method, or where the Standard or Manual provides a choice of procedures, adopt the method endorsed by the relevant State Road Authority in the State in which the work is being undertaken.

Register and Insure Plant: Conform to the following:

- Register and insure all plant as appropriate to its use on a public road. Plant to comply with statutory environmental regulations. This is a **HOLD POINT**.
- Provide all the plant and equipment and labour necessary for carrying out the work in accordance with this worksection.
- All plant and equipment used on the work is to be suitable and in accordance with the Contractor's submitted quality documentation and kept in good operating condition.

- Do not use in the work any plant or equipment demonstrated to be faulty in operation so as to effect the product quality or unsafe in operation as assessed by the Superintendent. This is a **WITNESS POINT**.

Control of Traffic: Conform to the following:

- Provision for traffic: Provide for traffic in accordance with 1101 *Control of traffic* while undertaking the work.
- Take all necessary steps to avoid or minimise delays and inconvenience to road users during the course of the work but without compromise to the safety of the employees and the road users.

Approvals

General: Comply with Superintendent approval.

Components

General: Refer to **Materials**.

Design

All asphalt mixes: Refer to **Mix Design**.

Drawings

General: Prepare drawings or other document.

Execution details

General: Conform to worksection requirements.

Materials

General: Refer listed materials for submissions.

Type tests

General: Submit previously designed mix. Refer Approval of Job Mix.

1.7 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause/subclause	Requirement	Notice for inspection	Release by
Submissions – Planning requirements	Evidence that plant is registered and insured	2 weeks before using plant	Superintendent
Aggregate			
Source	Selection of criteria for coarse aggregate hardness and durability	7 days before proceeding with selection	Superintendent
Mineral filler	Submit evidence of quality and effect of material on the properties of the asphalt mix	7 days before proceeding with mix	Superintendent
Mix design			
General	Submit mix design for Superintendent approval	14 days before using mix	Superintendent
Design of asphalt mixes incorporating RAP	Mixes containing more than 30% RAP to be submitted for assessment	7 days before using mix	Superintendent
Approval of Job Mix - General	Provide information in formatting specified to allow assessment	7 days before using mix	Superintendent
Approval of Job Mix - Approval to use previously designed mix	Details of previously designed mix to be submitted	7 days before commencing production	Superintendent
Sampling and testing			

Clause/subclause	Requirement	Notice for inspection	Release by
Frequency of sampling and testing	Frequency varied to correct non-conformance	24 hours after non-conformance identified	Superintendent
Non complying materials – Non compliance	Assessment of valuation or remedial procedure	24 hours after non-conformance	Superintendent
Delivery – work records	Submission for counter signing	Each day for daily completion	Superintendent
Placing			
Spreading	Procedure proposed for low temperature spreading	24 hours before proposed spreading	Superintendent
Joints	Submit plan of joints location for approval	7 days before commencing	Superintendent

WITNESS POINTS table

Clause/subclause	Requirement	Notice for inspection
Submissions – Planning requirements	Superintendent to assess faulty plant	Progressive
Aggregate – General	Source subject to inspection and approval of Superintendent	3 weeks before importing aggregate
Mix design – Approval of Job Mix	Submission of samples of constituent materials	7 days before importing materials
Manufacture and storage – Storage of mixed asphalt	Inspection of storage procedures by Superintendent	Progressive
Placing		
Protection of services and road fixtures	Inspection of condition of road fixtures and fixtures	
Tack coating	Direction by Superintendent to omit tack coat Progressive	
Finished pavement properties		
Density	Provide notice of procedures and results to Superintendent	Progressive
Measurement by mass	Method of weighing subject to Superintendent approval	3 days before measurement

2 MATERIALS

2.1 AGGREGATE

General

Standard: To AGPT04J.

Source: Obtain all materials from established sources and have established properties. Obtain each individual component of coarse and fine aggregate from the same sources as materials in design of the Job Mix.

Separate stockpiles of all aggregates from different sources or of different sizes.

Where requested, the source of all materials is subject to inspection and approval by the Superintendent and only material from a nominated quarry face or location is to be used. This is a **WITNESS POINT**.

Coarse aggregate

General: Conform to the following:

- Coarse aggregate is comprised of particles that are retained on the 4.75 mm sieve.
- Coarse aggregate to comply with AS 2758.5 with the application of those test properties specified in **Tables 2.1, 2.2** and **2.3** as appropriate except that the Superintendent may approve the use of non complying materials from sources of proven performance. This is a **HOLD POINT**.

Tables 2.1 and 2.2 provide alternative combinations of hardness and durability and use only one combination. Select the particular hardness and durability combination to be used unless specified in the Schedule of Job Details.

Fine aggregate

Fine aggregate: Conform to the following:

- Fine aggregate consists of crushed rock particles finer than the 4.75 mm sieve and manufactured from an approved source complying with the requirements of **Coarse aggregate**, clean natural sand, or both.
- The fine aggregate is to be clean, hard, durable and free from lumps of clay and other aggregations of fine materials, organic material and any other deleterious material.
- Fine aggregate consisting of crushed rock particles to have a minimum Degradation Factor, Crusher Fines of 60 when tested in accordance with AS 1141.25.3.

Table 2.1 Coarse Aggregate Requirements for Hardness and Durability Based on Los Angeles Abrasion Loss and Unsound and Marginal Stone Content

Test property	**Test value**			
	Heavy/Very Heavy Traffic Mix Types		**Other Mix types**	
Los Angeles Abrasion Loss (% maximum)	Rock type	LA	Rock type	LA
	All	25	Acid Igneous Granitic rocks Others	 35 30
			Intermediate igneous	30
			Basic igneous	30
			Metamorphic	30
			Sedimentary	25
			Dense metallurgical slags	30
Unsound stone content (%)	3 maximum		5 maximum	
Marginal and unsound stone content (%)	8 maximum		10 maximum	

Table 2.2 Coarse Aggregate Requirements for Hardness and Durability Based on Wet Strength and Wet/Dry Strength Variation

Test property	**Test value**	
	Heavy/Very Heavy Traffic Mix Types	**Other Mix types**
Ten Percent Fines Value (Wet) (kN)	150 minimum	100 minimum
Wet/Dry Strength Variation (%)	35 maximum	35 maximum

Table 2.3 Other Coarse Aggregate Requirements

Test property	**Test value**	
	Heavy/Very Heavy Traffic Mix Types	**Other Mix types**
Flakiness Index (% maximum)	25	35
Weak particles (% maximum)	1	1
Water absorption (% maximum)	2	2.5
Polished Stone Value or Polished Aggregate	48 minimum	45 minimum

Test property	Test value	
	Heavy/Very Heavy Traffic Mix Types	Other Mix types
Friction Value of wearing course asphalt		

Mineral filler

Definition: Mineral filler is that portion of mineral matter passing a 75 micron sieve, and includes rock dust derived from coarse and fine aggregates used in the production of asphalt in conformance with this worksection, and any other materials added to supplement the quantity and properties of filler in the mix.

Mineral filler: Conform to the following:

- The total filler component in the combined job mix for medium, heavy and very heavy traffic mix types to have a value of dry compacted voids in accordance with AS 1141.17 not less than 38%.
- Filler to be consistent in mineral composition and dry compacted air voids, to be dry, and free from lumps, clay, organic matter or other material deleterious to asphalt.
- Added filler (material not derived from the aggregate components) to comply with the relevant standards listed in **Table 2.4**. The Superintendent may approve materials other than those listed in **Table 2.4** provided that the Contractor supplies evidence of the quality and effect of the proposed materials on the properties of the asphalt mix.

This constitutes a **HOLD POINT**.

Rock dust that is not derived from the other aggregate components in the mixture may also be used as added filler provided that it is derived from materials that meet the requirements of **Aggregate**.

Materials for use as added filler are to meet the test requirements specified in **Table 2.6**.

Table 2.4 Standards for Materials Used as Added Filler

Material	Standard (See Note 1)
Hydrated lime	AS 1672.1 Limes and Limestones – Lime for Building
Fly Ash	AS 3582.1 Fly Ash Table 1, Fine Grade.
Cement Kiln Dust	See note 2
Slag	AS 3582.2 Slag – Ground Granulated Iron Blast-Furnace
Ground Limestone	See note 3
Cement	AS 3972 General purpose and Blended cements

1. Provision of test certificates for compliance with the relevant Australian Standard and this specification to be limited to those tests listed in **Table 2.6**.
2. Cement kiln dust to be solid material extracted from the flue gases in the manufacture of Portland cement, having a maximum water soluble fraction of 20% by mass and complying with the grading limits specified in **Table 2.5.**
3. Ground limestone to consist of rock dust derived from the grinding of sound limestone and complying with the grading limits specified in **Table 2.5**.

Table 2.5 Grading Limits for Ground Limestone and Cement Kiln Dust Materials for Use as Added Filler

Sieve Size AS (mm)	Percentage passing sieve size (by mass)
0.600	100
0.300	95–100
0.075	75–100

Table 2.6 Test Requirements for Materials for Use as Added Filler

Filler type	Test type	Test requirements
All	Grading (AS 0.600 mm, 0.300 mm and 0.075 mm sieves)	Report
All	Voids dry compacted filler	Report
All	Moisture content	3% max.
Fly ash	Loss on ignition	4% max.

Filler type	Test type	Test requirements
Cement kiln dust	Water soluble fraction	20% max.

2.2 BINDER

Bitumen

Bituminous binders: To AGPT04F.

Standard Classes of bitumen: Conform to AS 2008.

Class AR450 bitumen: Conform to RMS QA Specification 3253.

Multigrade bitumen: Conform to Austroads AP-T41 Specification framework for polymer modified binders and multigrade bitumens.

Other binders

Polymer modified binder: Comply with the Austroads AP-T41 Specification framework for polymer modified binders and multigrade bitumens.

Additives

Type and proportion: The type and proportion of additives to be used in the mix, other than those specified elsewhere in this worksection, to be in conformance with an approved specification which may be a manufacturer's recommendation, purchaser's specification or as agreed between the parties.

Warm mix asphalt additive

General: If required, include warm mix asphalt additive to asphalt to reduce the asphalt manufacturing temperature and/or to improve workability during the paving and compaction operations.

Rejuvenating agent

Properties: Rejuvenating agent, if required in mixes incorporating recycled asphalt, to be a low volatility oil capable of combining with bitumen to counteract hardening and produce a lower viscosity grade of binder. Rejuvenating agent to comply with recognised standards for such materials.

2.3 RECLAIMED ASPHALT PAVEMENT

Requirements

General: Provide reclaimed asphalt pavement (RAP) from milling or excavation of existing asphalt in conformance with the following:

- Crushed and screened as necessary to ensure a maximum size no greater than the maximum size of asphalt being produced and to achieve a reasonably well graded, free flowing, and consistent product.
- Free of foreign material such as unbound granular base, broken concrete, crumbed rubber or other contaminants. Asphalt containing tar is not to be used.
- Place in separate stockpiles prior to use.

2.4 MIX DESIGN

General

Requirements: Provide all mix designs. Where specified, the Contractor's mix design is to be assessed by the Superintendent for compliance with the requirements of this worksection. In such cases, the mix design is to be approved by the Superintendent prior to its use.

This is a **HOLD POINT**.

The types of mixes to be as listed in the schedule of job requirements, or as shown on drawings.

Aggregate grading and binder content

General: Unless otherwise specified, design asphalt mixes with a target combined aggregate grading (including filler) and binder content complying with the relevant limits given in **Tables 2.7, 2.8, 2.9, 2.10 or 2.11**. Bitumen content is expressed as a percentage by mass of the total mix.

Table 2.7 Dense Graded Asphalt (Medium, Heavy and Very Heavy Traffic Heavy Wearing Course and all Base Course Mix Types)

Sieve Size AS (mm)	Mix designation				
	AC10	AC14	AC20	AC28	AC40
	Percentage passing sieve size (by mass)				

Sieve Size AS (mm)	Mix designation				
	AC10	**AC14**	**AC20**	**AC28**	**AC40**
	Percentage passing sieve size (by mass)				
					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	58–75	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
Total	100	100	100	100	100
Binder Content (% by mass)	4.5–6.5	4.0–6.0	3.8–5.8[1]	3.5–5.5	3.0–5.0
NOTE: 1. For high fatigue base course mix types, the range of binder content shall be increased by 1 percentage point.					

Table 2.8 Dense Graded Asphalt (Light Traffic Wearing Course Mix Types)

Sieve Size AS (mm)	Mix designation		
	AC7	**AC10**	**AC14**
	Percentage passing sieve size (by mass)		
19.0			100
13.2		100	90–100
9.5	100	90–100	72–89
6.7	85–100	68–87	54–79
4.75	70–87	50–76	43–69
2.36	44–65	32–57	28–53
1.18	29–48	22–42	19–40
0.600	19–35	15–31	13–30
0.300	12–25	10–23	9–22
0.150	8–16	6–14	6–15
0.075	5–8	4–7	4–7
Total	100	100	100
Binder Content (% by mass)	5.0–7.0	4.5–6.5	4.3–6.3

Table 2.9 Open Graded Asphalt and Ultra Thin Asphalt

Sieve Size AS (mm)	Mix designation		
	OGA10	**OGA14**	**UTA10**
	Percentage passing sieve size (by mass)		
19.0		100	
13.2	100	85–100	10
9.5	85–100	45–70	80–100

Sieve Size AS (mm)	Mix designation		
	OGA10	OGA14	UTA10
	Percentage passing sieve size (by mass)		
6.7	35–70	25–45	30–55
4.75	20–45	10–25	20–40
2.36	10–20	7–15	18–36
1.18	6–14	6–12	14–30
0.600	5–10	5–10	10–25
0.300	4–8	4–8	7–20
0.150	3–7	3–7	6–12
0.075	2–5	2–5	4–8
Total	100	100	100
Binder Content (% by mass)	5.0–6.5	4.5–6.0	4.7–5.4

Table 2.10 Stone Mastic Asphalt

Sieve Size AS (mm)	Mix designation		
	SMA7	SMA10	SMA14
	Percentage passing sieve size (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
Total	100	100	100
Binder Content (% by mass)	6.0–7.3	6.0–7.0	5.8–6.8

Table 2.11 Fine Gap Graded Asphalt

Sieve Size AS (mm)	Mix designation	
	FGG7	FGG10
	Percentage passing sieve size (by mass)	
19.0		
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
Total	100	100

Sieve Size AS (mm)	Mix designation	
	FGG7	FGG10
	Percentage passing sieve size (by mass)	
Binder Content (% by mass)	6.0–7.0	6.0–7.0

Mix properties

Design criteria: Asphalt mixes to comply with the relevant target volumetric design criteria and other properties listed in this clause, provided that alternative design targets may be specified or agreed for particular applications. Laboratory preparation and compaction of asphalt mixes may be undertaken using either gyratory compaction or the Marshall Method. The design criteria to apply to only one method of compaction. Nominate the method of compaction, unless otherwise specified. Also comply with the recommendations of AS 2150.

Dense graded asphalt

Dense graded asphalt mixes: Conform to the following:

- Comply with the volumetric design criteria listed in either **Tables 2.12 or 2.13** and the Voids Mineral Aggregate (VMA) requirements listed in **Table 2.14**.
- Design all mixes to have a minimum effective binder film index of 7.5 microns except that high fatigue base is to have a minimum effective design binder film index of 10 microns.

Open graded asphalt

Open graded asphalt mixes: Conform to the following:

- Comply with the volumetric (Level 1) design criteria listed in **Table 2.15**. and comply with the Asphalt Particle Loss values listed in **Table 2.16**.
- OGA and UTOGA to have a maximum binder drain-off test value, at 170°C, of 0.3% by mass except that a lower value of test temperature may be applied where that temperature will not be exceeded during manufacture and transport of the asphalt.

Stone mastic asphalt

Stone mastic asphalt mixes: Conform to the following:

- Comply with the volumetric design criteria listed in **Table 2.17**.
- Contain a minimum of 0.3% by mass of cellulose or acrylic fibre or a minimum of 0.5% by mass of mineral fibre.
- Have a maximum binder drain-off test value, at 170°C, of 0.3% by mass.
- Use A15E polymer modified binder to eliminate the risk of flushing/bleeding in wheel paths.

Fine gap graded asphalt

Fine gap graded asphalt mixes: Comply with the volumetric (Level 1) design criteria given in **Table 2.18**.

Table 2.12 Design Requirements for Dense Graded Asphalt Mixes Prepared Using Gyratory Compaction

Mix type		Laboratory compaction level (cycles)	Air voids (%)	Air voids at 250 cycles – min (%)
Traffic category	Application			
Light	Wearing and base	50	3.0 – 7.0	–
Medium	Wearing and base	80	3.0 – 7.0	–
	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

Table 2.13 Design Requirements for Dense Graded Asphalt Mixes Compacted by the Marshall Method (50 Blow Compaction[1])

Mix type		Air voids (%)	Stability – min (kN)	Flow (mm)
Traffic category	Application			
Light	Wearing and base	3.0 – 7.0	5.5	2–4

Mix type		Air voids (%)	Stability – min (kN)	Flow (mm)
Traffic category	**Application**			
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, the air voids range to be reduced by 1 percentage point.
2. Where 35 blow Marshall compaction is used, the air voids range to be increased by 1 percentage point.

Table 2.14 Voids Mineral Aggregate (VMA)

Mix nominal size (mm)	VMA (% minimum)		
	Gyratory compaction	Marshall compaction (50 blow[1])	
		Heavy/Very Heavy Traffic Wearing Course Mixes	Other mix types
7	17	–	17
10	16	17	16
14	15	16	15
20	14	–	14
28	13	–	13
40	12	–	12

Note:
1. Where 75 blow Marshall compaction is used, the VMA targets to be reduced by 1 percentage point.

Table 2.15 Level 1 Design Requirements for Open Graded Asphalt Mixes

Mix type/Traffic category	Laboratory compaction		Air voids (%)
	Gyratory (cycles)	Marshall (blows)	
OGA Light/Medium	80	50	18–23
OGA Heavy/ Very Heavy	80	50	20–25
UTOGA	No specified requirement		

Table 2.16 Asphalt Particle Loss

Mix type/Traffic category	Asphalt particle loss – maximum (%)	
	Unconditioned	Moisture conditioned
OGA Light/Medium	25	30
OGA Heavy/ Very Heavy	20	35
UTOGA	No specified requirement	

Table 2.17 Level 1 Design Requirements for Stone Mastic Asphalt Mixes

Mix type		Laboratory compaction		Air voids (%)	VMA – minimum (%)
Size (mm)	Traffic category	Gyratory (cycles)	Marshall (blows)		
7	Light/Medium	80	50	3.0 – 6.0	19
10	Light/Medium	80	50	3.0 – 6.0	18
10	Heavy/Very Heavy	120	75	3.0 – 6.0	17

Mix type		Laboratory compaction		Air voids (%)	VMA – minimum (%)
Size (mm)	Traffic category	Gyratory (cycles)	Marshall (blows)		
14	Heavy/Very Heavy	120	75	3.0 – 6.0	16

Table 2.18 Design Requirements for Fine Gap Graded Asphalt Mixes

Traffic category	Laboratory compaction		Air voids (%)
	Gyratory (cycles)	Marshall (blows)	
Light	50	35	3.0 – 5.0

Design of asphalt mixes incorporating reclaimed asphalt pavement (RAP)

General: Prepare separate mix designs for all mixes containing RAP. Binder in RAP to be included as binder in the total mix. Alterations to the proportion of RAP constitute a design change.

Requirements: Mixes generally to comply with the design and manufacture requirements specified elsewhere in this worksection with the additional requirements specified in **Reclaimed asphalt pavement** and the following sub-clauses.

- Asphalt mixes containing not more than 15% of RAP by mass of total mix: Unless otherwise specified, RAP in proportions up to 15% by mass of the total mix to be permitted in all dense graded asphalt mixes.
- Asphalt mixes containing more than 15% but not more than 30% of RAP by mass of total mix: RAP in proportions greater than 15%, but not exceeding 30%, 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 excluded in the Schedule of Job Details. In addition to the requirements specified in **Design of asphalt mixes incorporating reclaimed asphalt pavement (RAP)**, allowance may be made for increase in binder stiffness due to hardened binder in RAP by adoption of bitumen binder one class lower in viscosity than that otherwise specified.
- Asphalt mixes containing more than 30% of RAP: To be accepted only where the Contractor can demonstrate suitable manufacturing plant and quality control procedures to ensure consistent production of hot mix asphalt of a standard not less than that otherwise specified. This constitutes a **HOLD POINT**.

Approval of job mix

General: If the approval of the job mix is required by the Superintendent, provide the information listed in Table 2.19 at least seven (7) days prior to commencement of production. This a **HOLD POINT**.

Identification: Each mix design to be identified by a unique number system allocated by the Contractor or Superintendent in accordance with the accepted practice of the Principal and to be designated the Job Mix.

Submission of Samples: Where specified in the Schedule of Job Details, or on request by the Superintendent, provide samples of the constituent materials used in the proposed mix design. The samples to be provided at the Contractor's expense and delivered to the address specified in the Schedule of Job Details. The quantity of samples to be in accordance with **Table 2.20**, or as directed by the Superintendent. This is a **WITNESS POINT**.

Approval to Use Previously Designed Mix: The Superintendent may accept a Job Mix used by the Contractor under other Contracts for the supply of asphalt of the particular type and nominal size specified subject to the following conditions:

- The project work is undertaken within a two-year period of mix design work for the Job Mix.
- The type, quality and sources of all constituent materials remain unchanged.
- The proportions of aggregates and filler are not varied by more than 20% of the proportion of that component in the original Job Mix.
- The in-service performance of the Job Mix materials has been satisfactory. This constitutes a **HOLD POINT**.

Table 2.19 Information to be Submitted by Contractor for Approval of Job Mix

Item	Information
1	Details of constituent materials required under this Specification including aggregates, filler, binder, additives (if used) and source of materials

Item	Information
2	The nominated grading, binder content, air voids and proportion of each component in the mix
3	Test results verifying constituent material properties and test results of trial mixes made at varying binder contents to arrive at the design mix
4	Test results in accordance with the design requirements specified in Mix properties.
5	The following test results performed on a batch of each mix proposed to be used, and produced from the mixing plant from which the asphalt is to be supplied: - Grading - Binder Content - Maximum density - Air voids at laboratory design compaction level

Table 2.20 Sample quantities of constituent materials

Material	Sample quantity
Each coarse and fine aggregate component	50 kg
RAP (if used)	50 kg
Added Mineral Filler	5 kg
Binder	8 litres
Additives	As appropriate

3 EXECUTION

3.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

3.2 MANUFACTURE AND STORAGE

General

Plant: Asphalt manufacturing plant to be of sound design and construction and capable of consistently producing asphalt mixes with the properties specified and 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 ensure continuity of production and enable effective sampling and testing prior to use. The facilities for handling particular materials to conform to the following:

- Aggregates: Handle and store in such a manner as to prevent contamination and avoid segregation.
- Filler: Handle and store in such a manner as to keep it dry and free flowing at all times. Where more than one type of filler is to be used, handle and store each separately.
- Additives, including cellulose or mineral fibre: Protect from moisture or contamination. Do not use wet materials.
- Binder tanks for heating and storage of binder: To be thermostatically controlled and each fitted with a thermometer that is located so that the temperature can be read conveniently. Provide a sampling cock in the outlet pipe from each tank.
- Do not heat bitumen binder to more than 185°C. Do not heat or store multigrade and Polymer Modified binders contrary to the temperature and time combinations specified by the manufacturer's written instructions.

Mixing temperatures

Temperature limits: Temperature of bitumen and aggregates at the mixing plant, and the temperature of asphalt as it is discharged from the asphalt plant, not to exceed the limits specified in **Table 3.1.1**.

Table 3.1.1 Mixing temperatures

Material	Maximum temperature (°C)

Material	Maximum temperature (°C)
Class 170, Class 320, Class AR450 Bitumen delivered into mixer	165
Class 600 Bitumen delivered into mixer	175
Aggregates before mixing with binder	200
Asphalt at discharge from asphalt plant	175[1]
Note: 1. The maximum temperature of open graded asphalt not to exceed that determined from the asphalt binder drain-off test, if applicable.	

Moisture content

After completion of mixing: The moisture content of the mix not to exceed 0.5%.

Production tolerances

Tolerances: Production tolerances on grading and binder content to comply with **Table 3.1.2**.

Table 3.1.2 Production Tolerances

Description	Maximum Tolerance on Job Mix Percentage
Grading: Sieve size one size larger than nominal size	Nil
Pass 26.5 mm sieve or larger	± 10
Pass 4.75 mm sieve to 19.0 mm sieve inclusive	± 7
Pass 1.18 mm sieve to 2.36 mm sieve inclusive	± 5
Pass 0.300 mm sieve to 0.600 mm sieve inclusive	± 4
Pass 0.150 mm sieve	± 2.5
Pass 0.075 mm sieve	± 1.5
Binder Content: Percent by mass of total mix	± 0.3
Source: AS 2150 Table 11.	

Storage of mixed asphalt

Requirements: Store asphalt prior to delivery to the purchaser, and is subject to observation of the following requirements:

- The mix is consigned to and deposited in the storage bins in such a manner as to minimise segregation.
- The storage bin to be insulated.
- The method of discharge to be such as to minimise segregation. Any caked or segregated portions of mix to be discarded.
- Asphalt with polymer modified binders not to be stored in plant silos for a period longer than eight hours or that recommended by the manufacturer of the polymer modified binder.
- Open graded asphalt and stone mastic asphalt not to be stored in plant silos for periods in excess of four hours.
- The total time of storage to be limited to 24 hours unless otherwise approved. Storage of mixed asphalt is a **WITNESS POINT**.

Manufacture of stone mastic asphalt

Requirements: The following particular requirements apply to the production of stone mastic asphalt:

- Filler systems to be designed or modified to provide for the appropriate quantity of added filler. In drum mix plants, loss of filler to be minimised by feeding direct into the mixer alongside addition of binder.
- Fibre to be added in a manner that ensures good dispersion of fibres, avoids loss of fibre through dust collection systems and avoids damage to fibre by overheating.
- Mixing times to be increased, where necessary, to ensure adequate dispersal and mixing of fibre.

Asphalt mixes incorporating reclaimed asphalt pavement (RAP)
Requirements: Only use RAP from stockpiles that have been tested for consistency in grading and binder content with materials used in mix design.

In batch mixing plants, the RAP to be either:

- Metered into the asphalt plant after heating and drying of aggregates
- Added directly to the weigh hopper with the other aggregate materials, for each batch.
- Weighed separately and added direct to the pugmill.

Increase batch mixing time, if necessary, to ensure adequate heat transfer and dispersion of RAP.

Protect RAP in drum mix plants from excessive temperatures by a combination of entry point to the drum and shielding from direct flame contact.

3.3 SAMPLING AND TESTING OF ASPHALT PRODUCTION

General
Sampling: Arrange for all relevant testing. Samples from asphalt production to be randomly selected (random sampling) by a recognised statistical technique from fresh production asphalt at the asphalt plant. Do not mix samples. Visually inspect each loaded truck for segregation, uncoated particles, excess bitumen or overheating, before dispatch from the plant.

Testing: Production asphalt to be tested for the following:

- Grading.
- Binder content.
- Maximum density.
- Temperature.

Frequency of sampling and testing
Minimum frequency of sampling and testing: As shown in **Tables 3.2.1** and **3.2.2**. **Table 3.2.1** provides for two levels of minimum frequency. The reduced frequency may only be adopted where the process is demonstrated to be under statistical control as specified in **Process control**.

Where a non-conformance occurs in any test requirement, the frequency of sampling and testing for that particular property to be increased to the normal level until conforming results have been obtained on five consecutive samples. This is a **HOLD POINT**.

Table 3.2.1 Frequency of Sampling and Testing of Production Asphalt

Test	Normal minimum frequency	Reduced minimum frequency
Grading	One test per 300 t of asphalt plant production	One test per 500 t of asphalt plant production
Binder content	One test per 300 t of asphalt plant production	One test per 500 t of asphalt plant production
Maximum density	One test per 300 t of asphalt plant production	One test per 500 t of asphalt plant production
Temperature	Each loaded truck	Lesser of each loaded truck or one per 15 minutes

Table 3.2.2 Frequency of Testing of Component Materials

Test	Minimum Frequency
Los Angeles Abrasion (where applicable)	3 Monthly
Unsound and marginal stone content (where applicable)	3 Monthly
Wet Strength (where applicable)	3 Monthly
Wet/Dry Variation (where applicable)	3 Monthly
Flakiness index of coarse aggregate	Monthly
Dry compacted voids of combined filler	Monthly
Added filler (Tables 2.5 and 2.6)	Certification of each delivery
Binder viscosity	Certification of each delivery
RAP grading and binder content	One test per 500 t of RAP

Process control

Implementation: Implement suitable measures for control of the asphalt process. Process control measures may include the use of statistical process control charts for some, or all, of the tests required in **Frequency of sampling and testing** and suitable decision rules for determining that the process is under statistical control and therefore subject to reduced minimum frequency of test.

Include in the Quality Plan elements of the process control system that incorporate the application of statistical process control.

3.4 DELIVERY

General

Transportation: Transport asphalt to the point of delivery in vehicles complying with the following requirements:

- The inside of vehicle bodies to be kept clean and coated with a thin film of an appropriate release agent to prevent asphalt sticking to the body of the vehicle. Take care to remove surplus release agent before loading asphalt into the vehicle.
- After loading with asphalt, cover the body of the vehicle to prevent contamination and reduce the rate of cooling of the mix.
- Where the length of the haul or the weather is such that the temperature of the asphalt may drop below a suitable placing temperature, or where excessive local cooling of the mix may occur, the vehicles are to be suitably insulated.

Work records

Asphalt work record: Particulars of the work performed are to be recorded by the Contractor on the **Asphalt Work Record** attached as **Annexure A** or as per the Contractor's own procedures where equivalent. Complete the **Asphalt Work Record**, which is to be countersigned by the Superintendent each day as a true record of the work performed. Supply a copy to the Superintendent. This is a **HOLD POINT**.

Delivery dockets: Attach delivery dockets stating the mass of each truck load of asphalt to **Annexure A Asphalt Work Record**.

3.5 PLACING

Preparation of surface

Cleaning: Prior to tack coating and placing of asphalt, the surface to be free of all deleterious material. Where required, sweep clean the area on which asphalt is to be placed.

Protection of services and road fixtures

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, bridge or culvert decks, kerbs and other road fixtures.

Clean: Immediately after the asphalt has been spread, clean off or remove any such material and leave the services and road fixtures in a satisfactory condition. This is a **WITNESS POINT**.

Priming

General: Where specified separately, prime crushed rock and gravel pavements.

Tack coating

Application: Conform to the following:

- Apply tack coat to the cleaned surface prior to placing asphalt.
- Tack coat to consist of bituminous emulsion complying with AS 1160. The type and breaking rate to be suitable to the climatic and surface conditions of use such that it is fully broken, free of surface water and intact before the commencement of asphalt spreading.
- Apply tack coat to provide a uniform application rate of residual binder of between 0.10 L/m^2 and 0.20 L/m^2.
- Apply tack coat by spray bar fitted to a mechanical sprayer. Perform hand spraying only in those areas where it is impracticable to use a spray bar.
- Take precautions to protect kerbs, channels, adjoining structures, traffic and parked vehicles from tack coat spray.
- Where asphalt is to be spread over clean, freshly placed asphalt, or over a clean primed surface, the Superintendent may direct the Contractor to omit the tack coat. This is a **WITNESS POINT**.

Placement of ultra-thin surfacing materials: Modify the tack coating procedure to provide a bond coat consisting of 0.9 L/m^2 (total) of 62% binder content polymer modified bitumen emulsion. Bitumen emulsion application rates of more than 0.5 L/m^2 are to be applied through a spray bar mounted directly on the asphalt paver, immediately ahead of the spreading of asphalt.

Spreading

Placing: Unless otherwise specified, employ self-propelled mechanical pavers to place asphalt except for areas where the use of a paver is impracticable.

Ambient conditions for placing: Conform to the following:

- The surface on which the asphalt is to be placed is to be dry and free from free-standing water.
- Do not place asphalt when the pavement surface temperature is less than 5°C.
- Wearing course asphalt not to be placed when the pavement surface temperature is less than 10°C except that placing at lower temperatures may be permitted subject to agreement on procedures used to compensate for rapid cooling of asphalt materials. This is a **HOLD POINT**.

Layer thickness: Spread asphalt in layers at the compacted thickness shown on the drawings, or as specified.

Level control: The method of paver level control is specified in the Schedule of Job Details. If no method is specified in the Schedule of Job Details, apply suitable automatic or manual screed level controls to achieve the standards specified in **Finished pavement properties.**

Spreading: Spread asphalt without tearing or segregation and conform to the following:

- Conduct spreading operations to ensure that the paver speed matches the rate of supply so that the number of paving stops is minimised.
- The paver is not to be left stationary for prolonged periods with the screed box in contact with either the previously placed asphalt or loose asphalt in front of the screed.

Compaction

General: Uniformly compact asphalt to the standards specified in **Density** as soon as the asphalt has cooled sufficiently to support the rollers without undue displacement. Compaction to be achieved using suitable sized steel wheeled or vibratory rollers or combination of steel wheeled or vibratory rollers and pneumatic tyred rollers.

Do not use pneumatic tyred rollers in the compaction of open graded asphalt and stone mastic asphalt. The method of compaction of open graded and stone mastic asphalt is to avoid damage to aggregate or drawing of binder to the surface of stone mastic asphalt. Generally apply no more than two vibratory passes using high frequency and low amplitude shall be applied.

Joints

General: Provide joints as follows:

- Longitudinally, if the width of the pavement is such that more than one paving run is necessary.
- Transversely, after the completion of a day's paving operations, or where a delay in paving operation allows asphalt to cool and adversely affect placing, and elsewhere if a break in a longitudinal run is required.
- The location of joints to be planned before work commences.
- The number of joints to be minimised by adopting good asphalt paving practices.
- All joints to be well constructed and comply with the shape requirements specified in **Finished pavement properties**. The location of planned joints is a **HOLD POINT**.

Longitudinal Joints: Conform to the following:

- Longitudinal joints in the wearing course are to coincide with traffic lane lines unless otherwise specified or agreed.
- Longitudinal joints to be offset from layer to layer by not less than 150 mm provided that no joint is placed directly below a trafficked wheel path.

Hot joints: Where asphalt is placed against the edge of a preceding lane that has not cooled below 100°C it is considered a hot joint.

- Construct hot joints by leaving a 150 mm strip of asphalt unrolled along the free edge until the adjoining lane is placed, and then compacting the unrolled strip simultaneously with the material in the adjoining lane.

Warm joints: Where asphalt is placed against the edge of a preceding lane that has not cooled below 60°C it is considered a warm joint.

- Construct warm joints by rolling the full width of the first lane being placed, prior to placing the adjoining lane.

Cold joints: Where asphalt is placed against the edge of a preceding lane that has cooled below 60°C it is considered a cold joint.

- Asphalt placed against a cold edge should overlap the previous edge by 25 mm to 50 mm.
- The overlap should be pushed back using lutes, immediately after spreading, to form a slight ridge that is compacted with the steel wheel roller.

Transverse joints: Offset transverse joints by not less than 2 m in adjoining paver runs and from layer to layer.

3.6 FINISHED PAVEMENT PROPERTIES

Level

Finished level: The level at the top of each course of asphalt not to differ from the specified level by more than 10 mm, except that where asphalt is placed against kerb and channel, the surface at the edge of the wearing course to be flush with, or not more than 5 mm above, the lip of the channel, unless otherwise specified or shown on the Drawings.

Alignment

General: The horizontal location of any point on the pavement not to vary by more than ± 50 mm from the corresponding points shown on the documents, except where alignment with an existing pavement structure is necessary, when the new work is to be joined to the existing work or structure in a smooth manner.

Thickness

General: Conform to the following:

- The average total compacted thickness of the combined asphalt courses to be not less than the specified thickness.
- The average thickness of any individual course to be not less than the specified thickness by more than 10%.
- Where confirmation of asphalt thickness is required, determine it by coring to a recognised random sampling plan.

Shape

Surface: No point on the finished surface to deviate below a 3 m straightedge, measured between any two points, by more than the tolerances specified in **Table 3.5.1**.

Table 3.5.1 Permissible tolerances in surface shape

Layer	**Deviations below 3 m straightedge (mm)**					
	Freeways and highways with high speed traffic		**Heavy and very heavy traffic roads**		**Medium and light traffic roads**	
	Parallel to centreline	**Transverse to centreline**	**Parallel to centreline**	**Transverse to centreline**	**Parallel to centreline**	**Transverse to centreline**
Wearing course	3	5	5	7	7	10
Inter-mediate and base	6	10	8	12	12	16

Ride quality: Determine ride quality where specified in the Schedule of Job Details from the average of three replica runs with a calibrated roughness car, laser profiler or ARRB TR Walking Profiler.

Lane division: Each lane to be divided into homogeneous sections 100 m long. Any length less than 100 m to be included with the section immediately preceding it and an average roughness determined for the section. Start and finish joints of the entire work, and bridge expansion joints, not to be included in any section.

Roundabouts not to be measured under **Shape**.

Density

Testing: Compliance testing of asphalt to be undertaken on a lot-by-lot basis. A pavement lot is an essentially homogeneous section of work completed within a shift of production, unless otherwise specified in the **Schedule of Job Details**.

Density testing is not to be performed on:

- Lots of less than 30 t.
- Layers with a nominal thickness less than 30 mm.
- Layers with a nominal thickness less than 2.5 times the nominal mix size, or open graded asphalt.

Location: The location of each in situ density test to be chosen by a method of random stratified sampling. For core sample tests, the layer thickness is the mean thickness of the core samples and for nuclear and impedance density gauge tests, the layer thickness is the nominal thickness. Repair all core holes by an appropriate method that is compatible with the pavement from which cores have been taken.

Perform density testing as soon as practicable after completion of work.

Relative compaction is the percentage ratio of the in situ density of the compacted asphalt and the reference density of the asphalt of a particular lot. The reference density is to be the mean of the five most recent maximum density measurements of the same mix, provided that:

- The tests have been completed within the previous 4 weeks
- The binder content of samples tested is within ± 0.3% of the job mix binder content
- There has been no change in the mix components or proportions.

Where 5 tests complying with the above conditions are not available, carry out a minimum of 5 tests in order to establish the reference density.

The characteristic value of relative compaction is calculated as (Mean – KS)

where:

Mean = The mean of the relative compaction results.

S = The sample standard deviation of the relative compaction results.

K = A factor that depends on the number of tests as shown in Table 3.5.2.

Table 3.5.2 Acceptance constant

Number of tests or measurements	Acceptance constant (K)
6	0.72
7	0.76
8	0.78
9	0.81
10	0.83

The work represented by a lot to be assessed as the characteristic value of in situ voids where:

Characteristic value of in situ air voids (%) = 100 – Characteristic relative compaction.

The value of characteristic voids to comply with the maximum characteristic values specified in Tables 3.5.3 and 3.5.4.

Table 3.5.3 Characteristic value of in situ air voids for wearing course asphalt

Asphalt Type and Thickness (mm)	Maximum Characteristic Value (%)
All heavy and very heavy traffic asphalt wearing courses	8
Medium traffic wearing course.	9
Light traffic wearing course	7

Table 3.5.4 Characteristic value of in situ air voids for base asphalt

Asphalt type and thickness (mm)	Maximum characteristic value (%)
Heavy and very heavy traffic mixes in layers ≤ 40 mm	8
Medium and light traffic mixes in layers ≤ 40 mm	9

Asphalt type and thickness (mm)	Maximum characteristic value (%)
Heavy and very heavy traffic (except high fatigue base) mixes in layers > 40 mm	7
Medium and light traffic mixes in layers > 40 mm	8
High fatigue base	6

The procedures and results of density testing constitute a **WITNESS POINT**.

4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

General

Scope: Measurement for payment will include all works shown on the plans or as specified but will not include asphalt lost in transit, works not shown on the plans and variations in quantities due to variations in actual thickness exceeding the specified tolerances.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

4.2 PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1144.1 Mix design	Ls	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 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
1144.2 Supply and install asphalt determined from measurement of area and thickness where specified in the 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 insitu densities of the lot.	All costs associated with supply, install and finishing of asphalt.

4.3 NON COMPLYING MATERIALS

Non compliance

General: In the event that the material supplied is not within the tolerances and standards defined for manufacture or placing of asphalt, the Superintendent may direct:

- That the reduced service life arising from the non complying material is offset by reducing payment for the non complying material by the method defined in the Schedule of Job Details; or,
- The removal of non complying material; or,
- With the consent of the Contractor, any other remedial treatment that is expected to provide the required level of service. This disposition of non-complying material is a **HOLD POINT**.

4.4 SEPARATE PAY ITEMS

General

Separate pay items to be included in the **Schedule of Rates** for each nominal course thickness and each nominal size and type of asphalt specified.

Method

Pay items: To be **Measurement by** m**ass or measurement by** a**rea and thickness.**

Any Special Job Requirements listed below to be additional separate Payment Items

Special job requirements (Optional)

5 ANNEXURE A: 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 ℃	Chainage		Paved Width (m)	Direction with or against chainage	Dist. from left edge to centre of run (m)	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 Representative: _____ (Signature) Contractor's Representative: _____ (Signature)

Affiliation: _____ Affiliation: _____

6 ANNEXURE B: NOTES FOR IMPLEMENTATION AND USE OF SPECIFICATION CLAUSES

6.1 GENERAL

Scope

The specification has been prepared for the manufacture, supply and placing of dense graded asphalt (also referred to as asphaltic concrete or AC), open graded asphalt (OGA), stone mastic asphalt (SMA) and fine gap graded asphalt (FGGA) for roadworks and related applications. Different criteria apply to quality of components and asphalt mix design according to the application. The nominal size and types of mixes to be used should be specified in the **Schedule of Job Details**.

The intended use of the materials may also involve the application of different construction requirements and these should also be nominated in the **Schedule of Job Details**. Guidelines for the application of such requirements are given in the notes to the relevant worksection clauses.

Careful consideration of the **Schedule of Job Details** is required to ensure that asphalt is fit for purpose, of the appropriate type and quality, and provided in a cost effective manner.

The terms used in the worksection guidelines are generally consistent with AS 2124, and include Principal, Superintendent, and Superintendent's Representative. Where these terms are in conflict with those otherwise used, a general interpretation clause should be inserted in the contract documents.

Quality

Requirements: The quality requirements of *0161 Quality (Construction)* are designed to apply the AUS-SPEC quality system requirements.

The following paragraphs may be substituted if desired:

'The Contractor is to establish, implement and maintain a Quality System in accordance with this worksection and the requirements of AS/NZS ISO 9001, or a recognised equivalent.'

'Where required in the Contract general clauses, the Contractor is to submit a Quality Plan prior to commencement of any works. The Quality Plan to take into account the specific requirements for inspection and testing, acceptance/rejection criteria, details of proposed methods and other quality requirements that are contained in the Contract Documents. No part of the Quality System is to be used to pre-empt or otherwise negate the technical requirements of the Contract Documents.'

Depending on project type and performance risk, the Principal may undertake an audit of a Contractor's Quality System and/or Quality Plan as part of prequalification or contract acceptance procedures. The Principal may also establish additional procedures for surveillance of contract activity and audit/verification of quality of materials and testing.

6.2 MATERIALS

Aggregate

The worksection refers to AS 2758.5, which requires the user to select from a number of options for determination of aggregate durability. These options tend to have been developed around the tests considered to provide the most suitable characterisation of the various stone types found in different localities. As a general rule, the standards and the worksection requirements are applied on a State by State basis as follows:

- Soundness based on Los Angeles Abrasion and Unsound Stone Content (**Table 2.1**) – Victoria and Western Australia.
- Soundness based on 10% Fines Value and Wet/Dry Strength Variation (**Table 2.2**) – All other States.

Minimum values of polishing resistance (PSV or PAFV) are provided as default values for general application. Surface friction requirements will vary according to the risks associated with operating environment or particular sites, which will also influence the choice of type of asphalt mix and other design factors associated with surface texture. Availability may also be a consideration. This may lead to the adoption of higher or lower minimum polishing values for some applications.

Mineral filler

Some asphalt specifications show confusion over the role and specification of filler in asphalt mixes. By strict definition, filler is that mineral matter passing the 75 micron sieve and includes filler sized particles derived from aggregates as well as added fine materials such as lime, fly ash, etc. In

practice, materials used as added filler are comprised predominately of particles smaller than 75 microns but may also contain a proportion of coarser particles. Tests applied to added filler materials apply to the complete sample, not just that portion passing the 75 micron sieve.

Binder

A guide to selection of binder type is provided in the notes to **Mix design**.

Reclaimed Asphalt Pavement (RAP)

A guide to the application of design and manufacturing requirements for RAP in asphalt is provided in the notes to **Mix design**.

6.3 MIX DESIGN

General

Gyratory compaction enables ready selection of different compaction levels to match expected service conditions as well as being able to simulate long term heavy traffic loadings by extended compaction. Gyratory compaction is also considered to achieve particle alignment that is a better representation of field compaction of asphalt. The specification also provides for the use of Marshall compaction where that method of compaction is preferred. It is important that only one set of criteria are applied, either Marshall or gyratory compaction. In due course it is expected that gyratory compaction will become more common than Marshall.

The mechanical properties of Marshall 'Stability' and 'Flow' do not directly measure fundamental properties but provide empirical relationships that have been found to correlate with asphalt mixes that provide suitable levels of field performance.

Several relatively new performance-based design criteria have been developed through the national research programs of AAPA, Austroads and ARRB Transport Research. The outcome of that research program has been published as AGPT04B Appendix A Mix design procedures.

Aggregate grading and binder content

The aggregate grading and binder content ranges shown in **Tables 3.7, 3.8, 3.9, 3.10 and 3.11** of the worksection are targets for design purposes. Application of production tolerances may result in actual production being outside those limits. **Table 3.7** restricts the proportion of finer materials in order to provide good texture for dense graded wearing course mixes for medium and heavy traffic and increased deformation resistance in heavier trafficked applications. **Table 3.8** allows increased proportions of finer materials in dense graded mixes for all lesser trafficked applications.

The Superintendent may approve the use of asphalt mixes with a design target outside the ranges shown where it can be shown that all the other performance requirements can be adequately met.

Mix properties - Selection of Mix Type, Binder Type, and Layer Thickness

The principal factors influencing the performance characteristics of asphalt mixes are:

- The selection and quality of components.
- The volumetric properties of the mix (nominal size, grading, binder content and voids relationships) and the layer thickness.

The worksection provides for different criteria for aggregate quality and voids relationships for dense graded mixes based on traffic categories. A guide to selection of traffic category is shown in the **Table B1** below. The relevant traffic category should be nominated in the **Schedule of Job Details**.

The mix type, nominal mix size, binder type and layer thickness should also be nominated in the **Schedule of Job Details**.

For most wearing course and structural asphalt applications, dense graded asphalt mix types are used. Other mix types are used as wearing course to provide particular surface characteristics for particular applications as follows:

- Open graded asphalt is used as a porous wearing course to reduce water spray and tyre noise levels on freeways and other high speed roads.
- Ultra thin asphalt (UTOGA) is a specialty asphalt mix for placing in thin layers (12–15 mm compacted thickness).It uses a modified grading to improve resistance to surface shearing forces, which reduces porosity but still provides coarse textured surface. UTOGA must be placed in conjunction with a heavy tack coat (see Section 3.4), sprayed seal or strain alleviating membrane interlayer (SAMI) to ensure strong bond to underlying surface.
- Stone mastic asphalt (SMA) is used to provide good surface texture and good deformation resistance on heavily trafficked roads. Smaller nominal sizes can also be used as a durable, well-textured surface in lightly trafficked applications.

- Fine gap graded asphalt (FGGA) provides a very fine textured surface in a mix that can be readily compacted to low air voids thereby providing good durability in lightly trafficked pavements. The grading envelope for FGGA provides for a wide choice of grading target but there is a design intent to produce a gap grading with limited intermediate sized aggregate fractions as described in Chapter 6 of APRG 18. While the grading and binder content produces a more workable mix, it can be more susceptible to deformation and is not appropriate for heavily trafficked or highly stressed areas.

A detailed guide to selection of different wearing course asphalt mixes for particular surface characteristics is provided in Austroads AGPT03/09-2009 Guide to Pavement Technology – Pavement surfacings.

The nominal size may be determined as a function of the layer thickness or the layer thickness selected on the basis of the nominal size required for a particular application. A guide to selection of layer thickness and nominal size is shown in **Table B2**.

Guides to selection of binder types for dense graded wearing and base course applications are shown in **Tables B3 and B4**. Not all binder types may be available in all locations and AR450 has only recently been introduced in NSW. Modified binders require delivery in minimum quantities and special handling and storage requirements. The specification of modified binders may, therefore, not be practical for small projects or remote locations. Before specifying a particular binder, the designer should ascertain the availability in the project location.

It should be noted that:

- The air void range for gyratory compaction of dense graded mixes are different to those for Marshall compaction.
- The limits for gyratory compaction are based on different compactive effort (cycles) for different traffic applications.
- The air void range for Marshall compaction provide the option of varying compactive effort for different traffic levels, or choosing a different air void range based on a single 50-blow compactive effort. The use of 50-blow compaction enables mixes of different applications and air voids to be selected from the one set of laboratory test data.
- If mixes are to be designed for different Marshall compactive effort, the air void range and VMA should be reduced by up to 1% for 75-blow compaction and increased by up to 1% for 35-blow compaction. Where different air voids criteria are required, a special clause should be inserted in the schedule of details.

Table B1 Guide to Traffic Category

Indicative Traffic Volume		**Traffic Category**	
Commercial vehicles/lane/day	**Structural design level**	**Free flowing vehicles**	**Stop/start OR climbing lane OR slow moving**
< 100	< $5x10^5$ ESAs	Light	Medium
100–500	$5x10^5$–$5x10^6$ ESAs	Medium	Heavy
500–1000	$5x10^6$–$2x10^7$ ESAs	Heavy	Very Heavy
> 1000	> $2x10^7$ ESAs	Very heavy	Very Heavy

Table B2 Guide to selection of nominal size of dense graded mixes

Nominal size (mm)	**Typical layer thickness (mm)**	**Typical use**
5	15–20	Very thin surfacing layer with fine surface texture. May not be available in all locations
7	25–30	Commonly used for surfacing residential streets and foot traffic areas where thin layers and fine surface texture are required.
10	30-45	General purpose wearing course in light and medium traffic applications
14	40–55	Wearing course mix for heavier traffic applications. Also some intermediate course applications depending on layer thickness
20	60-90	General purpose base and intermediate course mix for wide range of

Nominal size (mm)	Typical layer thickness (mm)	Typical use
		use.
28	85-120	Base and intermediate course but less commonly used than 20 mm. Control of segregation can sometimes be an issue.
40	120–160	Occasionally used as heavy duty base. Control of segregation can be a significant issue.

Table B3 Selection of binder type for dense graded wearing course applications

Traffic Category	Binder Class/Type	Recommended use
Light	320 or 170	Residential streets, car parks and foot traffic
	AR450	Alternative to 320, particularly in warmer climates
Medium	320 or AR450	Normal conditions and lower traffic ranges, particularly in cooler conditions
	320 or AR450	Good general purpose mix for wide range of applications
Heavy	320 or AR450	General purpose mix for heavily trafficked applications.
	600, AR450, Multigrade or PMB	Higher performance mixes for more critical traffic applications or where elastomeric polymers are required to improve flexibility. Stiffer binders require strong, stiff base.
Very Heavy	320 or AR450	Heavily trafficked intersections and slow moving traffic
	600, AR450, Multigrade or PMB	Special applications such as very heavily trafficked intersections and heavy-duty industrial pavements.

Table B4 Selection of binder type for dense graded intermediate and base course applications

Traffic Category	Binder Class/Type	Recommended use
Light and Medium	320	General purpose mixes for cooler conditions
	320 or AR450	General purpose mixes for most light and medium traffic applications
Medium/ Heavy (high fatigue base)	320 or AR450	Special high bitumen content sub-base layer providing high fatigue resistance. To avoid rutting, this mix should not be used within 125 mm of surface. The layer thickness should not generally exceed 70 mm or one third of the structural pavement depth.
Heavy	320 or AR450	General purpose mix for heavy traffic applications.
	600	High stiffness base for use in heavy duty pavements.
Very Heavy	320, 450, 600, Multigrade or PMB	Special applications such as heavy-duty industrial pavements and hard standing areas.

Table B5 Selection of binder type for other mix types

Mix Type	Traffic Category	Binder Class/Type	Recommended use
Open Graded Asphalt	Light or Medium	320 or 450	Wearing course on light to medium trafficked roads where low levels of noise and water spray are required.
	Heavy or Very Heavy	PMB	Wearing course on Freeways and other heavily trafficked roads where low levels of noise and water spray are required.
Stone Mastic Asphalt	Light or medium	320 or 450	Wearing course for light and medium trafficked roads where well textured mix is required.
	Heavy or Very	320, 450 or	Wearing course for heavily trafficked roads providing

Mix Type	Traffic Category	Binder Class/Type	Recommended use
	Heavy	Multigrade	high levels of texture and rut resistance.
	Very Heavy (Special applications)	PMB	Enhanced wearing course performance in heavily trafficked applications.
Fine Gap Graded Asphalt	Light	320 or 450	Fine textured, durable wearing course for use in residential streets, pedestrian areas, and other light traffic applications

Design and manufacture of asphalt mixes incorporating Reclaimed Asphalt Pavement (RAP)

As a general rule, no special requirements need apply to the use of RAP in hot mix asphalt.

Where the percentage of RAP does not exceed 15% of the total mix, provided that separate designs are prepared for such mixes, the proportions used in manufacture are not substantially altered from that used in design, and that the Quality Plan includes a reasonable management plan for monitoring incoming RAP materials.

Where RAP is to be added in proportions greater than 15%, but not more than 30% of the total mix, the use of bitumen binder of one class softer than that otherwise specified will generally provide suitable compensation for the influence of hardened binder in the RAP and produce asphalt mixes of comparable stiffness, fatigue resistance and deformation resistance to mixes manufactured with virgin materials.

Alternative procedures include the use of rejuvenators or a softer class of binder tailored to tests on actual penetration or viscosity of binders recovered from stockpiled RAP materials. The latter approach is appropriate where it is believed that accurate prediction of binder stiffness is critical to the long term performance of the asphalt, e.g. Heavy traffic base applications and Very Heavy traffic base and wearing course applications. A further option is to accept the material without adjustment to the grade of fresh binder. In such cases the asphalt may have slightly higher flexural stiffness that could reduce fatigue resistance in thin surfacing applications when the proportion of RAP approaches 25 or 30%.

The specifier may also restrict use of more than 15% RAP to particular mix types or project applications. Mixes that are not permitted to contain more than 15% RAP should be listed in the Schedule of Job Details. The use of RAP in proportions greater than 15% should not be allowed where polymer modified binders are specified but should be satisfactory for use with multigrade binder and most applications with standard classes of bitumen binder.

The use of RAP in proportions greater than 30% of the total mix should only be permitted where the Contractor can demonstrate suitable manufacturing plant and quality control procedures. Manufacture should only be carried out in asphalt plants specifically designed to handle such proportions of RAP without overheating and damage to binder in the RAP or new mix. The quality plan should indicate the procedures for monitoring the consistency of grading and binder properties of incoming RAP materials, the use of softer binders or rejuvenating agents to achieve a binder of comparable performance to that otherwise specified, and testing to validate the properties of the manufactured asphalt.

A guide to blending of binders or rejuvenating agents to achieve a target binder viscosity is provided in *the Austroads* AGPT04B and AGPT04E (Recycled materials). Caution must be used in determining targets for blending of binders as fresh binder or rejuvenator may not be fully combined with the aged binder during the asphalt manufacture process. Consequently, mix performance characteristics imparted by binder stiffness, particularly fatigue and rutting resistance, may be somewhat intermediate between that of the fresh binder and that predicted from the stiffness or viscosity calculated or determined by extraction and testing of the blended binder.

6.4 MANUFACTURE AND STORAGE

Guidance for binder storage and mixing temperatures may be obtained by reference to AAPA *Advisory Note 7: Guide to the Heating and Storage of Binders for Sprayed Sealing and Hot Mixed Asphalt.* Also see AGPT04K for more information on seals. The length of time that manufactured asphalt may be held in hot storage bins will vary according to the type of mix, type of binder and construction of storage bins. Maximum storage times (24 h) are generally applicable to standard dense graded asphalt mixes, standard bitumen binder and well insulated bins that may also include

supplementary heating. Shorter storage periods apply to high binder content mixes, polymer modified binders and poorly insulated bins. Additional guidelines for storage of polymer modified binders at elevated temperatures may be provided by the manufacturers of polymer modified binders. Other potential deleterious influences of extended storage may be assessed by monitoring mix temperature variation and segregation.

The addition of fibre to stone mastic asphalt is generally undertaken by one of the following alternative methods:

- Addition of loose or pelletised fibre direct to the pugmill of a batch mixer in meltable pressed packs
- Metering of loose or pelletised fibre direct to pugmill of batch mixing plant
- Metering of pelletised fibre through system designed for addition of RAP to drum mixing plant.
- Metering of loose or pelletised fibre direct to drum mixing plant through line that merges fibre with binder at point of addition to aggregates.

6.5 SAMPLING AND TESTING OF ASPHALT PRODUCTION

General: The purpose of inspection and testing is to provide reasonable assurance to the purchaser that the quality of component materials comply with the standards specified, and that the manufactured asphalt is in accordance with the designated job mix design.

Manufacturing compliance may be assessed at two levels:

- Verification that the job mix has been replicated, i.e. use of conforming components and combination in the design proportions to achieve the job mix grading and binder content.
- Verification that the design targets have been met, i.e. testing of compacted samples for volumetric properties and other specified properties.

For many applications, compliance with the job mix grading and binder content is adequate. If production is controlled within the tolerances specified, it is neither necessary nor cost effective to perform further testing for conformity to mix design criteria as a routine measure of quality. In fact, the variability inherent in such sampling and testing may lead to misleading interpretation of quality variation where no such variation really exists.

Where confirmation of volumetric properties is required, an additional clause should be inserted to require compaction of samples taken from production to be compacted using the same procedures as that specified for the design of the relevant mix. The sampling frequency should be the same as that applied to testing of grading and binder content.

Compacted samples may also be assessed for other design properties such as Marshall Stability and flow or resilient modulus. The Marshall test properties should meet the specified design criteria.

The manufacturer should not rely solely on the sampling and testing done for compliance purposes as the measures of process quality control. The worksection provides an incentive to the manufacturer to undertake suitable measures to improve the level of conformity and consistency of manufactured product by reducing the frequency of testing for compliance purposes where the manufacturer is using a suitable statistical process control system and where the results of compliance tests show an appropriate level of consistency in meeting the worksection requirements.

A guide to statistical process control systems is provided in AAPA *Implementation Guide IG-3: Asphalt Plant Process Control Guide*. Further guidance to the application of statistical techniques is provided in AS 3940 *Quality control – Guide to the use of control charts* including Cusum techniques and AS 3942 *Quality control – Variables charts – Guide*.

A typical statistical process control system that would be suitable for this application is one that incorporates the following elements:

Process control charts for the compliance tests for grading (one sieve below mix nominal size, 2.36 mm and 0.075 mm sieves), binder content, and maximum density.

Process charts should show:

- Actual individual sample test results plotted against the target value and specified tolerances.
- Five point rolling mean, with the target value, warning and control limits.
- Five point rolling range (the maximum of five points).

Corrective action should be taken when any of the following occur:

- One point lies outside the control limits.

- Two out of three points lie outside the warning limits. Investigation of possible assignable causes, and need for corrective action, should be undertaken if:
- Five consecutive points in the rolling mean are above or below the target.
- Five consecutive increasing points occur in the range.
- Two out of three points lie outside the warning limits.

The use of statistical process control measures are strongly encouraged as a means of reducing the uncertainties associated with interpretation of test results from single samples. The use of risk assessment procedures to define where variation may occur is also recommended.

6.6 DELIVERY

The rate of delivery should be matched to paving output to maintain consistent spreading to achieve good ride quality and uniform compaction and to avoid unnecessary delays in spreading operations and loaded asphalt being held on site for long periods.

Asphalt should arrive on site at a suitable temperature for spreading. The actual temperature will depend on mix type, layer thickness, ambient conditions and equipment available for compaction. Generally, compaction should be completed before the mix temperature falls below about 90°C (slightly higher for modified binders). A guide to temperature of dense graded hot mix asphalt mixes, at the time of spreading, to provide adequate time for compaction using typical equipment, is shown in

Table B6 Asphalt Spreading Temperatures (Dense Graded Asphalt)

Road surface temperature1 (°C)	**Minimum mix temperature2 (°C)**			**Range of mix temperature3 (°C)**
	Thickness of layer, mm			
	< 30	**30 – 40**	**41 – 100**	**> 100**
5 – 10	See note 4	See note 4	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. Surface temperature should be generally that applicable to the coolest area of the pavements, e.g., shade areas, if applicable.
2. Mix temperatures apply to Classes 170, 320 and AR450 bitumen binder. Use of Class 600, Multigrade, or PMBs may require minimum temperatures 5°C to 10°C higher than those shown.
3. Maximum temperatures apply when placing thick layers, to avoid excessive displacement under rolling.
4. Placing asphalt in thin layers under cool conditions may adversely affect the result due to the increased difficulty in achieving proper compaction, effective joints and good surface finish. Additional attention should be paid to issues of mix workability, asphalt temperature, compaction techniques and any influence from additional cooling due to wind or moisture.
5. Placing of asphalt over a previous layer that has not cooled below about 65°C requires special consideration and mix temperatures should be adjusted accordingly.

6.7 PLACING

Preparation of surface

Road surfaces must be clean to ensure good bond between new asphalt and the existing surface.

Priming

Crushed rock and gravel surfaces should be primed with a suitable application of primer, prior to placing asphalt, particularly where the total thickness of asphalt is 50 mm or less. Priming the surface assists in:

- Achieving a strong bond between asphalt and granular layers.
- Reducing the permeability of the surface of the granular layer.
- Stabilising the pavement moisture content and assisting in the curing of cement stabilised layers.
- Preserving the integrity of the granular surface after completion of preparation and before placing asphalt.

If priming is required, it must be included as a separate worksection and schedule item.

Tack coating

Tack coating for normal asphalt applications comprises a light application of bitumen emulsion to ensure adequate adhesion between layers. The placing of ultra thin asphalt is a specialty process that requires a higher application rate of tack coat (up to 0.9 L/m^2) to increase the surface bond. The type of bitumen emulsion used in such applications generally contains a polymer modifier and must be placed with a special integrated paving machine that sprays tack coat immediately ahead of depositing asphalt so that the tack coat is not damaged by spreading equipment.

The type of bitumen emulsion for normal applications should suit the conditions of use. Generally, rapid setting cationic emulsion is used in cooler regions where damp conditions may be encountered. In warmer or drier conditions, slower setting cationic emulsions and anionic emulsions may combine easier handling with satisfactory performance. Bitumen emulsion used for tack coating may be diluted with water to assist uniform coverage, provided that the residual binder application rate is achieved.

Tack coating is generally not necessary when placing over clean, freshly applied primed surfaces or newly placed, untrafficked asphalt.

Spreading

The specification provides for asphalt to be placed when pavement surface temperatures are as low as 5°C. Placing in cool conditions increases the difficulty in obtaining good standards of work and, where practicable, work involving thin layers (40 mm or less) or PMB binders should be programmed to be done when such conditions are less likely to occur.

The selection and use of automatic level control for asphalt paving should normally be determined by the Contractor, taking into account the applicability to site conditions and the geometric requirements of the finished result. The use of automatic level controls will usually only be applicable to larger jobs and heavier traffic. The Schedule of Job Details provides for specification of particular level control devices, if required.

Compaction

Selection of compaction equipment is the responsibility of the Contractor, provided that it is capable of achieving the required standards of compacted density, surface shape and finish.

Joints

Joints are the weakest part of the pavement. Cold joints should be minimised by planning of works to achieve a minimum number of construction joints and, where practicable, maximum use of hot or warm joints.

6.8 FINISHED PAVEMENT PROPERTIES

For general asphalt work, the application of shape standards as specified in **Shape**, together with the use of good placing practices as outlined in the notes to **Placing**, should provide adequate surface smoothness and ride quality.

The standard of ride quality that can be achieved will depend on:

- The roughness of the surface on which the asphalt layer is to be placed, and
- The extent of shape correction and additional asphalt layers that may be applied prior to the final layer.
- Ride quality will also be influenced by restrictions such as intersecting streets, road fixtures (e.g., manholes), and the need to match kerb and channel. Specifiers should avoid potential conflicts in requirements by simultaneously trying to control thickness, level and ride quality.

Achievement of specified densities will depend upon the provision of a stiff base and a workable mix.

1145 SEGMENTAL PAVING

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide segmental paving, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- *0136 General requirements (Construction).*
- *0152 Schedule of rates – supply projects.*
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1112 Earthworks (Roadways).*
- *1113 Stabilisation.*
- *1121 Open drains, including kerb and channel (gutter).*
- *1132 Lean mix concrete subbase.*
- *1133 Plain and reinforced concrete base.*
- *1141 Flexible pavement base and subbase.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

Australian standards

AS 1141	Methods for sampling and testing aggregates
AS 1141.11.1.1-2009	Particle size distribution — Sieving method
AS 2876-2000	Concrete kerbs and channels (gutters) – Manually or machine placed.
AS 3705-2012	Geotextiles-Identification, marking and general data
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 — 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/NZS 4586:2004	Slip resistance classification of new pedestrian surface materials
AS/NZS 4663:2004	Slip resistance measurement of existing pedestrian surfaces

Austroads

AGPT04G-2009	Guide to pavement technology: Part 4G Geotextiles and geogrids

Other publications

Concrete Masonry Association of Australia

CMAA MA56-2010	Guide to permeable interlocking concrete pavements
CMAA MA57-2010	Guide to concrete segmental and flag pavements - guide to specifying
CMAA T45-1997	Concrete segmental pavements - Design guide for residential access ways and roads
CMAA T46-1997	Concrete segmental pavements - Detailing guide

Clay Brick and Paver Institute

CBPI Manual 1: 2003 Clay paving design and construction

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- CBPI: Clay Brick and Paver Institute, now known as Think Brick Australia.
- CMAA: Concrete Masonry Association of Australia.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Clay 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 square metres 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.
- Laying patterns: Herringbone, Basketweave, stretcher, or zig zag running bond.
- Lippage: Height deviation between adjacent pavers.

1.5 SUBMISSIONS

Approvals

Submissions: To the Superintendent's approval. Submit the following for approval:

- Drawings.

1.6 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
MATERIALS			
GENERAL – Nominated materials	Submit segmental paving materials and supplier.	2 weeks before ordering	Superintendent
EXECUTION			
SUBGRADE PREPARATION – Dimensions and specification	Present the finished subgrade for approval	1 working day before proceeding	Superintendent
SUBBASE – Dimensions and specification	Present finished subbase for approval	1 working day before proceeding	Superintendent
BASE – Dimensions and specification	Present the finished base for approval	2 working days before proceeding	Superintendent

WITNESS POINTS table

Item	Requirement	Notice for inspection
EXECUTION		

Item	Requirement	Notice for inspection
SAND BEDDING COURSE - Screeding	Re-inspect screed left more than 1 day	Progressive
COMPLETION - Inspection	Regularly inspect joints after completion	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program for the works

Planning: Conform to the following:

- Provide planning resources to allocate plant and personnel for the contract period.
- Program the work to meet the constraints of **HOLD POINTS** and **WITNESS POINTS**.

3 MATERIALS

3.1 GENERAL

Nominated materials

Submissions: Submit details of all proposed segmental paving materials, including the following:

- Sand: Provide certification of the grading and quality to AS 1141.11.1.
- Segmental pavers: Submit the following type test results from NATA registered laboratory:
  - Characteristic breaking load and flexural strength: To AS/NZS 4456.5.
  - Dimensional deviations: To AS/NZS 4456.3.
  - Abrasion resistance: To AS/NZS 4456.9.
  - Salt attack resistance grade: To AS/NZS 4456.10.
  - Slip resistance type test: To AS/NZS 4586.
- Slip resistance site test of completed paving: To AS/NZS 4663.
- The source of supply.

Testing authority: NATA registered laboratory.

Approval: Do not deliver materials until the Superintendent has approved the nominated materials.
Inspection type: **HOLD POINT.**

3.2 CONCRETE AND CLAY SEGMENTAL PAVERS

Standards

General: To AS/NZS 4455.2.

Concrete segmental paving: To CMAA MA57, CMAA T45 and CMAA T46.

Permeable interlocking concrete pavers: To CMAA MA56.

Clay segmental paving: To CPBI Manual 1.

Dimensional deviations: To AS/NZS 4455.2 Table 2.2(A) and AS/NZS 4455.2 Table 2.2(B).

Properties

Minimum material and dimensional requirements: To AS/NZS 4455.2 Table 2.8.

Salt attack resistance grade: to AS/NZS 4455.2 Table 2.7.

Slip resistance classification: To AS 4586.

Proprietary product: Conform to the **SELECTIONS** schedule.

3.3 SAND

General

Quality: Provide well-graded, clean, hard sand, with uncoated grains of uniform quality and free of soluble salts or other contaminants which may cause efflorescence.

Storage: Cover sand on site to protect from rain.

Cement: Do not use cement bound material.

Bedding sand

Grading: Obtain material from a single source or blend to conform to the **Bedding sand grading table**.

Bedding sand grading table

AS Sieve	% 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

Grading for permeable pavements: To CMAA MA56 Section 9.

Moisture content: 4 – 8% and uniform when spread.

Joint filling sand

Grading: Conform to the **Joint filling sand grading table.**

Joint filling sand grading table

AS Sieve	% 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

Grading for permeable pavements: To CMAA MA 56 Section 9.

Moisture content: Dry when spread.

3.4 GEOTEXTILE MATERIALS

General

Standard: To AS 3705 and AGPT04G.

3.5 CONCRETE FOR EDGE RESTRAINTS

Properties

General: To *0319 Minor concrete works*.

Strength: If not shown on the drawings, or provided by kerb and/or gutter (channel), provide concrete edge restraints for pavers with the following minimum 28-day characteristic compressive strength:

- Edge restraints for pavers on road pavements: 32 MPa.
- Edge restraints for pavers on medians, traffic islands and driveways: 25 MPa.

3.6 SELECTIONS

Pavers

Restraints: Select pavers to the **Paver Schedule**.

Paver schedule

Property	PAV1	PAV2	PAV3
Material			
Shape type / shape name.			

Property	PAV1	PAV2	PAV3
Colour			
Thickness			
Laying pattern			
Minimum characteristic breaking load			
Dimensional deviation category			
Abrasion resistance			
Salt attack resistance grade			
Slip resistance classification			
Product			

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General
Requirement: Conform to *1101 Control of traffic.*

4.2 SUBGRADE PREPARATION

Dimensions and specification
General: Prepare subgrade to the required depth below the finished surface level as shown on the drawings and conform to *1112 Earthworks (Roadways)*.

Inspection type: **HOLD POINT**.

4.3 SUBBASE

Dimensions and specification
Construction: If shown on the drawings, construct a subbase or working platform, to conform to the following:

- *1113 Stabilisation.*
- *1132 Lean mix concrete subbase* or *1141 Flexible pavements base and subbase* as appropriate.

Inspection type: **HOLD POINT**.

4.4 BASE

Dimensions and specification
Construction: To *1133 Plain and reinforced concrete base* or *1141 Flexible pavements base and subbase*, as appropriate.

Inspection type: **HOLD POINT**.

Extent: Extend the base course in width to at least the rear face of all new edge restraints.

Tolerances
Deviation from a 3 m long straightedge: ±6 mm.

Remedial work: Do not use sand bedding material as a levelling material to compensate for base finishing outside the above tolerances.

Base surface drainage: Free without ponding.

4.5 EDGE RESTRAINTS

General
Extent: Provide edge restraints along the perimeter of all segmental paving as shown on the drawings. Make sure the faces of edge restraints abutting pavers are vertical.

Edge restraint support: On compacted base and/or subbase.

Joints
Contraction joints: Provide contraction joints 20 mm deep at maximum spacing of 3 m.

Kerbs and/or gutters, and edge strips

General: To AS 2876.

Construction: To *1121 Open drains including kerb and channel (gutter)* and *0319 Minor concrete works.*

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.

4.6 SAND BEDDING COURSE

Geotextile

Position: Place fabric over prepared base course before laying the sand bedding course.

Screeding

General: Spread the sand bedding course in a single uniform layer and screed in a loose condition to the nominated design profile and levels to achieve a uniformly thick nominal 20 mm to 30 mm layer following final compaction of the segmental 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 in the screeding sand exceeding 5 mm.

Remediation: If screeded sand left overnight is subject to rain, check for level and re-screed where necessary before pavers are placed.

Inspection type: **WITNESS POINT**.

Drainage

Bedding course drainage: If water ponding occurs at edge restraint, drain bedding course to existing subsurface drain or drainage pit using geotextile and 20 mm diameter PVC pipe.

Compaction

Moisture content: Prepare a trial section to establish the moisture content limits which will allow paver system compaction to be achieved.

Manual placing of pavers: Maintain the bedding sand at a uniform loose density.

Mechanised laying: Provide firm, uniform but not full compaction.

4.7 LAYING PAVERS

Manual laying

Placement and jointing: Uniformly place pavers on the screeded sand bedding to the documented laying pattern. Lay the pattern at either 90° or 45° to the line of edge restraints.

Joints: Lay pavers with uniform 3 mm nominal joint widths to provide a finished 2 mm to 4 mm joint range after bedding compaction and joint filling operations.

Variation: Mix the pavers between pallets to evenly distribute colour variation between pallets over the paved area.

Sequence: Lay first row next to edge restraint or established straight line.

Odd shapes: In each row, first lay the full units and follow with cut closer units. Do not use cut pieces smaller in size than one quarter of a full block.

Laying around obstacles

Concrete surround: 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 specific dimensions of authority access chambers.

Patterns around obstacles: Lay up both sides of the feature from the main or original laying face.

Control joints
Location: If pavers are placed over an isolation, contraction or expansion joint in an underlying concrete base, provide a control joint in the segmental paving.

Joint: 10 mm thick preformed jointing material of bituminous fibreboard.

Protection
Foot or barrow traffic: Provide boards overlaying paving to prevent disturbance of pavers before compaction.

Construction traffic: Do not allow construction traffic on the pavement before compaction and joint filling.

4.8 BEDDING COMPACTION

Method
Compactor: Compact the sand 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.

Lippage: Maximum 2 mm level difference between the adjoining edges of any two pavers.

Damage: Replace any pavers which are damaged during bedding compaction 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 adjacent to edge restraint.

Finished levels
Maximum deviation of finished surface level from the design level: ± 6 mm.

Finished level of edge restraints and drainage inlets: Minimum 5 mm below the finished paving level.

4.9 FILLING JOINTS

Timing
Compaction: Complete all compaction before filling joints. Complete joint filling of laid paving at the end of each day.

Method
Spreading: Spread the joint filling sand over the pavement and fill the joints by brooming.

Compaction: After spreading, make one or more passes of a plate compactor and refill the joints. Repeat the process until the joints are completely filled.

4.10 COMPLETION

Protection
Restrictions: 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 sand: Remove excess joint filling sand before opening to traffic.

Inspection
Joint filling: Inspect the pavement at regular intervals during the Defects Liability Period to make sure that all joints remain completely filled.

Inspection type: **WITNESS POINT**.

4.11 LIMITS AND TOLERANCES

Application
Summary: The limits and tolerances applicable to the various clauses in this worksection are summarised in the **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/tolerances**	**Worksection clause reference**
Base		
Maximum deviation from a 3 mm straightedge.	± 6 mm.	BASE
Laying paving units		
Joint widths	2 mm - 4 mm	LAYING PAVERS
Completed segmental paving		
Maximum deviation of surface level from design level for roads.	± 6 mm	BEDDING COMPACTION
Level adjacent to drainage inlets	Minimum 5 mm below the finished paving level.	BEDDING COMPACTION
Lippage - Difference in level of adjacent pavers	≤ 2 mm	BEDDING COMPACTION

1146 BITUMINOUS SLURRY SURFACING

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide bituminous slurry surfacing, as documented.

Performance
Requirements: Conform with the Drawings and the work specified or directed by the Superintendent. Conform with worksection *0161 Quality (Construction)*.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*
- *1143 Sprayed bituminous surfacing.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1141	Methods for sampling and testing aggregates
AS 1141.11.1-2009	Particle size distribution by sieving
AS 1141.12-1996	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 1141.25.1-2003	Degradation factor—Source rock
AS 1141.42-1999	Pendulum friction test
AS 1160-1996	Bituminous emulsions for the 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 1348-2002	Glossary of terms—Roads and traffic engineering
AS 2008-1997	Residual bitumen for pavements
AS 2150 – 2005	Hot mix asphalt – A guide to good practice
AS 2350 various	Methods of testing Portland and blended cements
AS 2758	Aggregates and rock for engineering purposes
AS 2758.1 - 1998	Concrete aggregates
AS 2758.5 – 2009	Asphalt aggregates
AS/NZS 2891	Methods of sampling and testing asphalt
AS/NZS 2891.3.1: 2011	Bitumen content and aggregate grading—Reflux method
AS 4283 – 1995	Cold mix asphalt for maintenance patching

Other publications

AUSTROADS	
AGPT03 – 2009	Guide to Pavement Technology Part 3 - Pavement surfacings
AGPT04F – 2008	Guide to Pavement Technology Part 4F: Bituminous Binders
AGPT04J – 2008	Guide to Pavement Technology Part 4J: Aggregate and source rock
AGPT05 – 2011	Guide to Pavement Technology Part 5: Pavement Evaluation and Treatment Design

AP-T41-06	Specification framework for polymer modified binders and multigrade bitumens
AP-T26-03	Guidelines and specification for bituminous slurry surfacing

International Slurry Surfacing Association

ISSA TB 100-1990	Test method for wet track abrasion of slurry surfaces
ISSA TB 109-1990	Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester and Sand Adhesion
ISSA TB 114-1990	Wet stripping test for cured slurry seal mix
ISSA TB 139-1990	Test method to classify emulsified asphalt/aggregate mixture systems by modified cohesion tester measurement of set and cure characteristics
ISSA TB 144-1990	Test method for classification of aggregate filler-bitumen compatibility by Schulze-Breuer and ruck procedure

1.4 STANDARD

General

Standard: To AP-T26 and AGPT03.

1.5 INTERPRETATION

Definitions

General: For the purposes of this worksection the definitions given below apply.

- Default terms: Where terms are not specifically defined in this worksection, AS 1348 is the default Standard.
- Microsurfacing: A bituminous slurry surfacing, usually containing polymer, that is capable of being spread in layers up to 30 mm thick for rut-filling and correction courses, and for wearing course applications where good surface texture is required to be maintained throughout the service life. The curing process is chemically controlled, whereas slurry seals use a thermal process.
- Polymer modified binder: A binder consisting of polymeric materials dispersed in bitumen with enhanced binder performance for particular applications. It is used in microsurfacing.
- Proprietary names: Bituminous mix is also commonly known under various proprietary names such as ‘cold overlay’, ‘microsealing’, ‘paveseal’, ‘microasphalt’, etc.
- Size: The size of the bituminous slurry sealing is based on the nominal largest stone size in the mix. For the purpose of this worksection, the size is either Size 5 or Size 7.

1.6 SUBMISSIONS

Approval

Submissions: To the Superintendent’s approval.

Documents

Submit the following for approval:

- Technical data: Refer to mix design.
- Calculations:
  - . Target application rate and thickness for bituminous slurry.
- Materials:
  - . Compliance certificates.
- Execution details:
  - . Proposal for plant and equipment.
- Type test results:
  - . Stockpiled aggregates.
  - . Supplied binder.
  - . Production mix.
  - . Surface texture depth and average skid resistance.

Design

Prototypes: Surface texture test run.

1.7 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Design and control of bituminous mixes – Nominated mixes	Submit details of nominated mix with NATA Certification	7 days before commencing	Superintendent
EXECUTION			
Production mix			
- **Bituminous slurry**	Target application rate and nominal layer thickness for approval	7 days before commencing	Superintendent
- **Sampling and testing of production mix**	Compliance with maximum permitted variations from approved mix	During mixing	Superintendent
Plant			
- **Provision of plant**	Nominate plant and equipment	14 days prior to commencing works	Superintendent
- **Paving unit calibration**	Documentation for detailed calibration	7 days before using paving unit	Superintendent
Operations			
- **Setout**	Extent of works to be confirmed by inspection	7 days before site preparation	Superintendent
- **Cleaning**	Provide cleaned surface for inspection	1 working day prior to spreading works	Superintendent
- **Surface defects**	Repair any surface defects	1 working day prior to spreading works	Superintendent
- **Tack coat**	Confirm requirement for tack coat	14 days prior to commencing on site	Superintendent
- **Weather limitations**	Cease works if weather conditions are not appropriate	Progressive	Superintendent
Spreading			
- **Rolling**	Confirm on inspection roller requirement	14 days prior to commencing on site	Superintendent
- **Traffic**	Capable to carry traffic in short period after slurry surfacing to approval of Superintendent	One hour after spreading	Superintendent
- **Surface texture**	Demonstrate surface texture	1 working day before commencing	Superintendent
- **Surface texture**	Confirm texture depth and average skid resistance by testing	One month after works complete and opened to traffic	Superintendent
Non-conformance - Materials and finished surfacing	Approval for correction or replacement	1 working day before corrective action	Superintendent
Control of traffic			

Clause title/Item	Requirement	Notice for inspection	Release by
- **Provisions**	Implement control procedures	Prior to starting works	Superintendent
- **Completion**	Final check of works complete	Prior to removal of traffic controls	Superintendent

WITNESS POINTS table – Off-site activities

Clause title/Item	Requirement	Notice for inspection
MATERIALS		
Aggregate - Compliance	Submit NATA test results for the nominated aggregate	7 days prior to commencing works
Mineral filler - General	Submit NATA test results for the nominated mineral filler	7 days prior to commencing works
Binders - General	Submit NATA test results for the nominated binder	7 days prior to commencing works
Water and additives - Additives	Submit NATA test results for the nominated Additives	7 days prior to commencing works

WITNESS POINTS table – On-site activities

Clause title/Item	Requirement	Notice for inspection
MATERIALS		
Aggregates - Compliance	Test results for on site stockpiles of aggregate	Minimum 7 days prior to incorporation in works
Binders - General	Verify blinder supplied is as was nominated	1 working day prior to incorporation in works
EXECUTION		
Operations		
- **Tack coat**	Test certificates for batches	2 working days prior to using in works
- **Water fog coat**	Confirm if pre wetting is required	Before commencing spreading
Spreading – Clean up	Leave road fixtures in clean and satisfactory condition	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 DESIGN AND CONTROL OF BITUMINOUS MIXES

Mix design

Design mix: The contractor is to design a mix that satisfies the properties given in the **Mix properties table.** The mix must be easy to lay and provide a finish that is stable and durable and satisfies all the requirements in this worksection including skid resistance and texture depth.

Mix properties table

Property	Test method	Value	
		Microsurfacing	**Slurry Seal**
Wear Loss	ISSA TB 100 1 hour 6 day	 540 g/m^2 maximum(3) 800 g/m^2 maximum(1)	 800 g/m^2 maximum(2) Not applicable
Traffic Time	ISSA TB 139 30 minutes 60 minutes	 12 kN.m minimum 20 kN.m minimum	 12 kN.m minimum 20 kN.m minimum
Adhesion	ISSA TB 114	≥ 90%	≥ 90%

Property	Test method	Value	
		Microsurfacing	**Slurry Seal**
	or ISSA TB 144	or 11 grade points minimum (AAA, BAA)	or Not applicable
Excess Binder Content > 3000 v/l/d	ISSA TB 109	Not applicable	540 g/m^2 maximum
Notes: v/l/d: vehicles/lane/day. (1) Microsurfacing > 3,000 v/l/d. (2) As for microsurfacing if applicable is for traffic volume > 3,000 v/l/d. otherwise not applicable. (3) Microsurfacing ≤ 3,000 v/l/d.			

Nominated mixes

Approval: Submit details of each proposed bituminous slurry surfacing mix design including details the constituent materials. Approval of the nominated mix will be in consideration of AS 4283. The Contractor must produce the mix to conform with all specifications. This is a **HOLD POINT**.

Details for submission: Details include:

- Nominal size of the design mix.
- Aggregate source and type.
- Combined aggregate grading/mineral filler particle size distribution as a single grading (not in a range).
- Bituminous emulsion content.
- Residual binder content of the emulsion.
- Proportions of constituent materials used (including binders, adhesion agent and additives).
- Type and sources of filler, binder and adhesion agent.
- All relevant compliance certificates.

Approved mix: When a nominated mix has been approved it is to be known as the 'Approved Mix'.

Approved grading and approved binder content: The combined aggregate/filler grading and the binder content of the approved mix is termed the 'approved grading' and the 'approved binder content' respectively.

Non-conformance: Revise and re-test nominated mixes that do not conform with specified requirements.

Prior approval

Conditions: A mix may be approved due to 'prior approval' in the following conditions:

- If the mix was used in a separate contract within 12 months of proposed works date.
- If full approved details have been previously used.
- If the constituent materials and quality remain unchanged from that previously approved.
- If the in-service performance of the bituminous slurry surfacing incorporating the nominated mix is acceptable.

Variations to approved mixes

Written approval required: Any changes to the approved mix, its method of production or source of supply of constituents require written approval 21 days prior to proposed implementation.

Certificates of compliance

Submission: Submit for approval NATA Certificates of compliance for each constituent and nominated mix.

Requirements: All phases of any particular test to be performed at one laboratory. All relevant test results to accompany the Certificate and be within twelve months of the submission date.

2.2 SCHEDULING

Program the works

- Provide planning resources to allocate plant and personnel for the contract period.
- Program the work to meet the constraints of **HOLD POINTS**, **WITNESS POINTS**.

3 MATERIALS

3.1 AGGREGATES

Material

Standard: To AS 2758.1, AS 2758.5 and AS 1141, Austroads AGPT04J.

Components: Crushed rock or crushed gravel, or a mixture of crushed rock or crushed gravel and natural sand.

Properties: Clean, hard, angular, durable particles, free from clay, dirt, organic material or other deleterious matter.

Aggregate properties

Requirement: For each source conform with the following table.

Aggregate properties table

Property	Test method	Requirement
Degradation factor	AS 1141.25.1	50 minimum
Los Angeles value	AS 1141.23	35 maximum
Aggregate wet strength	AS 1141.22	150 kN minimum
Wet/dry strength variation	AS 1141.22	30% maximum
Polished aggregate friction value	AS 1141.42	45 minimum
Sand equivalent	AS 1289.3.7.1	45 minimum

Grading limits

Standard: Test to AS 1141.11.1 and AS 1141.12.

Requirement: The aggregate (including mineral filler) to conform with the following table.

Grading limits for combined aggregate/filler table

Sieve size	Percent passing by mass	
	Size 5	Size 7
13.2 mm	100	100
9.50 mm	100	100
6.70 mm	100	85–100
4.75 mm	90–100	70–90
2.36 mm	50–70	45–70
1.18 mm	30–50	28–50
600 µm	20–35	19–34
300 µm	12–25	12–25
150 µm	7–18	7–18
75 µm	4–10	5–15

Compliance

Compliance certificates: When submitting details of the nominated mix submit test report on the quality and grading of the fine aggregate proposed to be used. For blended aggregates submit results for each constituent coarse aggregate and the proportions of the various sizes proposed.

This is a **WITNESS POINT**.

Currency: Such test results to be less than 12 months old and representative of current aggregate supply.

Production mix: Test results for each lot/stockpile of aggregate a minimum of seven days prior to incorporation in the works. This is a **WITNESS POINT**.

3.2 MINERAL FILLER

General

Standard: To AS 2150 and AS 2350.

Components: Hydrated lime, flyash, portland cement, or other material approved by the Superintendent.

Size: Mineral matter with minimum of 85 % passing a 75 µm sieve.

Composition: Consistent in mineral composition and dry compacted air voids.

Quality: Dry and free from lumps, clay, organic matter or other material deleterious to asphalt.

Materials: Added mineral filler to comply with table 3 of AS 2150. May consist of hydrated lime, fly ash, portland cement, flue dust from the manufacture of portland cement, asphalt plant baghouse fines or other approved material.

Submit: Submit compliance certificates for added mineral fillers for approval at time of nominated mix submission. This is a **WITNESS POINT**.

Proportion: The quantity of filler added to the bituminous microsurfacing during placement not to vary by more than 1% of the total aggregate (by mass) from the filler content nominated in the mix design.

3.3 BINDERS

Compliance

Submit: Submit compliance certificates for binders at time of nominated mix submission. This is a **WITNESS POINT**.

Verification: Provide information to verify that the binder supplied is the same as that nominated in the mix design. This is a **WITNESS POINT**.

Slurry binder

Standard: To AS 2008, AS 1160 and Austroads AP-T41/06, AGPT04F.

Type: Polymer modified bitumen emulsion.

Grade: The contractor is to select an appropriate grade of binder for bitumen emulsion to conform with that required for slurry surfacing.

Microsurfacing: Binder polymer modified to reach the properties in the Mix properties table.

Tack coat binder

Standard: To AS 1160.

Type: Bitumen emulsion.

3.4 WATER AND ADDITIVES

Added water

Properties: Potable and compatible with the component materials so that the performance requirements specified are met.

Additives

Submit: Submit compliance certificates for additives at time of nominated mix submission. Include the type, source and nominal proportions of additives. Supportive test data must show that the wear loss and excess binder content is within the limits. This is a **WITNESS POINT**.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 PRODUCTION MIX

Bituminous slurry

Characteristics: Able to be placed and spread evenly on the road surface. Capable of being spread in layers of variable thickness for surface correction and for wearing surface applications.

Definition: Bituminous slurry produced in the paving unit at the site is termed the production mix.

Submit: The target application rate (m^3 of mix/m^2 of road surface) and the corresponding nominal layer thickness. This is a **HOLD POINT**.

Manufacture the bituminous slurry to the approved production mix design within the tolerances in the **Maximum permitted variations from approved mix table.**

Maximum permitted variations from approved mix table

Production mix properties	Maximum permitted variations from approved mix (by mass)	
	Size 5	**Size 7**
Grading*		
Passing 9.50 mm AS sieve and larger Passing 6.70 mm Passing 4.75 mm Passing 2.36 mm and 1.18 mm Passing 0.600 mm Passing 0.300 mm Passing 0.150 mm Passing 0.075 mm	Nil Nil ±6% ±5% ±4% ±3% ±2% ±1.5%	Nil ±7% ±6% ±5% ±4% ±3% ±2% ±1.5%
Residual binder content	–0.5% +1.0%	–0.5% +1.0%
***Notwithstanding, these allowable variations not to fall outside the limits for design of nominated mix as given in the Grading limits for combined aggregate/filler table.**		

Sampling and testing of production mix

Testing samples: The Contractor is responsible for taking samples and to supply all facilities, equipment and labour for that purpose.

Frequency: Take two 1.5 kg representative samples of bituminous slurry from each lot at random intervals from the discharge of the paving unit and immediately seal the sample containers

Costs: Borne by the Contractor.

Lot: 50 m^3 or one day's production (whichever is the lesser), or such smaller quantity which is considered as representative of consistent production of the paving unit.

Drying: Prior to testing for residual binder content and aggregate gradation, as determined by AS 2891.3.1, for slurry surfacing, dry the samples to constant weight in an oven at 60℃ for a minimum of 15 hours.

Submit: Treat and test the samples of bituminous slurry at a NATA registered laboratory to confirm compliance with **Maximum permitted variations from approved mix table**. This is a **HOLD POINT**.

4.3 PLANT

Provision of plant

Condition: All plant to be maintained in good working condition.

Paving unit: Self propelled paver able to accurately proportion and deliver the mineral aggregate, filler, bitumen emulsion, water and additives to a mixer and discharge the thoroughly mixed slurry on a continuous basis.

Storage: the machine must have sufficient storage capacity to provide for the works extent.

Calibration: Individual calibration controls required for proportioning each component.

Spreader box: The slurry must be spread uniformly by means of a mechanical type spreader box attached to or forming part of the mixing unit.

Ancillary equipment: All required ancillary equipment to be provided by the contractor and in accordance with all statutory requirements. Such as rotary road brooms, rollers, signs, lamps, barricades, hand squeegees, shovels, hand brooms.

Submit: Submit the plant and equipment nominated for use in the works 14 days before works commence. This is a **HOLD POINT**.

Paving unit calibration

Timing: Each paving unit must be calibrated with the component materials of the approved mix design prior to the commencement of application of the slurry.

Previous calibration: Documentation covering the same materials and approved mix is acceptable provided that calibration has been carried out within the previous twelve months.

Documentation: Include an individual calibration for each component material at various settings which can be related to the paving unit's metering devices.

Submit: No paving unit is allowed on the work until the calibration has been verified and approved. This is a **HOLD POINT**.

4.4 OPERATIONS

Setout

Scope: The size, nominal thickness, and extent of bituminous slurry surfacing as shown on the Drawings or as directed. This is a **HOLD POINT**.

Marks: Place marks at intervals not exceeding 10 m on the line to be followed by the paving unit. Marking not necessary where line is defined by a kerb or edge.

Edges and joints: parallel to kerbs and shoulders and run off of the slurry to be prevented from occurring. Lines at intersections will be kept straight to provide a good appearance, use masking as necessary.

Cleaning

Sweep: Prior to any application of slurry sweep to ensure the surface is free from loose material, stones, dirt, dust and foreign matter. Sweep the surface beyond the edge of the area to be surfaced by at least 300 mm. Remove adhered foreign matter by other means.

Oil: Clean areas significantly affected by oil contamination.

Inspection: Provide the cleaned surface for approval prior to any spreading of the slurry. This is a **HOLD POINT**.

Protection of services and road fixtures

Precaution: Prevent slurry or other materials used from entering or adhering to gratings, hydrants, valve boxes, manhole covers, bridge or culvert decks or other road fixtures.

Surface defects

Repairs: Prior to spreading any slurry the contractor must repair any surface defects as directed in the schedule of works or by inspection with the Superintendent. This is a **HOLD POINT**.

Surface defects: Include crack patching, pothole repairs and repairs to failed pavement.

Tack coat

Required: Only required when the surface to be covered is extremely oxidised and ravelled or comprises concrete or brick. Tack coat as specified or as directed on inspection. This is a **HOLD POINT**.

Application rate: 0.2 - 0.24 L/m^2 of residual binder at 15°C.

Certificates: Test each delivery of emulsion for residual binder content to AS 1160 Appendix A and provide a certificate of compliance traceable to the relevant batch at the suppliers storage tank. This is a **WITNESS POINT**.

Samples and testing: Take two 2 L samples of bitumen emulsion from each bulk delivery, to AS 1160.

New works on road and carpark pavements: Provide the sprayed bituminous seal to *1143 Sprayed bituminous surfacing* two weeks prior to the application of the bituminous slurry surfacing wearing course.

Water fog coat

Surface: If necessary the surface may be pre-wet by fogging ahead of the spreader box. This is a **WITNESS POINT**.

Water: Entire surface is damp with no apparent flowing water ahead of the spreader box.

Application rate: Adjust to suit the temperature, surface texture, humidity and dryness of the surface being covered.

Weather limitations

Temperature: Do not commence spreading if either the pavement or air temperature is below 10°C and falling.

Bituminous slurry: May be applied when both pavement and air temperatures are above 7°C and rising, or above 10°C.

Rain: Do not proceed during rain or when rain appears imminent.

Cease works: If weather conditions are not appropriate. This is a **HOLD POINT**.

4.5 SPREADING

Water addition

Mix consistency: To be the desired consistency when deposited in the spreader box. Make no additions other than minor amounts of water for the purpose of overcoming temporary build-up of slurry in the corners of the spreader box.

Mixing slurry time and rate

Mixture properties: Adjust the mixing time to produce a complete and uniform coating of the aggregate and to produce a mixture that is conveyed into the moving spreader box at a sufficient rate to always maintain an ample supply across the full width of the strike-off.

Application rate

Extent: Adjust the strike-off to provide an application rate which will completely fill the surface voids and provide the nominal application rate as scheduled.

Rolling

Required: Rolling to be specified on drawings, schedules or as directed on inspection. This is a **HOLD POINT**.

Timing: Carry out rolling after the emulsion has broken and the mix is sufficiently stable. When the mix has cured sufficiently to prevent pick-up on the roller tyres.

Method: Use pneumatic tyred rollers to produce a dense, even, homogeneous compacted surface where there is insufficient local traffic to achieve satisfactory compaction.

Cleanup

Road fixtures: After the bituminous slurry has been spread, clean off any such material and leave such gratings, access chamber covers and other road fixtures, in a clean and satisfactory condition. This is a **WITNESS POINT**.

Traffic

Traffic time: Bituminous slurry surfacing to be capable of carrying slow moving traffic (<40 km/h) within one hour of application without permanent damage occurring, such as rutting or ravelling.

Cease work: When the time before the microsurfacing is capable of carrying traffic exceeds one hour, cease work unless specifically approved by the Superintendent. This is a **HOLD POINT**.

Surface texture

Characteristics: Uniform in appearance, and free of areas exhibiting segregation or excessive or insufficient binder.

Test run: Demonstrate the surface texture on a short test run for approval. If the surface texture is acceptable then all subsequent work to be finished to an equivalent surface texture. This is a **HOLD POINT**.

Increased texture: If increased surface texture is required, trail a fabric skirt behind the spreader box.

Testing for texture depth: One month after slurry is opened to traffic test for texture depth and average skid resistance to Austroads AGPT05. Based on the average of a minimum of 4 tests per lot. Submit test results within 5 days of testing. This is a **HOLD POINT**.

Joints

Longitudinal joints in the wearing course: Straight and placed at either the edge or the centre of a traffic lane. If necessary, lightly screed the edges and joints with a hand squeegee to achieve a smooth uniform appearance and to remove excess build-up of material.

Level and shape Tolerance

Level of wearing course: Finished surface level not to vary from the design level at any point by more than ±10 mm.

Adjacent gutters: Any kerb and/or gutter finished surface level not to be more than ± 10 mm above the level of the lip of the adjacent gutter.

Shape: The deviation from a 3 m long straightedge placed anywhere on the top of the finished surface not to exceed 10 mm when assessed within 24 hours of work completion.

4.6 NON-CONFORMANCE

Materials and finished surfacing

Nonconformance: Due to the following;

- any materials supplied fail to conform to the requirements in this worksection.

- any section of bituminous slurry surfacing fails to conform to the requirements of this worksection.
- bad workmanship.
- defective materials supplied by the Contractor.
- materials made defective by the method of operation adopted.
- texture depth. This is a **HOLD POINT**.

Rectification: Replace or correct nonconforming sections, and restore any underlying or adjacent surface or structure.

4.7 CONTROL OF TRAFFIC

Provisions

Precautions: Provide for traffic to *1101 Control of traffic* while undertaking the work and take all necessary precautions to protect the work from damage until such time as the new work has developed sufficient strength to carry normal traffic without damage. This is a **HOLD POINT**.

Delays: Take all necessary steps to avoid or minimise delays and inconvenience to road users during the course of the work. Where adequate detours or side tracks are included in the Contract or are otherwise available, temporarily divert traffic while the work is in progress.

Completion

Traffic: No traffic allowed on the new work until the surfacing is stable and able to withstand traffic without damage or pick up and if applicable sufficient rolling has taken place to prevent damaging the freshly applied bituminous mat.

Signs: Roadwork signs to remain in position until after the surfacing is complete and stable. This is a **HOLD POINT**.

4.8 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	Limits/Tolerances	Worksection reference
Mineral aggregate	As per Aggregate properties Table	**Aggregates**
Combined aggregate/filler	Grading limits as per Aggregate properties Table	**Aggregates**
Mineral filler	> 85% passing a 75 μm sieve	**Mineral filler**
Mix properties		
- Design properties	As per Mix properties Table	**Design and control of bituminous mixes**
- Permitted variations	As per Maximum permitted variations from approved mix Table	**Production mix**
Surface preparation	Sweeping to extend at least 300 mm beyond edge of area to be surfaced	**Operations**
Weather limitations	Slurry surfacing not to commence if either air or pavement temperature is below 10°C and falling, only commence if both air and surface temperature is above 7°C and rising or above 10°C	**Operations**
Shape and levels		
- Finished levels	Not to vary at any point by more than ± 10 mm from design levels. Immediately adjacent to kerb	**Spreading**

Activity	Limits/Tolerances	Worksection reference
	and/or gutters, levels ± 10 mm above design level	
- Finished shape	Deviation from the bottom of a 3 m straightedge within ± 10 mm	**Spreading**

1151 ROAD OPENINGS AND RESTORATION

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Provide road opening and restoration works for installation of services within public road reserves comprising clearing, excavation, backfilling and restoration of surfaces, as documented. This worksection excludes the installation activities of the relevant public utility services.

Performance

Requirements: Provide the works as specified and/or as shown on the drawings and as directed/approved by the Superintendent. Conform to public utility services and Council requirements.

1.2 CROSS REFERENCES

Worksections

Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*
- *1141 Flexible pavement base and subbase.*
- *1142 Bituminous cold mix.*
- *1143 Sprayed bituminous surfacing.*
- *1144 Asphaltic concrete (Roadways).*
- *1145 Segmental paving.*
- *1392 Trenchless conduit installation.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

AS 1289	Methods for 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
AS 1289.5.6.1-1998	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
AS 1289.5.7.1-2006	Soil compaction and density tests—Compaction control test—Hilf density ratio and Hilf moisture variation (rapid method)
AS 1289.6.1.2-1998	Soil strength and consolidation tests—Determination of the California Bearing Ratio of a soil—Standard laboratory method for an undisturbed specimen
AS 1348-2002	Glossary of terms—Road and traffic engineering
AS 1742	Manual of uniform traffic control devices
AS 1742.3-2009	Traffic control devices for works on roads

Other publications

Street Openings Conference

Guide to codes and practices for street openings, 2009

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- CBR: California Bearing Ratio.
- CRO: Council's Restoration Officer.
- TGS: Traffic Guidance Scheme.
- CTPO: Council's Tree Preservation Officer.
- WAE: Work-as-executed (drawings).

Definitions

General: For the purposes of this worksection the following definitions apply in addition to those of AS 1348:

- Carriageway: That portion of a road or bridge devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes.
- Clearing: The removal of vegetation or other obstacles at or above ground.
- Footpath: The paved section of a pathway.
- Pathway: A public way reserved for the movement of pedestrians and of manually propelled vehicles.
- Pavement: That portion of a carriageway placed above the subgrade for the support of, and to form a running surface for, vehicular traffic.
- Selected material zone: The top part of the Upper zone of formation in which material of a specified higher quality is required.
- Shoulder: The portion of the carriageway beyond the traffic lanes and contiguous and flush with the surface of the pavement.
- Verge: That portion of the formation not covered by the carriageway or footpath.

1.5 SUBMISSIONS

Approval

Submissions: To the Superintendent's approval.

Documents

Submit the following for approval:

- Drawings: W.A.E. drawings (certified).
- Calculations: Survey set-out data for trench excavations.
- Execution details: As documented. Refer to **HOLD POINTS**, **WITNESS POINTS.**

Materials: Select backfill, cement, bituminous/asphaltic pavement materials.

- Technical data: Compaction data on backfill.

1.6 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause/subclause	Requirement	Notice for inspection	Release by
Provision for traffic – Safety	Submit a Traffic Guidance Scheme	2 weeks before construction	Superintendent
Set out of works			
Pathways and driveways	Install utility services by trenchless method	7 days before installation	Superintendent
Set out inspection and approval	Submit set out line	7 days before surface work	Superintendent and CRO
Excavation			

Trench	Submit proof of approval of method of excavation	7 days before excavation	Superintendent
Location of services	Written confirmation by appropriate authority that service is retired and inactive	2 weeks before excavation	Superintendent
Excavation level	Excavated foundation level as planned or directed	3 days before approval of foundation	Superintendent
Unsuitable material	Removal of unsuitable foundation material	3 days before approval of foundation	Superintendent
Trench backfill - Backfill	Nominate backfill material for approval	7 days before backfill	Superintendent
Restoration preparation - approval	Present prepared areas prior to paving restoration	3 days before restoration	Superintendent and CRO
Surface restoration			
Temporary pavement removal	Approval to retain in place temporary base material 7 days before restoration of pavement		Superintendent
Subbase and base	Approval of source of material	7 days before restoration of pavement	Superintendent
Pathways and paved public areas	Approval to retain in place temporary subbase material	7 days before restoration	Superintendent
Segmental paving units	Approval of paving pattern near features	7 days before restoration	Superintendent and CRO
Completion - Clean up	Present cleaned up restoration works for approvals	As directed	Superintendent

WITNESS POINTS table – On site activities

Clause/subclause	Requirement	Notice for inspection
Surface treatment removal		
Concrete and asphalt pavements	Removal and legally dispose	3 days before removal
Segmental paving units	Hand removal and stacking	24 hours before removal
Segmental paving units	Removal and legally dispose	3 days before removal
Grass	Unsuitable grass for assessment and removal to disposal	3 days before removal
Small plants, shrubs and trees	Suitable items for assessment and stores at nominated locations	7 days before removal
House stormwater pipes	Maintain/assess damage for repair/replacement	As directed
Excavation		
Topsoil	Suitability for reuse – assessment and stockpile	3 days before removal
Stockpiles	Stockpile at sites nominated by Superintendent	3 days before removal
Existing trees		

Work near trees	Duration of open excavation to be determined by Superintendent with conditions by CTPO	3 days before excavation
Work near trees	Avoid root damage conditions by CTPO	3 days before disturbing roots
Trench backfill		
Backfill	Source of backfill for trenches approved by Superintendent	7 days before importing material
Trees	Approval to place fill near trees	7 days before placing material
Compaction – Relative compaction	Approval to vary moisture content for material compaction	3 days before placing material
Compaction – Relative compaction	Submit test results on compacted backfill within 2 weeks of testing	As directed
Restoration preparation		
Carriage pavements and pathways	Condition determined by CRO and Superintendent As directed	
Temporary carriageways	Steel plating and warning signs for approval	As directed
Surface restoration		
Pathways and paved public areas	Restoration directed by the Superintendent	3 days before restoration
Concrete footpaths	Match thickness, finish and pattern to adjoining components or as directed by the Superintendent	7 days before formwork
Verge plants, shrubs and trees	Planting holes, replanting items, backfill and maintain as directed	As directed

2 PRE-CONSTRUCTION PLANNING

2.1 THE WORKS GENERALLY

Programming

Utility services: Liaise with and document the constraints on excavation imposed by the existing utility services.

Concrete pavements: Procedures to obtain approval for open trenching in carriageway concrete pavements.

Program:

- Provide planning resources to allocate plant and personnel for the contract period.
- Program the work to meet the constraints of **HOLD POINTS**, **WITNESS POINTS**.

2.2 PROVISION FOR TRAFFIC

Safety

Traffic obstruction: Construct the Works in a safe manner with the least possible obstruction to traffic, both vehicular and pedestrian.

Guidance scheme: Submit a Traffic Guidance Scheme and carry out all activities for controlling traffic, both vehicular and pedestrian, in conformance with *1101 Control of traffic*. This is a **HOLD POINT**.

Access

Properties adjacent to the works: Provide continuous safe, all weather vehicular and pedestrian access wherever possible.

Notice: Provide 48 hours to property owners whose access will be restricted.

3 EXECUTION

3.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

3.2 EXISTING UTILITY SERVICES

Marking

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

Contact: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, of locating underground pipe and cables (possible within two working days). See www.1100.com.au.

Locations: Obtain locations of water, sewer, stormwater, gas, electricity and telephone services. Utility Authorities: In addition contact names listed in *0136 General Requirements (Construction)* to verify the location of services.

3.3 SET OUT OF WORKS

Preparation

Initial limits: Set out the limits of the proposed excavation for trenches, pits and chambers required for the utility service installation. Set out legibly in chalk or crayon for inspection by Council's Restoration Officer without permanently defacing any surface. This is a **WITNESS POINT**.

Adjusted limits: Adjust the set out to minimise or eliminate residual small portions of paving slabs. Make adjustments in conformance with **Pathways** and **Carriageways** and with respect to the existing paved surfaces and joint patterns.

Utility services under concrete pavements

Approval: Installation of utility services by open trenching methods in carriageway concrete pavements is not permitted without the prior approval of the Superintendent, or Council in the case where the Utility Authority is the Principal in the Contract. Install the utility services under carriageway concrete pavements in conformance with *1392 Trenchless conduit installation*.

Additional work adjacent to the works

Procedure: The Council may require removal and restoration of footpaths and/or carriageway pavements, adjacent to the Works, in addition to the removal and restoration requirements of this worksection. Such additional work is identified and defined by Council's Restoration Officer at the **Set out inspection and approval** hold point of the Contract.

Payment: In this case, payment for the additional removal and restoration activities is made as a Variation to the Contract at the schedule rates for the particular activities.

Pathways and driveways

Set out: Vary the set out line in conformance with the reinstatement requirements of the Street Opening Conference publication *Guide to codes and practices for street openings.*

Conform to codes and practices as follows:

- Bitumen and concrete paving: In conformance with the reinstatement provisions and sketches of the above guide.
- Segmental paving units: Ensure the set out line is at least one whole unit clear of both sides of the minimal alignment of the trench.
- Textured or patterned concrete set out line: As determined by Council's Restoration Officer in conjunction with the Contractor's surveyor and the Superintendent.
- Driveways: Where the Superintendent directs that driveways are not to be disturbed, install the utility services under driveways in conformance with *1392 Trenchless conduit installation*. This is a **HOLD POINT**.

Carriageways

Asphalt pavements: Set out the proposed trench at the minimum width for the depth of service and, wherever possible, at right angles to the road reserve boundary.

Survey marks

Authority requirements: Refer any trench or surface work proposed in the vicinity of Permanent or State Survey Marks to the Land Information Centre of the Department of Land and Water Conservation or other appropriate Authority responsible for survey records, prior to commencement or Work, to obtain protection or relocation requirements.

Set out inspection and approval

Timing: Submit the set out line to the Superintendent for approval prior to the commencement of any surface clearing work. This action is a **HOLD POINT**.

Release: The Superintendent and Council's Restoration Officer will inspect and approve the set out, and define any additional removal and restoration work required by Council, prior to the release of the hold point.

3.4 SURFACE TREATMENT REMOVAL

Concrete and asphalt pavements

Method: Saw cut trench set out lines located on concrete or asphalt footpaths, and asphalt carriageway pavements for the full depths of the bound pavement layers except where the set out line is located along expansion joints.

Removal of concrete and asphalt: Break out concrete or asphalt footpath and carriageway pavement material between the trench set out lines, remove and legally dispose of off-site or stockpile at a site nominated by the Superintendent. This is a **WITNESS POINT**.

Segmental paving units

Removal: Take up by hand segmental paving units both full and cut, between the trench set out lines, and neatly stack on wooden pallets at locations as directed by the Superintendent. This is a **WITNESS POINT**.

Concrete edging: Break out, remove and legally dispose of off-site or stockpile at a site nominated by the Superintendent. This is a **WITNESS POINT**.

Concrete subbase: If present, sawcut along the trench set out lines.

Dimensioned stone

Kerb and gutter: Take up stone units within the set out lines and stack on wooden pallets at locations as directed by the Superintendent. This is a **WITNESS POINT**.

Grass

Method: Neatly cut grass turf between trench set out lines into 300 mm squares. Take up and store the turf at locations as directed by the Superintendent and water as directed during the storage period. If the grass is considered by the Superintendent to be unsuitable for reuse, remove and legally dispose of it off-site. This is a **WITNESS POINT**.

Small plants, shrubs and trees

Suitability for re-planting: As determined by the Superintendent.

Storage: Take up small plants, shrubs and trees, between the set out lines, and store at locations nominated by the Superintendent. Wrap the root ball in a hessian or plastic bag with drain holes and water as directed during the storage period.

Unsuitable vegetation: Remove and legally dispose of off-site other plants deemed unsuitable for replanting.

House stormwater pipes

Gutter discharge: Maintain house stormwater pipes discharging into carriageway gutters at all times.

Damage: If caused by the Contractor's activities, repair or replace damaged pipes to the satisfaction of the Superintendent. This is a **WITNESS POINT**.

3.5 EXCAVATION

Topsoil

Definition: Topsoil, which is considered by the Superintendent to be suitable for reuse in the restoration work

Topsoil: Strip, remove and stockpile at a site nominated by the Superintendent.

Timing: Before undertaking trench excavation. This is a **WITNESS POINT**.

Trench

Dimensions: Excavate trenches to the standard widths and depths for the particular utility service installation or to dimensions shown on the drawings.

Stabilisation: Provide shoring, sheet piling or other stabilisation of the sides necessary in conformance with statutory requirements.

Approval by other public utility authorities: Where other public utilities exist in the vicinity of the Works, obtain the approval of the relevant authority to the method of excavation before commencing excavation. Provide proof of approval of the relevant authority to the Superintendent. This is a **HOLD POINT**.

Location of services

Existing underground services: Locate by exploratory excavation prior to the principal trench excavation.

Retired services: Before removal, provide confirmation in writing from the appropriate Authority that retired services are inactive. This is a **HOLD POINT**.

Removal of services: Excavate, remove off site and legally dispose of all retired services components. Backfill the resulting excavation in conformance with **Trench backfill**.

Excavation level

Trench or foundation excavation: To the planned level for the bottom of the specified bedding or foundation level or such other depth as directed by the Superintendent. This action is a **HOLD POINT**. The Superintendent's approval of the trench or foundation level is required prior to the release of the hold point.

Stockpiles

Excavated material: Segregate the earth and rock material and stockpile, at sites nominated by the Superintendent, for reuse in backfilling operations. This is a **WITNESS POINT**.

Locations: Do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along gutters where stockpiling is permitted along the line of the trench excavation.

Disposal: If stockpiling is not permitted legally, dispose of excavated material off-site.

Unsuitable material

Disposal: Remove any material from the bottom of the trench or at foundation level which is deemed unsuitable by the Superintendent and legally dispose of off-site and replace with backfill material in conformance with the requirements of this worksection.

Levels: Align the bottom of the excavated trench or foundation at the specified level and slope of the utility service. This is a **HOLD POINT**.

3.6 EXISTING TREES

Protection during works

Existing trees: Protect from all damage during the works.

Harmful materials: Do not store, stockpile, dump or otherwise place under or near trees bulk materials and harmful materials including oil, waste concrete, clearings, boulders and the like. Prevent wind blown materials from harming trees and plants.

Work near trees

Damage: Prevent damage to tree bark. Do not attach stays and guys to trees.

Work under trees: Do not remove topsoil from, or add topsoil to, the area within the dripline of the trees.

Hand methods: Use hand methods to locate, expose and cleanly remove the roots on the line of excavation. If it is necessary to excavate within the drip line, use hand methods or trenchless methods, to preserve root systems intact and undamaged.

Roots: Do not cut tree roots exceeding 50 mm diameter. If it is necessary to cut tree roots, use means such that the cutting does not unduly disturb the remaining root system. Immediately after cutting, water the tree and apply a liquid rooting hormone to stimulate the growth of new roots (e.g. Formula 20® or Hormone 20®). This is a **WITNESS POINT**.

Backfilling: Backfill to excavations around tree roots with a mixture consisting of three parts by volume of topsoil and one part of well rotted compost with a neutral pH value, free from weed growth and harmful materials. Place the backfill layers, each of 300 mm maximum depth, compacted to a dry density similar to that of the original or surrounding soil. Do not backfill around tree trunks to a height

greater than 200 mm above the original ground surface. Immediately after backfilling, thoroughly water the root zone surrounding the tree.

Compacted ground: Do not compact the ground or use skid-steel vehicles under the tree dripline. If compaction occurs, give notice and obtain instructions.

Compaction protection: Protect areas adjacent the tree dripline. Submit proposals for an elevated platform to suit the proposed earthworks machinery.

Watering: Water trees as necessary, including where roots are exposed at ambient temperature > 35°C.

Mulching: Spread 100 mm thick organic mulch to the whole of the area covered by the drip line of all protected trees.

Open excavations under tree canopies: The duration to be determined by the Superintendent at the time of the excavation and in conformance with the requirements of Council's Tree Preservation Officer. This is a **WITNESS POINT**.

3.7 TRENCH BACKFILL

Bedding, haunch, side and overlay zones

Installation: In conformance with the particular utility authority requirements.

Overlay zone thickness: Maximum of 300 mm immediately over the utility service.

Material: As nominated by the utility authority.

Backfill

Extent: Between the overlay zone and the top of subgrade.

Material: As determined by the Superintendent and may comprise the following:

- Approved stockpiled excavated material.
- Imported fill.
- 14 :1 moist washed river sand/cement mix or non-cohesive backfill material.

Nominate backfill material for approval of the Superintendent at least 7 days prior to commencement of work. This is a **HOLD POINT**.

Imported material: From a source approved by the Superintendent, free of tree stumps and roots and capable of being compacted in conformance with **Compaction**. This is a **WITNESS POINT**.

Selected material zone

Extent: The section of trench within the zone, if applicable.

Backfill material: Selected material free from stones larger than 100 mm maximum dimension and the fraction passing a 19 mm Australian Standard sieve to have a 4 day soaked CBR value, in conformance with AS 1289.6.1.2, not less than that of the adjacent selected material zone.

Trees

Backfill at trees generally: Backfill, for a minimum 300 mm thickness, around tree roots with a topsoil mixture approved by the Superintendent, placed and compacted in layers of 150 mm minimum depth to a dry density equal to that of the surrounding soil.

Backfill at trees in carriageway pavements: To the direction of the superintendent.

Backfill level: Do not place backfill material above the original ground surface around tree trunks or over the root zone. This is a **WITNESS POINT**.

Watering: Thoroughly water Immediately after backfilling the tree root zone.

3.8 COMPACTION

Relative compaction

Requirements: To the **Compaction table** when tested in conformance with AS 1289.5.4.1 for modified compactive effort or AS 1289.5.6.1 for density index for cohesionless material as applicable.

Compaction table

Layer	Relative compaction	Density index
Foundations or trench base to a depth of 150 mm below foundation levels	92%	70
Material replacing unsuitable material	92%	70
Bedding material	92%	70

Layer	Relative compaction	Density index
Selected backfill and ordinary backfill material		70
– below 1.5 m of finished surface	92%	70
– within 1.5 m of finished surface	97%	80
Backfill material within the selected material zone	97%	80

Layers: Compact all material in layers not exceeding 150 mm compacted thickness. Compact each layer to the relative compaction specified before the next layer is commenced.

Moisture content: At the time of compaction, adjust the moisture content of the material so as to permit the specified compaction to be attained at a moisture content which, unless otherwise approved by the Superintendent, is neither less than 60% nor more than 95% of the apparent optimum moisture content, as determined by AS 1289.5.7.1 (modified compaction). This is a **WITNESS POINT**.

Testing compaction: To AS 1289.5.7.1 compaction of completed backfill testing and submit the results. Test compaction at a minimum frequency of 1/every second layer/50m² of backfill surface area. This is a **WITNESS POINT.**

Precautions: If compacting adjacent to utility services, use compaction methods which do not cause damage or misalignment of any utility service.

3.9 RESTORATION PREPARATION

Carriageway pavements and pathways

Make good: Restore carriageway pavements and pathways in a continuous manner to the equivalent condition.

Equivalent condition: The condition equivalent to that existing at the commencement of the works as determined by Council's Restoration Officer and the Superintendent. This is a **WITNESS POINT**.

Structures

Levels: Set the levels of utility service surface pits, access chamber frames and lids and any other affected structures, so that carriageway pavements and footpaths can be restored to original levels. Liaise with other utility authorities if any other utility service surface box requires adjustment or replacement prior to restoration.

Approval

Before paving: Prior to the commencement of any paving restoration work, form up and prepare the areas for paved restoration and present the prepared areas to the Superintendent and Council's Restoration Officer for approval. This action is a **HOLD POINT**. And verify any additional restoration work required by Council, prior to the release of the hold point.

Temporary carriageways

Temporary restoration: If the planned date for final restoration exceeds 5 days provide temporary restoration and re open immediately after backfilling to subgrade level to the following alternatives:

- Bituminous cold mix, of a maximum thickness 50 mm, on a base of compacted crushed stone, gravel or other material approved by the Superintendent.
- Steel plating, over the trench, of sufficient thickness and bearing area outside the trench to support traffic loadings and suitably secured with pins or bituminous cold mix to the satisfaction of the Superintendent. Provide advance warning signs in conformance with AS 1742.3. This is a **WITNESS POINT**.

Temporary footpaths and driveways

Temporary restoration: If the planned date for final restoration exceeds 2 days provide temporary restoration and re open immediately after backfilling to subgrade level.

Material: Bituminous cold mix, of maximum thickness 50 mm, or other material approved by the Superintendent.

3.10 SURFACE RESTORATION

Temporary pavement removal

Temporary pavement material: Remove and dispose of off-site prior to final carriageway pavement restoration.

Temporary base material: If approved by the Superintendent, the temporary base material may remain in place and be incorporated into the final pavement if it complies with the requirements of this

worksection for the subbase (including the requirements for compaction and testing) and has not been disturbed or contaminated during removal of the temporary surfacing.

In any case, remove and dispose the asphaltic material of off-site. This is a **HOLD POINT**.

Subbase and base

Material: Provide crushed rock, CRB20-2 or CRS20 material, from a source approved by the Superintendent and configure in layers and depths as indicated in **Annexure A**.

Supply and installation: To *1141 Flexible pavement base and subbase*. This is a **HOLD POINT**.

Compaction: Uniformly compact each layer of the subbase and base courses over the full area and depth within the trench to a relative compaction of 100 per cent when tested in conformance with AS 1289.5.4.1.

Tests: Undertake compaction tests at a minimum frequency of 1/ every second layer/50 m² of restoration surface area.

Carriageway bituminous wearing surface

Materials and installation:

- To *1143 Sprayed bituminous surfacing* or *1144 Asphaltic concrete (Roadways)*, as applicable.
- To the requirements set out in Annexure A.
- To present a waterproof surface at application.

Surface tolerance: Departures from a 3.m straightedge less than ±5 mm 7 to 10 days after completion, and the surface such that an impact is not transmitted to traffic passing over the restoration.

Construction details:

- Extend the bituminous surfacing and/or asphalt to a minimum dimension of 100 mm beyond the perimeter of any trench excavation.
- Make the joint between new and existing asphalt vertical and cut by diamond saw or milling machine.
- Treat the vertical face and subgrade surface of the old asphalt by bituminous tack coating.

Thickness tolerance: No variation more than +10 mm or less than –0 mm at any point from the specified layer thickness.

Pathways and paved public areas

Materials generally: Consistent with the surface existing before commencement of the works, or as directed by the Superintendent. This is a **WITNESS POINT**.

Subbase: 150 mm crushed stone CRB20-2 compacted to 100 percent relative compaction in conformance with AS 1289.5.4.1. If approved by the Superintendent, the temporary material may remain in place and be incorporated into the final subbase. This is a **HOLD POINT**.

Lippage at patches: Match the surface level at any point along the patch's edge with the adjoining footpath surface within ± 5 mm.

Concrete footpaths

General: Include textured and patterned concrete

Construction: Conform to the following:

- Material: 20 MPa concrete
- Surface finish and pattern: Match existing adjoining footpaths and driveways as appropriate or as directed by the Superintendent. This is a **WITNESS POINT.**
- Expansion joints: 15 mm thick preformed jointing material of bituminous fibreboard or equivalent approved by the Superintendent placed where new concrete abuts existing concrete and in line with joints in existing concrete.
- Control joints:
  - Form control joints strictly in line with the control joints in existing concrete.

Around electricity supply poles: Terminate the concrete paving 200 mm from the pole and fill the resulting space with cold mix asphalt.

Asphalt footpaths

Materials and installation: To *1144 Asphaltic concrete (Roadways)*, or *1142 Bituminous cold mix*, as nominated by Council's Restoration Officer.

Thickness: Match the adjoining footpath.

Finish: Compact to a smooth even surface.

Segmental paving units

Materials and installation: To *1145 Segmental paving* and as follows:

- Laying: Re-lay to match the pattern and surface levels of the existing paving.
- Damaged paving units: Replace with new units, paving units which are unsuitable for relaying, as determined by the Superintendent, with new units of the same material, type, size and colour as the existing.

Tree surrounds, service boxes and poles: Match the pattern at similar existing features in the immediate area or be as directed by the Superintendent in consultation with Council's Restoration Officer. This is a **HOLD POINT.**

Turfed verges

Topsoil: 50 mm minimum thickness, placed on the subgrade prior to restoration of turfed verges.

Existing grass turf: Re-lay to conform with the original grassed surface.

Method: Hand butt turfs against each other in rows and topdress the seams with topsoil, rolled and watered to ensure direct and uniform contact with the topsoil.

Additional turf: If required complete the affected area with turf of the same species.

Verge plants, shrubs and trees

Topsoil: Match the surrounding thickness, placed on the subgrade prior to restoration of turfed verges.

Planting holes: Excavate, at locations determined by the Superintendent in consultation with Council's Restoration Officer, and spread the material evenly around each hole.

Plant material: Re-plant existing plants, shrubs and trees which are suitable for replanting as determined by the Superintendent. Backfill the planting hole with topsoil and compact by foot up to surface level.

Staking: Stake the shrubs and trees as directed by the Superintendent, and water and maintain for 2 months after the date of formal completion of the restoration works. These constitutes a **WITNESS POINT**.

3.11 COMPLETION

Clean up

Extent: Clean up the areas affected by the Works and associated construction activities and restore to a condition equivalent to that existing at the commencement of the Works.

Rubbish: Remove and legally dispose of all formwork, rubbish and residue construction materials, off site including material left at stockpiles.

Approval: Present the cleaned up restoration works to the Superintendent for approval. This action is a **HOLD POINT**. The Superintendent's approval is required prior to the formal completion of the restoration works.

3.12 WORK-AS-EXECUTED DRAWINGS

Requirements

Submission: Supply the Superintendent with fully marked-up work-as-executed drawings for the whole of the contract within 2 weeks of approval of the restoration works by the Superintendent. Prints of the contract drawings will be supplied by the Principal free of charge for this purpose.

Format: To *0136 General requirement (Construction)*.

4 ANNEXURE A

4.1 RESTORATION REQUIREMENTS

Description of Location: ……..

Restoration pavement layers:

Wearing surface type	.....	Thickness (mm)	..... (or nominal stone size)
Base layer type	.....	Thickness (mm)	.....
Sub base layer type	.....	Thickness (mm)	.....
Selected material	.....	Thickness (mm)	.....

Special requirements (e.g. linemarking, traffic signs, advice to adjacent property owners etc.)

.....

.....

.....

.....

.....

1152 ROAD OPENINGS AND RESTORATION (UTILITIES)

1 GENERAL

1.1 RESPONSIBILITIES

Application
General: The worksection applies to Work under Contract where the Principal to the Contract is the relevant Utility Authority for the works under execution. The Utility Authority may be a Local Council for Council initiated utility works.

Objectives
General: Provide clearing, excavation, backfilling and restoration activities associated with the documented installation of public utility services within public road reserves or other reserves under the control of Local Government Authorities. This worksection excludes the installation activities of the relevant utility services.

Performance
- Utility Authority.
- Streets opening conference information bulletin on codes and practices and the model agreement for Local Councils and utility service providers.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0257 Landscape – roadways and street trees.*
- *1101 Control of traffic.*
- *1132 Lean mix concrete subbase.*
- *1133 Plain and reinforced concrete base.*
- *1134 Steel fibre reinforced concrete base.*
- *1135 Continuously reinforced concrete base.*
- *1141 Flexible pavement base and subbase.*
- *1142 Bituminous cold mix.*
- *1143 Sprayed bituminous surfacing.*
- *1144 Asphaltic concrete (Roadways).*
- *1145 Segmental paving.*
- *1191 Pavement markings.*
- *1392 Trenchless conduit installation.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1289	Methods for testing soils for engineering purposes – Soil compaction and density tests
AS 1289.5.1.1-2003	Determination of the dry density/moisture content relation of a soil using standard compactive effort
AS 1289.5.2.1-2003	Determination of the dry density/moisture content relation of a soil using modified 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 1289.5.6.1-1998	Compaction control test—Density Index method for a cohesionless material
AS 1289.5.7.1-2006	Soil compaction and density tests- Compaction control test - Hilf density ratio and Hilf moisture variation
AS 1289.6.1.2-1998	Soil strength and consolidation tests—Determination of the California Bearing Ratio of a soil—Standard laboratory method for an undisturbed specimen
AS 1348 - 2002	Glossary of terms - Roads and traffic engineering
AS 1742	Manual of uniform traffic control devices
AS 1742.3-2009	Traffic control for works on roads
AS 4000-1997	General conditions of contract
AS/NZS ISO 9000: 2006	Quality management systems - Fundamentals and vocabulary
SAA HB 90.3-2000	The Construction Industry – Guide to ISO 9001:2000

1.4 STANDARDS

General

Standards: To the relevant Road Authorities, Work cover and Utility Authority's specifications.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AADT: Annual average daily traffic.
- CRO: Council's restoration officer.
- CTPO: Council's tree preservation officer.
- EMP: Environment Management Plan.
- GAT: Glossary of Austroad Terms.
- GPR: Ground penetrating radar.
- HP: HOLD POINT.
- RMS: Roads and Maritime Services.
- TGS: Traffic Guidance Scheme.
- WAE: Work-as-executed.
- WP: WITNESS POINT.

Definitions

General: For the purposes of this worksection the following definitions apply. The text in brackets is additional to the referenced definitions, as follows:

- AS 1348.
  - Base (Base course): One or more layers of material usually constituting the uppermost structural element of a pavement and on which the surfacing may be placed.
  - Carriageway: That portion of a road or bridge devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes (and inclusive of medians, traffic facilities and heavy duty driveways).
  - Clearing: The removal of vegetation or other obstacles at or above ground.
  - Footpath: The paved section of a pathway (or verge).
  - Pathway: A public way reserved for the movement of pedestrians and of manually propelled vehicles.
  - Pavement: That portion of a carriageway placed above the subgrade for the support of, and to form a running surface for, vehicular traffic (including the subbase and base course).
  - Shoulder: The portion of the carriageway beyond the traffic lanes and contiguous and flush with the surface of the pavement.
  - Subbase (Subbase course): The material laid on the subgrade below the base either for the purpose of making up additional pavement thickness required over the subgrade, or to prevent intrusion of the subgrade into the base, or to provide a working surface on which the remainder of

the pavement can be constructed. (The subbase course is often a different quality material to the base course.)

. Subgrade: The trimmed or prepared portion of the formation on which the pavement is constructed. (Subgrade level is the level immediately below the pavement.)

. Wearing Course (Surface): The part of the pavement upon which the traffic travels.

- SAA HB 90.3:
  . Hold Point (HP): A defined position in the construction/manufacturing stages of the Contract beyond which work is not to proceed without mandatory verification and acceptance by the Superintendent, or other person approved by the Superintendent.
  . Witness Point (WP): A nominated position in the manufacture/construction stages of the Contract where the option of attendance may be exercised by the Superintendent, after notification of the requirement.
  . Verge: That part of the road reserve between the carriageway and the road reserve boundary.
- AS/NZS ISO 9000:
  . Quality Check Lists (Contractor's Checklist): Forms completed during the manufacture/construction process verifying key steps, and records required for the Quality Register. Check lists apply to each identified lot of work.
- AS 4000:
  . Contractor: Means the person bound to carry out and complete work under the Contract. (A Contractor may be internal or external to the Utility Authority).
  . Principal: Means the Principal stated in the Annexure to the General Conditions of Contract. (The Utility Authority or Service Provider for whom the service installation and restoration work is being conducted.)
  . Superintendent: Means the person stated in the Annexure to the General Conditions of Contract as the Superintendent or other person from time to time appointed in writing by the Principal to be the Superintendent and notified as such in writing to the Contractor by the Principal and, so far as concerns the functions exercisable by a Superintendent's Representative, includes a Superintendent's Representative an individual appointed in writing by the Superintendent.
- Other:
  . Ancillary road elements: Road elements including kerb and gutter, drainage pits, drainage lines, subsoil drainage lines, pavement markings, street furniture (i.e. signs, bins, road safety barriers, etc.)
  . Carriageway Concrete Pavements: Reinforced concrete pavements. Does not include roller compacted concrete bases and subbases.
  . Council: The Local Government Authority for the area where the work is being performed.
  . Protected Species: Plants identified by Council or other relevant authorities as protected species.
  . Roads Authority: A person or body that is, by or under Roads Act 1993, declared to be a roads authority and in relation to a particular public road means the roads authority for that road (Road Act 1993).
  . Selected material zone: The top part of the upper zone of formation in which material of a specified higher quality is required as shown on drawings and schedules or as directed.
  . Utility Authority: Refer to Principal.

1.6 SUBMISSIONS

Approval

Submissions: To the Superintendent's approval.

Documents

Submit the following for approval:

- Drawings: W.A.E. Drawings (certified)
- Quality Plan
- Calculations: Survey set-out data for trench excavations.
- Execution details: As documented. Refer to **HOLD POINTS**, **WITNESS POINTS.**

Materials: Select backfill, cement, bituminous/asphaltic pavement materials.

- Technical data: Compaction data on backfill.

1.7 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause/subclause	Requirement	Notice for inspection	Release by
Planning and programming - Environmental Control measures	Submit an EMP for approval	2 weeks before construction	Superintendent
Provision for traffic			
- **Safety**	Submit a TGS for approval	2 weeks before works affecting traffic	Superintendent
- **Major roads**	Submit the TGS for formal approval of RMS, Council, Police	2 weeks before work affecting relevant roads	Superintendent
- **Local road closure**	Submit the TGS for approval of Council	2 weeks before road closures	Superintendent
Major roads – Utility Services	Approval for utilities within roads unable to be trenched	2 weeks before commencing works	Superintendent
Existing Utility services - marking	Provide details of affected services	7 days before excavation	Superintendent
Set out - Preparation	Submit the set out line for approval	7 days before commencing clearing	Superintendent and CRO
Surface treatment removal – Small plants, shrubs and trees.	Inspection of suitability of replanting small plants, shrubs and trees.	3 days before removal	Superintendent and CTPO
Excavation			
- **Trench**	Submit excavated level for approval	1 day before next relevant activity.	Superintendent
- **Location of services**	Provide details of requirements and approval of public utilities removed	7 days before commencing excavation	Superintendent
- **Contaminated or hazardous material**	Notify event and submit disposal proposal	1 hour within finding	Superintendent
Existing trees – Protection during works	Inspection of all trees with CTPO	7 days before clearing	Superintendent
Trench backfill			
- **Backfill**	Submit details of material	7 days before providing material	Superintendent
- **Water table**	Submit proposal to protect subgrade and respond to Superintendent directions.	7 days before next relevant activity	Superintendent
Restoration Preparation – Paved restoration	Inspect and setout extent of works	3 days before proceeding with pavement	Superintendent
Final carriageway	Submit evidence of	3 days before final	Superintendent

restoration – Subbase and base	settlement and identify cause	restoration	
Final pathways and driveways restoration			
- **Materials and tolerances**	Submit suitability of temporary materials	3 days before proceeding with pavement	Superintendent
- **Decorative segmental pavers on concrete base**	Submit alternative pavers	3 days before ordering	Superintendent and CRO
Completion - Clean up	Present the cleaned up restoration works for approval	3 days before programmed inspection	

WITNESS POINTS table – On-site activities

Clause/subclause	Requirement	Notice for inspection
Provision for Traffic		
- **TGS**	Emergency works – application of TGS.	2 hours before proceeding
- **Access to properties adjacent to the works**	Provide report on liaison with affected owners/occupiers to the Superintendent	1 working day before restricting access
Set out		
- **Preparation**	Set out marked legible to satisfy Superintendent	Progressive
- **Pathways and driveways**	Locations for trenchless conduit installation as directed	Progressive
- **Carriageways**	Obtain protection or relocation requirements for Permanent/State Survey Marks for appropriate Authority	7 days prior to affecting survey marks
Surface treatment removal		
- **Concrete and asphalt pavements**	Removal of concrete and asphalt, disposal or stockpile as directed.	3 days before works commencing
- **Pavers and dimension stones**	Submit locations for stacking components	3 days prior to stacking
- **Decorative pavers**	Replacement pavers and protection of adjacent areas	24 hours prior to removing pavers
- **Grass**	If grass is considered unsuitable by the Superintendent remove and dispose	5 days before commencing works
Surface treatment removal - House storm water pipes	Notify damage to pipes and proposal for reinstatement to Superintendent	1 hour after damage
Excavation		
- **Topsoil**	Obtain Superintendent direction for top-soil disposal	3 days prior to removing top soil
Protection of trees		
- **Work near trees**	Restrictions on work near trees involving CTPO	Progressive
- **Tree roots**	Obtain approval for root work involving CTPO	Progressive
Trench backfill – backfill under	Submit details of proposed	3 days before providing material

footpaths and carriageways	material	
Compaction – Relative compaction	Adjust the moisture content of the material to achieve specified compaction	Progressive
Compaction of trench backfill	Procedures, conformity with compaction criteria and testing frequency to be provided to Superintendent	Progressive
Restoration Preparation		
- **Carriageway pavements and pathways**	Restore pavements and pathways to agreed original condition with Superintendent and CRO	Prior to commencement of works
- **Temporary pavement – carriageways**	Submit proposals for temporary restoration including materials	3 days prior to commencing works
Restoration preparation – temporary footpaths and driveways	Provide access each day or as directed by the Superintendent	Progressive
Final carriageway restoration - asphaltic concrete wearing surfaces	Conform to relevant Road Authority – provide proposals	3 days prior to placing
Final pathways and driveways restoration –		
- **Materials and tolerances**	Exceptions to level tolerances to be resolved by Superintendent	Progressive
- **Pavement markings and street furniture**	Final locations subject to Superintendent's direction	7 days prior to locating
- **Concrete footpaths and driveways including textured and patterned**	Preformed jointing material to be approved	3 days prior to ordering
- **Segmental pavers on sand bed**	Replacement of pavers and pattern around features to be approved	7 days prior to proceeding
Verge plants, shrubs and trees – replanting	Replaced trees to be agreed with CTPO and Superintendent	7 days prior to importing trees and/or replanting

2 PRE-CONSTRUCTION PLANNING

2.1 THE WORKS GENERALLY

Planning

Check list: Conform with the Flow diagram 1 in *Guides to codes and practices for street openings* or Equivalent guide in States other than NSW.

Programming

Utility services: Liaise and document the constraints on excavation imposed by the existing utility services.

Concrete pavements: Procedures to obtain approval for open trenching in carriageway concrete pavements.

Program: Conform to the following:

- Obtain a Road opening permit from the appropriate Roads Authority unless specifically exempted.
- Provide planning resources to allocate plant and personnel for the contract period.
- Plan for the disposal of spoil and waste.

- Program the work to meet the constraints of **HOLD POINTS**, **WITNESS POINTS**.

Environmental control measures

Requirement: Implement an Environment Management Plan containing erosion and sedimentation control measures, and noise and dust control measures, as required by the relevant Environmental legislation and in accordance with the requirements of the relevant Statutory Authorities. This is a **HOLD POINT**.

2.2 PROVISION FOR TRAFFIC

Safety

Traffic obstruction: Construct the Works in a safe manner with the least possible obstruction to traffic, both vehicular and pedestrian.

Guidance scheme: Submit a Traffic Guidance Scheme and carry out all activities for controlling traffic, both vehicular and pedestrian, in accordance with *1101 Control of traffic*. This is a **HOLD POINT**.

Emergency works: Obtain and implement a Traffic Guidance Scheme, pre-approved by the Superintendent. This is a **WITNESS POINT**.

Access and notification

Impact of the works: Consult with the affected property owners and/or occupiers to minimise the impact of the Works on the property owners' operation including impacts of the Works and the Traffic Guidance Scheme on businesses and around commercial areas. Provide a report on this liaison to Superintendent. This is a **WITNESS POINT**.

Properties adjacent to the works: Provide continuous safe, all weather vehicular and pedestrian access wherever possible.

Notice: Provide 48 hours to property owners whose access will be restricted.

Signage: Provide 450 mm wide and 300 mm high steel signs that are visible on all approaches, quoting the name of the utility, its logo, the contractors name and an emergency phone number. All letters to be aerial font and 40 mm high letters and numbers.

Emergency works: Provide notice as soon as possible upon commencement of such works.

Major roads

Approval: Obtain formal approval of the Traffic Guidance Scheme from the State road authorities, council and police for works located on state roads, regional roads, and in the proximity to certain traffic control devices as determined by the Superintendent. This is a **HOLD POINT**.

Local road closures

Full road closures on local roads: Obtain prior approval of its Traffic Guidance Scheme from Council. This is a **HOLD POINT**.

Emergency works: Obtain and implement commencement of the Contract, a Traffic Guidance Scheme pre-approved by the Superintendent. This is a **WITNESS POINT**.

2.3 MAJOR ROADS

Utility services

Approval: Do not install utility services by open trenching methods in carriageway concrete pavements, full depth asphalt carriageways or regional roads with more than 10,000 AADT, without prior approval. This is a **HOLD POINT**.

Alternative: Install utility services under these carriageway pavements in conformance with *1392 Trenchless conduit installation* or the relevant Utility Authority's Specification as directed.

Maintenance: If maintenance of the Utility Authority's services requires the use of open trenching methods in these carriageway pavements, proceed only with approval.

Restoration: To **Final restoration of carriageway subbase and base (flexible)** or the relevant road authority's requirements.

2.4 QUALITY ASSURANCE

Quality plan

QA accreditation: Provide evidence of approved QA accreditation as required by the Contract, and of an approved Quality Plan for the Works.

Quality plan: Incorporate all checklists, inspections, testing and documentation as required in **Annexure C**, and as necessary to ensure that the Works conform to the Contract Documents.

Hold and witness points
Quality plan: Incorporate **HOLD** and **WITNESS POINTS** into the checklists.

Hold point sign-off: By the approved Contractor's Representative and the Superintendent.

Notice for the Superintendent: To the **Summary of HOLD POINTS** and the **Summary of WITNESS POINTS**.

Notice for Council officers: If the Superintendent instructs the Contractor that inspection is required at certain Hold Points or Witness Points by Council Officers, the Contractor is to give 24 hours notice to Council.

Hold Point approval by Contractor's inspector
Sign-off: If allowed by the Quality Plan, the Superintendent may allow the Contractor's nominated inspector to sign off certain Hold Points. This will be determined by the Contractor's performance in relation to the requirements of the Quality Plan and the Contract.

Testing
Frequencies: Conduct testing to the frequencies in **Annexure C**. All work represented by failed tests is to be retested and where necessary rectified.

Auditing
Co-operation: The Superintendent may audit the Contractor's Quality Assurance system as required. Fully co-operate in providing all information required by the Superintendent.

No additional payment
Costs: The provisions for quality assurance are deemed to be included in the rates generally in conformance with this worksection and there will be no additional payment for compliance with the specified Quality Assurance requirements.

3 EXECUTION

3.1 PROVISION FOR TRAFFIC

General
Requirement: Conform to *1101 Control of traffic*.

3.2 EXISTING UTILITY SERVICES

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

Contact: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, collecting enquiries and passing them on to affiliated utilities to assist in locating underground pipe and cables (initial response possible within two working days with responses from utilities some time later). See www.1100.com.au.

Locations: Obtain locations of water, sewer, stormwater, gas, electricity and telephone services. For example: When working around the vicinity of telecommunications plant conform to the 'Duty of Care' document provided by Telstra for essential precautions and approach distances.

For all Telstra DBYD (Dial Before You Dig) enquiries, contact Telstra Plan Services via email – Telstra.Plans@team.telstra.com and Phone: 1800 653 935 for urgent, onsite or optic fibre enquiries.

Utility Authorities: In addition to the' Dial before you dig' responses, the contact names listed in *0136 General Requirements (Construction)* to verify the location of services. This is a **HOLD POINT**.

3.3 SET OUT

Preparation
Initial limits: Set out the limits of the proposed excavation for trenches, pits and chambers required for the utility service installation. Set out legibly in chalk or crayon for inspection by Council's Restoration Officer without permanently defacing any surface. This is a **WITNESS POINT**.

Adjusted limits: Adjust the set out to minimise or eliminate residual small portions of paving slabs. Make adjustments in conformance with **Pathways** and **Carriageways** and with respect to the existing paved surfaces and joint patterns.

Timing: Prior to the commencement of any surface clearing work, submit the set out line to the Superintendent for approval. This action is a **HOLD POINT**.

Release: The Superintendent and Council's Restoration Officer will inspect and approve the set out, and define any additional removal and restoration work required by Council, prior to the release of the Hold point.

Pathways and driveways

Set out: Vary the set out line in conformance with the reinstatement requirements of the Streets Opening Conference publication *Guide to codes and practices for street openings.*

Conform to codes and practices as follows:

- Bitumen and concrete paving: In conformance with the reinstatement provisions and sketches of the above guide.
- Segmental paving units: Ensure the set out line is at least one whole unit clear of both sides of the minimal alignment of the trench.
- Textured or patterned concrete: Locate the set out line as determined by Council's Restoration Officer in conjunction with the Contractor's surveyor and the Superintendent.
- Driveways: If directed that driveways are not to be disturbed, install the utility services under driveways in conformance with *1392 Trenchless conduit installation*. If trenchless installation methods are not practicable, Locate and obtain approval for the set out line to enable an aesthetically acceptable restoration of the pavement. This is a **WITNESS POINT**.

Carriageways

Asphalt pavements: Set out the proposed trench at the minimum width for the depth of service and, wherever possible, at right angles to the road reserve boundary.

Concrete pavements: Seek the advice and approval of the appropriate road authority/and or professional engineer for the location of trench set out lines. Refer also to the *Guides to codes and practices for street openings.* This is a **WITNESS POINT**.

Survey marks

Authority requirements: Before commencing trench or surface work within the vicinity of Permanent or State Survey Marks, refer to the Land Information Centre of the Department of Land and Water Conservation or other appropriate Authority responsible for survey records, for protection or relocation requirements.

3.4 ADDITIONAL RESTORATION WORK

Restoration

Removal and restoration: The relevant Council may request removal and restoration to footpaths and/or carriageway pavements, adjacent to the Works, in addition to the removal and restoration requirements of the scope of this worksection.

Identify: Such additional work will be identified and defined by Council's Restoration Officer at the **Set out** of the Contract.

Variation: In this case, payment for the additional removal and restoration activities to be made as a Variation to the Contract at the agreed schedule of rates for the particular activities.

Approval: Do not proceed with additional work without the prior approval of the Superintendent.

3.5 MATERIALS DISPOSAL, RECYCLING TO EXCAVATION

Disposal

Spoil: Legally dispose of all spoil and waste material to an appropriate recycling facility, disposal site or a legal waste management centre. Pay the costs of disposal, including loading, haulage and any tipping fees.

3.6 SURFACE TREATMENT REMOVAL

Concrete and asphalt pavements

Method: Saw cut trench set out lines located on concrete or asphalt footpaths, and asphalt carriageway pavements for the full depths of the bound pavement layers except where the set out line is located along expansion joints.

Removal of concrete and asphalt: Break out concrete or asphalt footpath and carriageway pavement material between the trench set out lines, remove and legally dispose of off-site or stockpile at a site nominated by the Superintendent. This is a **WITNESS POINT**.

Segmental paving units

Removal: Take up by hand segmental paving units both full and cut, between the trench set out lines, and neatly stack on wooden pallets at locations directed by the Superintendent. This is a **WITNESS POINT**.

Concrete edging: Break out, remove and legally dispose of off-site or stockpile in conformance with **Materials disposal**. This is a **WITNESS POINT**.

Concrete subbase: If present, sawcut along the trench set out lines.

Decorative pavers

Utility services option: Do not disturb pavement consisting of decorative pavers laid on a mortar bed and a concrete base unless Trenchless Conduit Installation is impractical.

Removal: If it is necessary to disturb these surfaces, carefully remove pavers for reuse, and stack and secure against theft, or damage. Remove mortar bedding mix.

Sawcutting: Do not sawcut pavers unless evidence is provided that replacement pavers, of the same type, size, colour and decoration, are available.

Concrete subbase: Saw cut along the trench set out lines and remove. If using percussion equipment for removal of the pavement, ensure that adjacent areas of paving are not disturbed. This is a **WITNESS POINT**.

Dimensioned stone

Kerb and gutter: Take up stone units within the set out lines and stack on wooden pallets at locations as directed by the Superintendent. This is a **WITNESS POINT**.

Grass

Method: Neatly cut grass turf between trench set out lines into 300 mm squares. Take up and store the turf at locations as directed and water as directed during the storage period.

Disposal: If the grass is considered unsuitable for reuse by the Superintendent, remove and legally dispose of off-site. This is a **WITNESS POINT**.

Small plants, shrubs and trees

Inspection: The CTPO will identify small plants, shrubs and trees and/or protected or heritage listed species between the set out lines which are suitable for replanting. This is a **HOLD POINT**.

Storage: Take up identified small plants, shrubs and trees, between the set out lines, and store at locations nominated by the Superintendent. Wrap the root ball in a hessian or plastic bag with drain holes and water as directed during the storage period.

Unsuitable vegetation: Remove and legally dispose of off-site, other plants deemed unsuitable for replanting.

House stormwater pipes

Gutter discharge: Maintain house stormwater pipes discharging into carriageway gutters at all times.

Damage: Repair or replace damaged pipes to the same diameter and in a sound manner to the satisfaction of the Superintendent if caused by the Contractor's activities. Provide a watertight seal to all joints and connections. This is a **WITNESS POINT**.

Street furniture

Storage: Remove and store in a safe manner street furniture and signage that is installed between the trench set out lines or is likely to interfere with or be damaged by the Works.

3.7 EXCAVATION

Topsoil

Definition: Topsoil which is considered by the Superintendent to be suitable for reuse in the restoration work.

Topsoil: Strip, remove and stockpile at a site nominated by the Superintendent. If on-site stockpiling is impracticable, stockpile the topsoil off-site, or legally dispose off-site, as directed.

Timing: Before undertaking trench excavation. This is a **WITNESS POINT**.

Trench

Dimensions: Excavate trenches to the standard widths and depths for the particular utility service installation or to dimensions as shown on the drawings.

Stabilisation: Provide shoring, sheet piling or other stabilisation of the sides necessary to conform with statutory requirements.

Excavation level: Excavate trench or foundation excavation to the planned level of the bottom of the documented bedding or foundation or as directed. This is a **HOLD POINT**.

Trenching grade: < 0.5% fall.

Trench width: Conform with the underground services in a shared trench agreement between respective service authorities.

Location of services

Existing underground services: Locate by exploratory excavation or by ground penetrating radar (GPR) prior to the principal trench excavation. Refer to NSW WorkCover guide *Work near underground assets*.

Retired services: Before removal, provide confirmation in writing from the appropriate Authority that retired services are inactive. This is a **HOLD POINT**.

Approval by other public utility authorities: Where other public utilities exist in the vicinity of the Works, before starting excavation, either:

- Obtain the approval of the relevant authority for the method of excavation, or
- Incorporate the requirements of the relevant utility in the proposed work methods.

Provide proof of approval and/or conformity with the requirements of the relevant authority to the Superintendent. If there are any retired services seek approval before removing by providing confirmation in writing from the appropriate Authority that retired services are inactive. This is a **HOLD POINT**.

Removal of services: Excavate, remove off-site and dispose legally all components of retired services. Backfill the resulting excavation in conformance with **Trench backfill**.

Stockpiles

Excavated material: Segregate the earth and rock material and stockpile, at sites nominated by the Superintendent, for reuse in backfilling operations.

Locations: Do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along gutters where stockpiling is permitted along the line of the trench excavation.

Disposal: If stockpiling is not permitted, legally dispose of excavated material off-site.

Unsuitable material

Disposal: Remove any material at the bottom of the trench or at foundation level which is deemed unsuitable by the Superintendent. Legally dispose of off-site and replace with backfill material in conformance with the requirements of this worksection.

Levels: Align the bottom of the excavated trench or foundation at the specified level and slope of the utility service.

Contaminated or hazardous material

Procedure: If hazardous material is encountered, notify the Superintendent and dispose of the material to the requirements of the relevant Statutory Authorities. This is a **HOLD POINT**.

3.8 EXISTING TREES

Protection during works

Existing trees: Existing trees are legally protected by Council's Tree Preservation Order. Inspect and mark all trees for preservation in conformance with the requirements of the Superintendent and CTPO. This is a **HOLD POINT**.

Protection: Do not store, stockpile, dump or otherwise place under or near trees bulk materials and harmful materials including oil, waste concrete, clearings, boulders and the like. Prevent wind blown materials from harming trees and plants.

Work near trees

Damage: Prevent damage to tree bark. Do not attach stays and guys to trees.

Work under trees: Do not remove topsoil from, or add topsoil to, the area within the dripline of the trees.

Hand methods: Use hand methods to locate, expose and cleanly remove the roots on the line of excavation. If it is necessary to excavate within the drip line, use hand methods or trenchless methods, to preserve root systems intact and undamaged.

Aware: Be aware of the restrictions on work near trees and if required seek direction from CTPO. This is a **WITNESS POINT**.

Roots: Do not cut tree roots exceeding 50 mm diameter. If it is necessary to cut tree roots, use means such that the cutting does not unduly disturb the remaining root system. Immediately after cutting, water the tree and apply a liquid rooting hormone to stimulate the growth of new roots (e.g. Formula 20® or Hormone 20®). This is a **WITNESS POINT**.

Backfilling: Backfill excavations around tree roots with a mixture consisting of three parts by volume of topsoil and one part of well rotted compost with a neutral pH value, free from weed growth and harmful materials. Place the backfill layers, each of 300 mm maximum depth, compacted to a dry density similar to that of the original or surrounding soil. Do not backfill around tree trunks to a height greater than 200 mm above the original ground surface. Immediately after backfilling, thoroughly water the root zone surrounding the tree.

Compacted ground: Do not compact the ground or use skid-steel vehicles under the tree dripline. If compaction occurs, give notice and obtain instructions.

Compaction protection: Protect areas adjacent the tree dripline. Submit proposals for an elevated platform to suit the proposed earthworks machinery.

Watering: Water trees as necessary, including where roots are exposed at ambient temperature > 35°C.

Mulching: Spread 100 mm thick organic mulch to the whole of the area covered by the drip line of all protected trees.

Open excavations under tree canopies: The permitted duration for open excavations will be directed by the Superintendent and CTPO at the time of inspection of the plants and trees. This is a **WITNESS POINT**.

3.9 TRENCH BACKFILL

Bedding, haunch, side and overlay zones

Installation: In conformance with the particular utility authority requirements.

Overlay zone thickness: Maximum of 300 mm immediately over the utility service.

Material: As nominated by the utility authority.

Geotextile: Install a geotextile sheet on any coarse overlay material to prevent piping of fines.

Backfill

Extent: Between the overlay zone and the top of subgrade.

Material: As determined by the Superintendent and may comprise the following:

- Approved stockpiled excavated material.
- Imported fill.
- 14:1 moist washed river sand/cement mix or non-cohesive backfill material.

Nominate backfill material for approval of the Superintendent. Material to be free of tree stumps, roots and any vegetative matter capable of being compacted in conformance with **Compaction**. This is a **HOLD POINT**.

Water table

Seepage zones: If sand/cement backfill is used, ensure that any natural seepage zones are not cut off by the impervious sand/cement material. Provide a pervious drainage layer or suitable subsoil drainage to preserve natural seepage.

Water in pervious material: If sand, crushed rock or similar pervious materials are used for trench backfill and bedding in a clay subgrade, there is a risk that seepage water will be trapped in the pervious material and then saturate the adjacent clay subgrade, and weaken it. If these circumstances occur, install subsoil drainage for the bedding and backfill, or provide an impervious layer of material between any possible sources of seepage and the pervious backfill material. These conditions are shown on the drawings.

Water table: If excavation is required below the natural water table and the permanent exclusion of water from subgrade is not possible in the opinion of the superintendent then submit proposals to

protect the subgrade against weakening or obtain directions from the Superintendent to vary the excavation requirements. This is a **HOLD POINT**.

Selected material zone

Backfill material: Free from stones larger than 100 mm with the fraction passing a 19 mm AS sieve having a 4 day soaked CBR value not less than that of the adjacent selected material zone in conformance with AS 1289.6.1.2.

Verge and landscape areas

Material: Provide backfill material to pass 75 mm sieve and not containing any organic or deleterious material or reactive clay. Place topsoil in landscape areas on the subgrade to the same thickness as the surrounding topsoil.

Trees

Backfill at trees generally: Backfill, for a minimum 300 mm thickness, around tree roots with a topsoil mixture approved by the Superintendent, placed and compacted in layers of 150 mm minimum depth to a dry density equal to that of the surrounding soil.

Backfill level: Do not place backfill material above the original ground surface around tree trunks or over the root zone.

Watering: Immediately after backfilling, thoroughly water the tree root zone.

Footpaths, carriageways and heavy duty driveways

Extent: To subgrade level.

Materials: One of the following:

- Sand (do not use if the bedding/overlay is coarse aggregate).
- Fine crushed rock/recycled concrete in conformance with *1141 Flexible pavement base and subbase*.
- Selected backfill material with an equivalent 4 day soaked CBR value to AS 1289.6.1.2, and a maximum particle size of 75 mm and not containing any organic or deleterious material or reactive clay.
- Under footpaths provide 25:1 sand/cement mix (compaction testing is not required).
- Under carriageways provide 14:1 sand/cement mix (compaction testing is not required).

Submission of relevant material is a **WITNESS POINT**.

3.10 COMPACTION

Relative compaction

Requirements: To the **Compaction table** when tested in conformance with AS 1289.5.4.1 for modified compactive effort.

Non-cohesive materials: Tested to AS 1289.5.6.1.

Sand/cement backfill material: No compaction testing is required.

Compaction table

Zone	Relative Compaction	Density Index (for Non-Cohesive Materials)	Moisture Content (percent of optimum moisture content)
Bedding and Overlay Zones	To Utility Authority's Specification	To Utility Authority's Specification	To Utility Authority's Specification
Backfill in verge and landscape areas	90% Standard	70	Between 60% and 100%
Backfill to subgrade level under footpaths and carriageways	98% standard 95% modified	80	Between 60% and 100%

Layers: Compact all material in layers not exceeding 150 mm compacted thickness unless it can be demonstrated to the Superintendent's satisfaction by suitable testing that the specified compaction can be achieved with the thicker layers.

Moisture content: At the time of compaction, adjust the moisture content of the material to attain the specified compaction at a moisture content which, unless otherwise approved is neither less than 60%

nor more than 95% of the apparent optimum moisture content, as determined by AS 1289.5.7.1 (modified compaction). This is a **WITNESS POINT**.

Testing compaction: Arrange for compaction testing in conformance with AS 1289.5.7.1 on the completed backfill and submit the results of such tests within 2 weeks of the tests being performed. Undertake compaction tests at a minimum frequency of 1/second layer/50 m^2 of backfill surface area. This is a **WITNESS POINT.**

Precautions: When compacting adjacent to utility services, adopt compaction methods which will not cause damage or misalignment to any utility service.

Testing frequency: Compaction tests to be undertaken at the frequencies shown in **Annexure C** or as directed.

3.11 RESTORATION PREPARATION

Carriageway pavements and pathways

Make good: Restore carriageway pavements and pathways in a continuous manner to the equivalent condition.

Equivalent condition: The condition equivalent to that existing at the commencement of the Works as determined by Council's Restoration Officer and the Superintendent. This is a **WITNESS POINT**.

Safety: Provide all temporary and final restorations in carriageways and pathways of sufficient quality to ensure the safety of the site for pedestrian and vehicular traffic.

Structures

Levels: Set the levels of utility service surface pits, access chamber frames and lids and any other affected structures so that carriageway pavements and footpaths can be restored to original levels. If any other utility service surface box requires adjustment or replacement before restoration, liaise with other utility authorities.

Paved restoration

Procedure: Set out the areas for paved restoration and arrange an inspection with the Superintendent for direction on any additional works that may be required. This is a **HOLD POINT**.

Requirements: Backfill and restoration to the **Annexure A** table.

Temporary carriageways

Subbase and base: After backfilling to subgrade level, install the subbase and base material in conformance with the final restoration of the wearing surface (course) unless otherwise agreed by the Superintendent.

Temporary restoration: If the carriageway will be re-opened to traffic prior to final restoration, provide temporary restoration. Monitor and maintain temporary restorations in a safe condition until the final restoration is completed.

Materials: Either:

- Bituminous cold mix to *1142 Bituminous cold mix*, 40-50 mm thickness, on the final subbase and base material unless otherwise agreed by the Superintendent.
- Steel plating, over the trench, of sufficient thickness to support traffic loadings and suitably secured with pins and bituminous cold mix. This is a **WITNESS POINT**.

Steel plating: If used, provide advance warning signs to AS 1742.3.

Temporary footpaths and driveways

Subbase and base: After backfilling to subgrade level install the subbase and base material in conformance with final restoration of the wearing surface (course) unless otherwise approved.

Temporary restoration: If the footpath or driveway will be re-opened to pedestrian traffic prior to final restoration, provide temporary restoration. Monitor and maintain temporary restorations in a safe condition until the final restoration is completed.

Access: Liaise with property owners regarding access and ensure that pedestrian and vehicular access is provided to all properties at the end of each day's work unless otherwise approved. This is a **WITNESS POINT**.

Temporary restoration materials:

- Bituminous cold mix, in conformance with *1142 Bituminous cold mix,* 20–40 mm thickness, or other approved material. Make a smooth and evenly graded connection with adjoining pavements such that the temporary restoration does not present a trip hazard for pedestrians.

- Sheeting or steel plating, over the trench, of sufficient thickness to support traffic loadings and suitably secured with pins and bituminous cold mix. Ensure that steel plating does not cause a trip hazard for pedestrians by matching the level of the steel plating to the adjacent surface with bituminous cold mix.

Temporary pavement removal

Temporary pavement material: Remove and dispose of off-site prior to final carriageway pavement restoration.

Temporary base material: If approved, the temporary base material may remain in place and be incorporated into the final pavement if it complies with the requirements of this worksection for the base and subbase (including the compaction and testing requirements) and has not been disturbed or contaminated during removal of the temporary surface.

Asphaltic material: Remove and dispose of off-site.

3.12 FINAL CARRIAGEWAY RESTORATION

Subbase and base

Settlement of temporary pavement: If the temporary restoration shows signs of settlement, before proceeding with the final restoration, identify the cause of the settlement and rectify to the satisfaction of the Superintendent. This is a **HOLD POINT**.

Material: Crushed rock or recycled concrete in conformance with 1141 Flexible pavement base and subbase.

Layers and depths: Match the existing pavement. If the existing pavement includes cement stabilised crushed rock or a lean mix concrete subbase, restore the pavement using materials and layer depths to match the existing pavement.

Compaction: Uniformly compact each 150mm layer of the subbase and base courses over the full area and depth within the trench to a relative compaction either as follows:

- 98% when tested in conformance with AS 1289.5.2.1 (Maximum Modified Dry Density)
- 102 % when tested in conformance with AS 1289.5.1.1 (Maximum Standard Dry Density).

Precautions for underlying utility services: Adopt compaction methods which will not cause damage or misalignment to underlying and adjacent utility services or adjacent structures.

Tests: Undertake compaction testing in conformance with this clause, and with the approved Quality Plan.

Program

Timing: Undertake final restoration as soon as practicable and within the time specified in the Contract.

Flexible pavements generally

Tack coat: Provide a waterproof surface for application of final material with the bituminous surfacing tack coat for asphalt or seal coat for sprayed bituminous seals.

Construction details: Conform to the following:

- Existing wearing course: Remove and dispose of off-site, material extending between 100 mm and 400 mm beyond the perimeter of any trench excavation as approved.
- Asphalt placed as restoration: Similarly, extend in plan to cover the area of previous wearing course.
- Make the joint between new and existing asphalt vertical and cut by diamond saw or milling machine.
- Treat the vertical face and subgrade surface of the old asphalt by bituminous tack coating.

Defects: Seal any joints which appear between the existing and new asphalt during the defects maintenance period with an approved joint sealant.

Asphaltic concrete wearing surfaces

Material generally: Asphaltic concrete supplied and placed in conformance with *1144 Asphaltic concrete (Roadways).*

Material for Regional and State roads: Supply and place asphaltic concrete in conformance with the requirements of the relevant Road Authority. This is a **WITNESS POINT**.

Thickness and aggregate size: Match the existing wearing surface.

Bituminous spray seal surfaces

Material generally: Match existing surfaces in conformance with *1143 Sprayed bituminous surfacing.*

Thickness and aggregate size: Match the existing pavement.

Asphaltic concrete underlay: Restore the pavement in asphaltic concrete matching the total thickness of the existing pavements.

Small openings: Restore using asphaltic concrete (AS20) minimum thickness 50 mm, supplied and placed in conformance with *1144 Asphaltic concrete (Roadways).*

Concrete carriageways

Concrete carriageways: To *1132 Lean mix concrete subbase, 1133 Plain and reinforced concrete base*, 1134 *Steel fibre reinforced concrete base* or *1135 Continuously reinforced concrete base*, as appropriate.

Surface tolerance

Surface tolerance: Maximum ± 5 mm surface deviation from a 3 m straightedge seven to ten days after completion, so that an impact is not transmitted to traffic passing over the restoration.

Pavement markings

Pavement markings: Reinstate pavement markings to match existing pavement markings and in conformance with *1191 Pavement markings*.

3.13 FINAL PATHWAYS AND DRIVEWAYS RESTORATION

Materials and tolerances

Timing: Undertake final restoration as soon as practicable and within the time specified in the Contract.

Matching finishes: Restore pathways, and other public areas, with materials consistent with the existing surface before commencement of the Works, or as directed in consultation with the Council.

Temporary pavement material: Remove and dispose of off-site prior to final carriageway pavement restoration.

Temporary base material: If approved, the temporary base material may remain in place and be incorporated into the final pavement if it conforms with this Worksection for the subbase (including the requirements for compaction and testing) and has not been disturbed or contaminated during removal of the temporary surfacing. This is a **HOLD POINT**.

Surface tolerance: Match the levels existing before the surface was disturbed and make a smooth junction with the adjacent existing surfaces, covers and features.

Lippage: 5 mm maximum variation between the level of the restored surface and the adjacent surface, covers and features. If the levels of existing surfaces, covers, or features do not allow the specified level tolerance to be achieved, the restoration to be at the Superintendent's direction. This is a **WITNESS POINT**.

Pavement markings and street furniture

Pavement markings: Reinstate pavement markings to match existing pavement markings and to *1191 Pavement markings.*

Street furniture: Remove and store street furniture. Reinstate at locations matching the original location unless directed otherwise by the Superintendent. This is a **WITNESS POINT**.

Subbase and base

Material: Provide crushed rock, CRB20-2 or CRS20 material, from an approved source and configure in layers and depths as indicated in **Annexure A**.

Supply and installation: To *1141 Flexible pavement base and subbase*.

Compaction: Uniformly compact each layer of the subbase and base courses over the full area and depth within the trench to a relative compaction of 100 per cent when tested in conformance with AS 1289.5.4.1.

Tests: Undertake compaction tests at a minimum frequency of 1/every second layer/50 m^2 of restoration surface area.

Flexible subbase/base

Material: Fine crushed rock or recycled concrete to *1191 Pavement markings.*

Thickness: Match the existing subbase (minimum 50 mm thickness for footpaths and light duty driveways and 150 mm thickness for medium and heavy duty driveways).

Compaction: To 92 per cent relative compaction when tested to AS 1289.5.2.1 (Maximum Modified Dry Density) or 95% relative compaction when tested to AS 1289.5.1.1 (Maximum Standard Dry Density).

Rigid base

Concrete base: Reinstate the base using 20 MPa concrete to match the thickness of the existing base.

Testing: Undertake compaction testing in conformance with this clause, Quality Assurance and the Contractor's approved Quality Plan.

Precautions for adjacent utility services: Adopt compaction methods which will not cause damage or misalignment to underlying and adjacent utility services or adjacent structures.

Concrete footpaths and driveways including textured and patterned

Minimum width of restorations: Conform to section 7.7 of the Streets Opening Conference Information Bulletin.

Surface finish: Restore concrete footpaths and driveways to match the same surface finish and pattern as the original surface.

Concrete footpaths: Construct concrete footpaths using 20 MPa concrete to the same thickness (with a minimum of 75 mm), as the adjoining footpaths.

Light duty driveways: Construct light duty driveways serving single residential dwellings as follows:

- Concrete: 25 MPa concrete to the same thickness (with a minimum of 100 mm) as the original driveway.
- Reinforcing: If the existing driveway contains reinforcing, provide F62 Steel Fabric with 40 mm top cover.

Medium/heavy duty driveways: Construct medium duty driveways serving multiple residential dwellings and light commercial developments and heavy duty driveways as follows:

- Concrete: 25 MPa concrete to the same thickness as the original driveway (minimum of 150 mm)
- Reinforcing: F72 Steel Fabric with 50 mm top cover.

Expansion joints: In concrete footpaths, provide 15 mm thick preformed jointing material of bituminous fibreboard, or equivalent as approved in line with joints in existing concrete and at full width transverse joints with existing concrete. This is a **WITNESS POINT**.

Control joints: Form control joints strictly in line with the control joints in existing concrete.

Treatment at poles: Around electricity supply poles, terminate the concrete paving 200 mm from the pole and fill the resulting space with cold mix asphalt.

Asphalt footpaths

Materials and installation: To *1144 Asphaltic concrete (Roadways)*.

Thickness: Match the adjoining footpath.

Finish: Compact to a smooth even surface.

Segmental pavers on sand bed

Materials and installation: To *1145 Segmental paving*.

Pavers: Match existing with existing pavers. Relay existing pavers to match the pattern and surface levels of the existing paving.

Cut or damaged pavers: Replace with new pavers of the same material, type, size and colour as the existing pavers unless otherwise authorised by the Superintendent.

Paving around trees: Match the paving pattern at tree surrounds, service boxes and poles, to similar existing features in the immediate area or as directed. This is a **WITNESS POINT**.

Decorative segmental paving on concrete base

Application: The restoration of pathways or driveways with a natural stone, concrete or masonry paver surface or other surface products laid on a mortar bed and concrete base.

Concrete base: Reconstruct the concrete base as follows:

- Concrete: 25 MPa concrete with thickness to match the existing concrete.
- Reinforcing: Match existing. If the concrete base is reinforced, tie the reinforcement to the existing reinforcing, either by exposing the reinforcing either side of the restoration to allow a minimum 300 mm lap, or by installing tie bars drilled and grouted into the existing concrete.

- Tie bars: 600 mm long Y12 reinforcing bars installed at 1000 mm centres by drilling 200 mm deep 16 mm diameter holes at mid-slab depth and grout tie bars into holes using a 1 cement:1 sand grout mix unless otherwise directed by the Superintendent.
- Unreinforced concrete base: Roughen the sawn face to allow formation of a keyed joint.

Jointing: If transverse or longitudinal joints have been disturbed as a result of the Works, reinstate them to match the existing joints.

Damaged or sawcut pavers: Remove any pavers adjacent to the trench which have been damaged during the Works. Remove sawcut pavers back to the nearest existing joint.

Mortar bed: Match the material and thickness to the existing mortar bed.

Existing pavers: If existing pavers are to be relaid, replace cut or damaged pavers with new pavers of the same material, type, size, colour and decoration as the existing pavers. Liaise with Council's Restoration Officer for details related to the supply of pavers. If existing pavers cannot be sourced, supply an approved alternative in consultation with Council's Restoration officer. This is a **HOLD POINT**.

Laying: Match existing surface levels, jointing pattern, gap width and infill material.

Turfed verges

Topsoil: 50 mm minimum thickness, placed on the subgrade prior to restoration of turfed verges.

Existing grass turf: Re-lay to conform with the original grassed surface.

Method: Hand butt turfs against each other in rows and topdress the seams with topsoil, rolled and watered to ensure direct and uniform contact with the topsoil.

Additional turf: If required complete the affected area with turf of the same species.

Verge plants, shrubs and trees

Topsoil: Match the surrounding thickness, placed on the subgrade prior to restoration of turfed verges.

Planting holes: Excavate at locations matching the original location unless directed otherwise in consultation with the relevant Council Officer responsible for road restorations, and spread the material evenly around each hole.

Plant material: Re-plant existing plants, shrubs and trees which are suitable for replanting as determined by the Superintendent. Backfill the planting hole with topsoil and compact by foot up to surface level.

Unsuitable plants: Replace any plants which are not suitable for replanting with plants of the same species and size, or as agreed by the Superintendent in consultation with the Council Tree Preservation Officer or other appropriately authorised Council Officer. This is a **WITNESS POINT**.

Staking and watering: Stake as necessary and water and maintain in to *0257 Landscape – road reserves and street trees* as necessary to ensure suitable re-establishment.

Replacement: Replace shrubs and trees which fail to re-establish and maintain in conformance with *0257 Landscape – road reserves and street trees.*

3.14 COMPLETION

Clean up

Extent: Clean up the areas affected by the Works and associated construction activities and restore to a condition equivalent to that existing at the commencement of the Works.

Rubbish: Remove and legally dispose of off-site all formwork, rubbish and residue construction materials, including material left at stockpiles.

Approval: Present the cleaned up restoration works for formal approval of the completion of the restoration works. This action is a **HOLD POINT**.

Work-as-executed drawings

Requirement: Supply the Superintendent with fully marked-up Work-as-Executed Drawings for the whole of the Contract in conformance with the Utility Authorities' Specification.

4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

General

Payment to the schedule of Rates: To *0152 Schedule of rates – supply projects*, this worksection, the drawings and Pay items **1152.1 to 1152.16** inclusive.

Lump Sum prices: Not acceptable.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology

The following methodology will be applied for measurement and payment:

- Provision for traffic, both vehicular and pedestrian, is deemed to be included in the schedule rates generally in conformance with this worksection.
- Segmental paving works: In conformance with this worksection and not *1145 Segmental paving*.
- Trenchless installation of utility services under driveways: In conformance with *1392 Trenchless conduit installation.*

4.2 PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1152.1 Sawcut existing pavement/footpath - 1152.1(1) Bituminous carriageway pavement - 1152.1(2) Bituminous footpath - 1152.1(3) Concrete footpath, including textured or patterned concrete.	Linear metre measured along the actual line of cut.	Give separate rates for sawcuts in each type of material. All costs associated with the sawcutting operations including hire of plant and provision of water.
1152.2 Remove existing pavement/footpath	m² of pavement removed. Width and length as shown on the drawings or as directed by the Superintendent.	This includes both bituminous and concrete material and concrete base from segmental paving where applicable. All costs associated with breaking out, removing, transporting off-site, disposal and any tipping fees applicable.
1152.3 Segmental pavers (including decorative segmental pavers) - 1152.3(1) Take up and stack existing pavers—Carriageway - 1152.3(2) Take up and stack existing pavers—Footpath - 1152.3(3) Lay existing pavers—Carriageway - 1152.3(4) Lay existing pavers—Footpath - 1152.3(5) Supply and lay new pavers—Carriageway - 1152.3(6) Supply and lay new pavers—Footpath	m² of surface of segmental pavers (or decorative segmental pavers) taken up or laid. Width and length as shown on the drawings or as directed by the Superintendent.	Separate rates to be given for taking up existing, laying existing and supply and lay new pavers for carriageways or footpaths as appropriate. For items 1152.3(1) and 1152.3(2), all costs associated with taking up and stacking pavers on pallets at locations as agreed. Concrete base, where applicable, shall be removed under Pay Item 1152(2). For items 1152.3(3) and 1152.3(4), all costs associated with the laying and compaction of subbase, including concrete base where applicable, and existing segmental pavers, bedding sand and joint filling sand, mortar bed where applicable, including any

Pay items	Unit of measurement	Schedule rate scope
		cutting of units, concrete edging, joints overlying concrete pavement joints, and concrete surrounds or aprons around surface penetrations. For items 1152.3(5) and 1152.3(6), all costs associated with laying and compaction of subbase, including concrete base where applicable, and supply, laying and compaction of segmental pavers, bedding sand and joint filling sand, mortar bed where applicable, including any cutting of units, concrete edging, joints overlying concrete pavement joints, and surrounds or aprons around surface penetrations.
1152.4 Remove existing edge strips	Linear metre measured along the length of the edge strip.	All costs associated with breaking out, removing, transporting off-site, disposal and any tipping fees applicable.
1152.5 Grass turf - 1152.5(1) Take up and store existing turf. - 1152.5(2) Lay existing turf. - 1152.5(3) Supply and lay new turf.	m² of surface of grass turf taken up or laid. Width and length as shown on the drawings or as directed by the Superintendent.	Separate rates to be given for taking up existing, laying existing and supply and lay new turf. For item 1152.5(1), all costs associated with cutting, taking up and storing turf. Grass unsuitable for reuse to be removed under Pay Item 1152.5(2). For item 1152.5(2), all costs associated with the topsoil bedding, rolling, laying of existing turf and topdressing. For item 1152.5(3), all costs associated with the topsoil bedding, rolling, supply and laying of new turf and topdressing.
1152.6 Verge plants, shrubs and trees - 1152.6(1) Take up and store existing. - 1152.6(2) Plant existing. - 1152.6(3) Plant new. - 1152.6(4) Disposal of unsuitable.	Each plant, shrub or tree taken up or planted (excludes Pay Item 1152.6(4)).	Separate rates to be given for taking up existing, replanting existing and supply and plant new plants, shrubs or trees. For item 1152.6(1), all costs associated with taking up, storing and watering. For Item 1152.6(2), all costs associated with topsoil placement, preparatory work, planting, staking and subsequent care of each plant. For Item 1152.6(3) all costs associated with topsoil placement, preparatory work, supply and planting, staking and subsequent care of each new

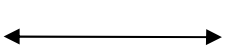
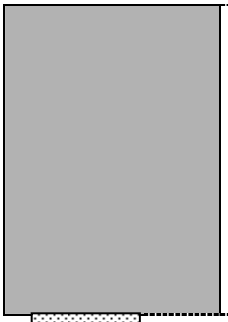
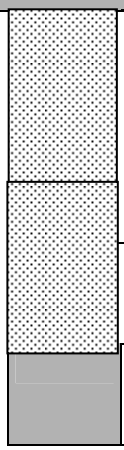
Pay items	Unit of measurement	Schedule rate scope
		plant. For Pay Item 1152.6(4) the cubic metre of unsuitable plants, shrubs and trees. For Item 1152.6(4) all costs associated with transporting off-site, disposal and any tipping fees applicable.
1152.7 Stockpiling of topsoil	m^3 as bank volume calculated from the width and length shown on the drawings or directed by the Superintendent, by the depth of topsoil.	All costs associated with stripping topsoil, carting and placing into stockpile. For topsoil to be disposed of off-site apply Pay Item 1152.8(2).
1152.8 Trench excavation - 1152.8(1) To stockpile - 1152.8(2) Disposal off-site (including unsuitable material)	m^3 as bank volume of excavation calculated as follows: Width—as specified for the particular utility service installation. Depth—average actual depth from topsoil stripped ground surface to underside of specified bedding. Length—actual excavation length, centre to centre of pits.	Separate rates to be given for excavation to stockpile and disposal off-site. The schedule rate to be an average rate to cover all types of material encountered during excavation. Separate rates not be included for earth and rock. All costs associated with: Excavation, including excavation and replacement of unsuitable material. Replacement for over-excavation for any reason. Protection of trees and treatment to cut tree roots. For item 1152.8(1), all costs associated with carting and placing into stockpile. For item 1152.8(2), all costs associated with transporting off-site, disposal and any tipping fees applicable.
1152.9 Trench backfill - 1152.9(1) From stockpiled material. - 1152.9(2) From imported material. - 1152.9(3) 25:1 sand/cement mix. - 1152.9(4) 14:1 sand/cement mix.	m^3 measured as backfill compacted volume in place in the trench calculated as follows: Width—average trench width. Depth—average actual depth from top of subgrade to top of bedding overlay material around the utility service. Length—actual trench length, centre to centre of pits.	All costs associated with backfilling (including supply and installation of geotextile where appropriate), compaction, testing and treatment around tree roots. For item 1152.1, all costs associated with loading and carting from stockpile. For items 1152.2, 1152.3 and 1153.4 all costs associated with supply and delivery of imported material, including material for a selected material zone where specified.
1152.10 Temporary pavement—Carriageway and footpath	m^2 of trench area restored with temporary pavement calculated by multiplying the trench width by the actual length of temporarily restored pavement.	All costs associated with the supply, delivery, placing and compaction of the base material and bituminous cold mix and all activities and material necessary for maintenance of the temporary pavement in a safe condition until the permanent restoration is

Pay items	Unit of measurement	Schedule rate scope
		executed.
1152.11 Temporary steel plating	m² of trench area plus adequate allowance for support on both sides of the trench calculated by multiplying the trench width by the actual length of trench to be covered.	All costs associated with the hire, delivery, placement, securing and subsequent removal and return to depot of the steel plates and all activities and materials necessary for maintenance of the plating until permanent restoration is executed.
1152.12 Flexible subbase	m² of trench calculated by multiplying the trench width by the length.	All costs associated with the removal of temporary pavement, supply, delivery, spreading and compaction.
1152.13 Flexible base	m² of trench calculated by multiplying the trench width by the length.	All costs associated with the removal of temporary pavement where no subbase is required, supply, delivery, spreading and compaction.
1152.14 Carriageway wearing surface (course) - 1152.14(1) Asphaltic concrete. - 1152.14(2) Sprayed bituminous surfacing. - 1152.14(3) Concrete.	m² of new surface area in conformance with this Worksection calculated from the trench width +200 mm (or up to 800 mm as agreed) by the length.	All costs associated with the removal of temporary pavement or existing pavement to the new perimeter, supply, delivery, spreading, compaction and provision of pavement markings as appropriate. For item 1152.14(3) All costs associated with the forming, compaction of foundations, supply, delivery and compaction of mass concrete subbase, supply, delivery, placing, finishing and curing concrete base. Where shown on the Drawings or as directed by the Superintendent this pay item to include the supply and placement of reinforcing steel and the provision of pavement markings as appropriate.
1152.15 Footpaths and driveways - 1152.15(1) Asphalt/sprayed bituminous seal. - 1152.15(2) Plain concrete. - 1152.15(3) Textured/patterned concrete.	m² of paved surface, including driveways. Width and length as shown on the drawings or as directed by the Superintendent.	Separate rates to be given for each thickness of footpath or driveway. For item 1152.15(1), all costs associated with the forming, compaction of foundations, supply, delivery and compaction of subbase and bituminous material. For items 1152.15(2) and 1152.15(3) all costs associated with the forming, compaction of foundations, supply, delivery and compaction of subbase, supply delivery, placing, finishing and curing concrete, including texturing or patterned finish where applicable.

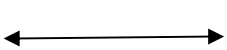
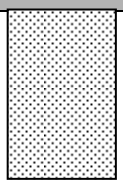
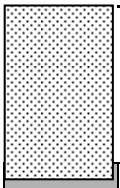
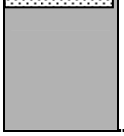
Pay items	Unit of measurement	Schedule rate scope
		Where shown on the Drawings or as directed by the Superintendent this pay item to include the supply and placement of reinforcing steel.
1152.16 Cleanup	m^2 of carriageway and/or footway surface or other surface as applicable. Width and length as shown on the drawings or as directed by the Superintendent.	All costs associated with the cleaning up of the Work site and transporting off-site and disposal of material including any tipping fees applicable.

5 ANNEXURE A

5.1 TYPICAL FINAL RESTORATION IN FOOTPATH

Reinstatement Width  Finished Surface Level	Zone	Zone thickness	Material	Compaction Requirement
	Wearing Surface (Course)	75 mm min concrete Asphalt—match existing Segmental paving on sand bed—match existing Segmental decorative paving on concrete base—match existing	As specified in Final restoration of pathways and driveways	
 Sub-grade Level	Subbase/ Base Course	Match existing thickness (minimum 50 mm) Segmental decorative paving on concrete base—subbase only required if existing	As specified in Final restoration of pathways and driveways	92% MMDD or 95% MSDD
	Subgrade	Varies	As specified in Trench backfill	90% MSDD or Density Index 70
	Bedding Zone	As per Utility Authority's Specification	As per Utility Authority's Specification	As per Utility Authority's Specification

6 ANNEXURE B - TYPICAL FINAL RESTORATION IN CARRIAGEWAY OR HEAVY DUTY DRIVEWAY

Reinstatement Width  Finished surface level	**Backfill zone**	**Backfill zone thickness**	**Backfill material**	**Compaction requirement**
 Base level	Wearing Surface (Course)	Match existing	Match existing	
 Subbase level	Base Course	Match existing	As specified in Final restoration of carriageway subbase and base (flexible)	98% MMDD or 102% MSDD
Subgrade level	Subbase course	Match existing	As specified in Final restoration of carriageway subbase and base (flexible)	
	Subgrade	Varies	As specified in Trench backfill	98% MSDD or 95% MMDD Density Index 80
	Bedding Zone	As per Utility Authority's Specification	As per Utility Authority's Specification	As per Utility Authority's Specification

7 ANNEXURE C - MINIMUM TESTING FREQUENCY

Activity	**Key quality verification requirements**	**Minimum test frequency**	**Test method**
Trench backfill under carriageways and footpaths, materials supply	Material properties as specified in this Specification	1 per contract or source of supply for each type of material used or suppliers test certificates. Minimum 1 per 500 m^3 or as required by the relevant AUS-SPEC Pavement Specification.	As specified
Trench backfill under carriageways and footpaths, placement	Compaction	1 per 2 layers per 100 lineal metres of trench or per 20 road openings for openings of less than 10 m^2 plan area whichever results in the most frequent testing.	AS 1289.5.1.1 AS 1289.5.2.1 AS 1289.5.6.1
Subbase and base materials supply	Material properties as specified	Suppliers test certificates in conformance with the relevant AUS-SPEC Pavement Specification.	As specified
Subbase and base placement	Compaction	1 per pavement layer, per 100 lineal metres of trench or per 20 road openings for openings of less than 10 m^2 plan area whichever results in the most frequent testing.	AS 1289.5.1.1 AS 1289.5.2.1
Wearing surface materials	Material properties as specified in the relevant AUS-SPEC Pavement Specification	Supplier test certificates in conformance with the relevant AUS-SPEC Pavement Specification.	As specified
Wearing surface placement	Testing as specified in the relevant AUS-SPEC Pavement Specification	Check evenness of restored surface in accordance with **Final restoration of carriageway wearing surface (course)**	As specified

1163 RIGID ROAD SAFETY BARRIER SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide concrete safety barriers from precast units, fixed forms or slip forming, as documented or as directed. This worksection details the requirements for public domain, Type F and VCB rigid road safety barrier systems.

Performance
Patented safety barrier system or crash attenuator: To conform to the manufacturers specifications and instructions.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1191 Pavement markings.*
- *1192 Signposting.*
- *1194 Non-rigid road safety barrier systems.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

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.
AS 1379-2007	Specification and supply of concrete.
AS 1906	Retroreflective materials and devices for road traffic control purposes.
AS 1906.2-2007	Retroreflective devices (non pavement application).
AS 3610-1995	Formwork for concrete.
AS 3610.1-2010	Documentation and surface finish
AS 3799-1998	Liquid membrane-forming curing compounds for concrete.
AS/NZS 3845: 1999	Road safety barrier systems.

Other publications for information or incorporated.

AUSTROADS	
AGRD06-2010	Guide to road design – Part 6 Roadside design, safety and barriers

1.4 STANDARD

General
Standard: To AS/NZS 3845.

1.5 INTERPRETATION

Definitions
General: For the purposes of this worksection the following definitions apply:

- Rigid road safety barrier system: A road safety barrier system where there is no observable dynamic deflection. The deformation is contained in the impacting vehicle.

1.6 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Approvals
- Method statement for precast barriers.

Calculations
- Survey set out for barrier systems.
- Curing compound application rate.

Materials
- Concrete.
- Reinforcement.
- Pre formed joint filler.
- Curing compound.

Execution details
- Process description for manufacture, supply and installation.

Documents
Submit the following for approval:

Design
Proprietary extrusion machine details.

Technical data:
- Concrete strength test results.
- Relative compaction test results.

1.7 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
MATERIALS			
Concrete - Properties	Confirm concrete strength requirements for slip forming	5 working days before commencing works	Superintendent
EXECUTION			
Existing underground services - Location	Locate services before placing footings, Dial before you dig	7 working days before commencing works	Superintendent
Establishment - Method Statement	Process description for the manufacture, supply and installation of any road safety barrier system	7 working days before commencing works	Superintendent
Establishment - Location of barriers	Safety barrier set out approval	2 working days before construction	Superintendent
Manufacture of precast reinforced concrete - Procedures	Submit process details for manufacture of precast safety barriers	5 days before commencing manufacture	Superintendent
Manufacture of precast reinforced concrete - Manufacturing records	Submit information on specific precast barriers	3 working days before use	Superintendent
Placing, compacting and finishing concrete	Submit proprietary extrusion machines for approval	5 working days prior to commencing works	Superintendent

- Slip forming			
Joints in concrete placed in-situ - Expansion joints	Jointing material for approval	3 working days before ordering	Superintendent
Curing – General	Curing method and materials for approval	3 working days before placing concrete	Superintendent
Signage and line marking at barrier - Removal of temporary traffic control devices	Inspection of permanent works before removal of temporary works	24 hours before removal	Superintendent

WITNESS POINTS table – On-site activities

Clause title/Item	Requirement	Notice for inspection
Traffic safety - General	Protect concrete barriers from impact by general traffic for a period of 7 days	Progressive
Quality requirements – Concrete strength	Strength results to be submitted	Progressive
Installation - Dowelled base fixings	Provide dowels fixed in place for inspection	Prior to installing barriers
Installation - Compaction of foundations	Provide the compacted base for inspection with relative compaction test results	Prior to installing barriers
Installation - Electrical conduits	Location of conduits subject to approval	24 hours before placing conduits
Placing, compacting and finishing concrete - Fixed form construction	Immediately carry out any necessary repairs	Progressive
Curing – Curing compound	Certificate of compliance required	Prior to use

2 PRE-CONSTRUCTION PLANNING

2.1 TESTING

Certificates of compliance

Certificates of compliance: Provide Certificates from a NATA registered laboratory. Perform all phases of any particular test at one laboratory. Tests to be carried out within 12 months of the submission date.

2.2 PLANNING

Work methods

- Document extent.
- Method statement.
- Programming of concrete barriers.
- Select method of execution.

3 MATERIALS

3.1 CONCRETE

Properties

Standard: To AS 1379.

Concrete: Supply and placement of concrete, steel reinforcement, formwork, tolerances, construction joints and protection conform with *0319 Minor concrete works* except as specified in this worksection.

Minimum concrete strength: 30 MPa at 28 days for cast-in-situ formed concrete or precast concrete.

Slip form strength: Obtain approval for minimum strength for slip forming prior to commencing works. This is a **HOLD POINT**.

Aggregate size: 20 mm maximum nominal size.

Slump: Conform to the following specified slump at the point of placement:

- Extrusion: 15 mm.
- Slip forming: 25 mm.
- Fixed forms: 75 mm.

Ready mixed concrete: If ready-mixed concrete is used, mix and deliver the concrete to conform with AS 1379.

3.2 REINFORCEMENT

General

Drawings: Reinforcing steel as shown on the drawings.

Cover: The minimum cover to the nearest concrete surface is 50 mm unless documented otherwise on the drawings.

Supports: Do not use wire, timber or coarse aggregate to support reinforcing steel. Use either concrete or plastic.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 EXISTING UNDERGROUND SERVICES

Location

Services laid in proximity to the barrier system: Locate prior to placement of footings and protect services from damage. This is a **HOLD POINT**.

Location: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, for locating underground pipe and cables (possible within two working days). See www.1100.com.au.

4.3 TRAFFIC SAFETY

General

Traffic control: To *1101 Control of traffic*.

Material stacks: Locate any temporary stacks of new or surplus material associated with the works clear of the traffic flow and behind the line of the safety barrier system being removed, under construction or to be constructed.

Works program: Manage the sequence for construction to ensure that there are no traffic hazards or safety issues for road users.

Protection from traffic: Protect constructed concrete barriers from impact by general traffic for a period of 7 days. This is a **WITNESS POINT**.

4.4 ESTABLISHMENT

Method Statement

Submit: Prior to the installation of any road safety barrier system, submit a process description for the manufacture, supply and installation of road safety barrier systems for approval. Include the source of any precast manufacturing or proprietary items. This is a **HOLD POINT**.

Location of barriers

Set out: Set out the work so that all road safety barriers are located to conform with the drawings or as directed. Peg or paint mark the start and finish points and line of safety barrier. This is a **HOLD POINT**.

4.5 MANUFACTURE OF PRECAST REINFORCED CONCRETE

Precast reinforced concrete

General: Conform to dimensions and details as shown on the drawings to conform with the requirements for rigid road safety barrier systems in AS 3845.

Location of manufacturer: Precast concrete units may be supplied by an offsite manufacturer, or manufactured onsite by the Contractor.

Procedures

Method statement for the precast units: Submit the proposed methods of manufacture, including handling, transport, storage and erection, program of manufacture and delivery details. This is a **HOLD POINT**.

Manufacturing records

Records: Submit the following information prior to erecting the precast concrete safety barriers:

- Unit number or other identification mark.
- Date and time of casting.
- Concrete temperature and ambient temperature.
- Date and time of lifting from the mould.
- Quality and type of concrete materials.
- Details of curing prior to lifting from mould.
- Details of curing while stacked in the casting yard.
- The date of transport to the site.
- Any non-conformance or defect and any remedial works carried out. This is a **HOLD POINT**.

4.6 QUALITY REQUIREMENTS

Concrete strength

Testing: Sample and test concrete at a NATA registered laboratory.

Method: Provide a pair of cylinders tested for compressive strength for every 50 m^3 of concrete placed.

Timing: Submit the 28 day strength results. This is a **WITNESS POINT**.

4.7 INSTALLATION

General

Method: Unless otherwise stated on the drawings, the barrier may be precast, constructed in fixed forms or slip-formed to the dimensions and details as shown on the drawings.

Connections to non-rigid barriers

Connections: If a non-rigid road safety barrier will be connected to a rigid road safety barrier, cast anchorage assemblies into the road safety barrier to the dimensions and details shown on the drawings. All other components for non-rigid road safety barriers are specified in *1194 Non-rigid road safety barrier systems*.

Preparation of the base

Cleaning: Clean the base of all loose materials and dust before any works are commenced.

Dowelled base fixings

Location: Safety barriers constructed on new or existing pavements.

Cored holes: Provide 25 mm diameter 200 mm in length dowels in fine concrete or cement-mortar-filled holes at regular staggered spacings to conform with AS 3845 and as shown on the drawings.

Dowels: Dowel sizing and location as shown on the drawings. This is a **WITNESS POINT**.

Precast spacings: If precast units are used, accurately align and space the cored holes.

Compaction of foundations

Firm base: Shape and compact the foundation material to form a firm base.

Relative compaction: Other than for barriers constructed on pavement courses, achieve relative compaction of 95% to conform with AS 1289.5.4.1 for standard compactive effort. Submit test results. This is a **WITNESS POINT**.

Pavement courses: If barriers placed on pavement courses, compact the foundation to the requirements of the respective pavement course.

Electrical conduits

Cables location: For safety barriers containing street lighting standards, locate the conduit carrying electrical cables in the base rather than in the barrier, as detailed on the drawings, unless otherwise approved. This is a **WITNESS POINT**.

Keyed conduit trench: Unless shown otherwise on the drawings, the conduit trench forms a key and no dowels are required for slip-formed barriers.

Precast safety barrier segments

Mortar pad: After debonding the concrete surface, construct a (nominal) 10mm cement mortar pad beneath the barrier full width and length.

4.8 PLACING, COMPACTING AND FINISHING CONCRETE

General

Continuous: Place concrete continuously between the ends of the concrete safety barrier systems or between construction joints or within a precast safety barrier segment.

Placement: Except at properly formed construction joints, do not place fresh concrete against concrete that has taken its initial set.

Compaction: Compact concrete thoroughly.

Formwork design: Conform to AS 3610 section 4.

Formwork construction: Conform to AS 3610.1.

Concrete finish: Finish surfaces uniform in appearance with a class 3 surface finish to AS 3610.1 unless otherwise shown on drawings or directed.

Cracks: Construct/supply finished concrete barriers free of any cracks other than of movement joints no wider than 0.05 mm at any point on the surface at the completion of the curing period.

Rejected: Barriers with cracks wider then 0.05 mm will be rejected.

Fixed form construction

Tamping: Tamp unformed surfaces to bring a layer of fines to the surface and then screed to the documented level.

High/low spots: Immediately following compaction and screeding, test unformed surfaces for high or low spots and make any necessary corrections before the concrete hardens.

Repairs: Immediately after stripping the forms, use an approved method to perform any necessary repairs to the formed surfaces. This is a **WITNESS POINT**.

Hand finishing

Concrete finish: If hand finishing is required for slip form construction, provide a barrier of uniform appearance.

Slip forming

Submit: Prior to extruding any concrete safety barrier, submit evidence that the proposed proprietary machine can extrude the barrier shape to conform with the specification and drawings. This is a **HOLD POINT**.

4.9 ALIGNMENT AND LEVEL

Finish and appearance

Top and face of the barrier: True to line with the top surface of uniform width, free from humps, sags and other irregularities.

Line and level tolerance

Design line: Within ± 50 mm of the plan location as shown on drawings.

Design levels: Within ± 20 mm of the design levels as shown on the drawings.

Surface tolerance

Test: ± 5 mm surface deviation from the edge of a 3 m straight edge laid on top of or along any face of the barrier except at grade changes or curves in which case the faces are to transition uniformly.

4.10 JOINTS IN CONCRETE PLACED IN-SITU

Contraction joints

Fixed or slip forms: Straight, square (± 5º) to the line of the barrier.

Depth: 50 (± 5) mm on all exposed surfaces at 4 m spacing.

Method: Sawn or formed.

Sawing: Saw joints before uncontrolled cracking begins and within 12 hours after placing the concrete.

Expansion joints

Type: Straight, square (± 5º) to the line of the barrier.

Width and spacing: As shown on the drawings.

Sealant: Fill with a preformed joint filler of bituminous fibreboard or an approved equivalent. This is a **HOLD POINT**.

Pavement joints

Matching: If the barrier is cast on concrete pavement, continue the contraction, isolation, tied or expansion joints in the pavement through the barrier to form a continuous joint through both structures.

Adjacent to pavement

Match: If the barrier is cast adjacent to a concrete pavement, form the contraction joints at 4 m centres.

Precast units

Connections: Place precast units so that all connections are tight, secure and true in line and level.

4.11 CURING

General

Method: Cure concrete placed in safety barriers by either steam curing, moisture curing or by spraying an approved curing compound on all exposed surfaces of the fresh concrete.

Submission: Submit the proposed method and materials for curing for approval prior to use. This is a **HOLD POINT**.

Protection: Protect exposed surfaces from rain or other damage, until hard set has occurred.

Curing time: Maintain the curing membrane intact in a continuous and unbroken film for 7 days after placing the concrete.

Damage: Make good any damage to the membrane by respraying the affected area as soon as the damage occurs.

Curing compound

Slip-formed barriers: Provide wax emulsion, hydrocarbon resin or water borne curing compounds in conformance with AS 3799 Class A Type 1, Class B Type 1-D or Class Z Type 1-D respectively.

Compliance: Provide a certificate of compliance for the curing compound from a laboratory with appropriate NATA registration. This is a WITNESS POINT.

Application rate: Apply the curing compound in a fine spray to provide even coverage at a rate of 0.2 l/m² or the rate determined on the test certificate to achieve 95 % water retention, whichever is the greater.

Equipment on site: Keep equipment and materials for the curing operations on site at all times during slip-forming of the barrier.

4.12 DELINEATORS

Fixing

Standards: Conform to AS 1906.2.

Method: Fix with brackets to the concrete safety barrier as shown on the drawings.

Arrangement and colour
Approaching 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.

4.13 SIGNAGE AND LINE MARKING AT BARRIER

Permanent signage, and longitudinal line marking
Provide: Provide permanent signage, and longitudinal line marking adjacent to the concrete safety barrier to conform with *1191 Pavement markings* and *1192 Signposting*.

Removal of temporary traffic control devices
Inspect: Do not remove temporary traffic control devices installed for the control of traffic before the concrete safety barrier, permanent signing and longitudinal line marking have been inspected and approved. This is a **HOLD POINT**.

4.14 LIMITS AND TOLERANCES

Application
Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause/ subclause**
For cast-in-situ formed concrete or precast concrete	Strength 28 days: 30 MPa Max aggregate size: 20 mm Slump: - 15 mm for extrusion - 25 mm for slip forming - 75 mm for fixed forms	**Concrete**
Compaction of foundations	Relative compaction: 95%	**Installation**
Concrete formed finish	Class 3 to AS 3610	**Placing, compacting and finishing**
Line and level tolerance	Line: ± 50 mm from plan location Levels: ± 20 mm from design level Surface: ± 5 mm from straight edge	**Alignment and level**
Contraction joints	50(± 5) mm deep at 4 m spacing	**Joints in concrete placed in-situ**

1171 SUBSURFACE DRAINAGE

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide subsurface drainage, as documented.

Performance
Requirements: Conform to the requirements of this specification, the drawings and directions of the Superintendent.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1102 Control of erosion and sedimentation.*
- *1112 Earthworks (Roadways).*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1141	Methods for sampling and testing aggregates.
AS 1141.11.1-2009	Particle size distribution by dry sieving.
AS 1141.22-2008	Wet/dry strength variation.
AS 1289	Methods of testing soils for engineering purposes.
AS 1289.5.5.1-1998	Soil compaction and density tests - Determination of the minimum and maximum dry density of a cohesionless material - Standard method.
AS 1289.5.6.1-1998	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
AS/NZS 1477-2006	PVC pipes and fittings for pressure applications.
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 2758.1-1998	Concrete aggregates.
AS 3705-2012	Geotextiles - Identification, marking and general data.
AS 3706	Geotextiles - Methods of test.
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.

Other publications

AUSTROADS	
AGPT04G-2009	Guide to Pavement Technology Part 4G- Geotextiles and geogrids
AGPT10-2009	Guide to Pavement Technology Part 10– Subsurface drainage
ASTM D2434-68-2006	Standard Test method for permeability of granular soils (Constant head)

1.4 STANDARDS

General
Standard: To AGPT10.

1.5 INTERPRETATION

Definitions
General: For the purposes of this worksection the definitions given below apply.
Panel drain: Corrugated flat plastic pipe.

1.6 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.
Documents
Submit the following for approval:
- Materials: Off-site certificates of components.
- Calculations: Survey set out of drainage works and quantity calculations.
- As-executed drawings: Include drainage system information sheets and works.
- Components: Pipes and fittings, and geotextiles.
- Samples: For conformity testing to relevant Standards.
- Technical data: System drainage information.
- Execution details: Refer to **HOLD POINTS**.

1.7 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.
HOLD POINTS table

Item/Clause title	Requirement	Notice for inspection	Release by
MATERIALS			
Subsurface drainage pipes - General	Submit compliance certificates	7 days before proceeding to provide pipes	Superintendent
Other types of subsurface drainage pipes - Alternatives	Submit details of proposed alternative pipes and evidence of conformity for approval.	7 days before proceeding to provide pipes	Superintendent
Geotextile - General	Provide documentation of conformity of geotextile and installation process	14 days before proceeding to provide geotextile	Superintendent
EXECUTION			
Establishment - Set out	Submit the proposed set-out in addition to the designed set-out	7 days before planned execution	Superintendent
Excavation – Existing under ground services	Submit evidence of approval of the relevant authorities.	14 days before planned excavation	Superintendent
Excavation - Trenches	Approval of completed trenches required prior to installation of drainage work	1 working day prior to installation of drainage work	Superintendent
Recording of subsurface drainage - Information sheet	Progressive supply of subsurface drainage details	5 working days after completion of each drain or drainage system	Superintendent

WITNESS POINTS table – Off-site activities

Item/Clause title	Requirement	Notice for inspection
MATERIAL		
Subsurface drainage pipes - Corrugated flat plastic pipe and fittings	Type of pipe and fitting	7 days prior to proceeding
Subsurface drainage pipes - Thick walled P.V.C. pipe	Certificate of compliance	7 days prior to proceeding

WITNESS POINTS table – On-site activities

Item/Clause title	Requirement	Notice for inspection
EXECUTION		
Temporary drainage during construction, Equipment and material	Locate materials and equipment clear of water courses	7 days prior to positioning
Excavation, Blasting operation	Measure ground vibration resulting from blasting	Progressive
Outlet structures, Discharge and salinity prevention	Locate discharge to avoid recharge of water table	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program for compliance and usage of component and materials.
- Authorities: Arrange approvals and confirm environmental requirements.

3 MATERIALS

3.1 SUBSURFACE DRAINAGE PIPES

General

Approval: Before providing pipes, submit compliance certificate and test results determined from AS 2439.1 as evidence that the pipes conform to the requirements of this worksection. This is a **HOLD POINT**.

Corrugated circular plastic pipe and fittings

Pipe: Conform to the following:

- Standard: To AS 2439.1.
- Class: 1000, for 65 mm or 100 mm diameter as shown on the drawings.
- Type: Slotted, except where shown otherwise on the drawings.

Fittings: Provide joints, couplings, elbows, tees and caps as follows:

- To AS 2439.1.
- To the manufacturer's recommendations.

Corrugated flat plastic pipe and fittings

Pipe: Conform to the following: This is a **WITNESS POINT**.

- Type: 'Stripdrain' or 'Megaflo' or approved equivalent enclosed in geofabric or seamless tubular filter fabric.
- Size: As shown on the drawings.
- Fittings: To the manufacturer's recommendations.

Thick walled PVC pressure pipe

Pipe: Conform to the following:

- To AS/NZS 1477.
- Size:
  - . Nominal diameter: 58 mm.
  - . Minimum wall thickness: 6.5 mm.
- Type: Slotted except where shown on the drawings. Details of slot sizes and spacings to Annexure A.

Joints: Square ends and butt jointed.

Certificate of Compliance: Submit a test certificate to AS/NZS 1477. This is a **WITNESS POINT**.

3.2 OTHER TYPES OF SUBSURFACE DRAINAGE PIPES

Alternatives

Approval: Submit full details of the type of pipe, certification from the manufacturer of its suitability and quality for use in each particular application. Address the crushing strength, flexural strength, jointing system and slotting details. This is a **HOLD POINT**.

3.3 FILTER MATERIAL

General

Quality: Clean, hard, tough, durable particles.

Where subsoil drains are laid in or adjacent to planted area's: Ensure the PH of the filter material is within the range 6 – 7.

Compaction: Compact cohesionless material to a Density Index of 70% determined by AS 1289.5.6.1.

Type A filter material

Source: Crushed rock or granular material.

Grading: To the **Type A filter material table.**

Use: In trench drains and Type B drainage mats: To *1174 Drainage mats*.

Type A filter material table

Test method	Property	Requirement
AS 1141.11.1	**Material passing AS sieve**	**% by mass**
	6.7 mm 4.75 mm 2.36 mm 1.18 mm 425 µm	100 85 to 100 0 to 40 0 to 5 0 to 2

Type B filter material

Source: Granular material.

Grading: To the **Type B filter material table.**

Coefficient of saturated permeability: At least 8 m / day after three hours of flow when compacted to its maximum dry density in conformance with AS 1289.5.5.1 and then tested to conform with ASTM-D2434-68.

Grading variation as a result of compaction processes: To the **Type B filter material variation table.**

Use: In trench drains and Type A drainage mats: To *1174 Drainage mats*.

Type B filter material table

Test Method	Property	Requirement
AS 1141.11.1	**Material passing AS sieve**	**% by mass**
	4.75 mm 2.36 mm 425 µm 300 µm 150 µm	100 95 to 100 20 to 80 0 to 30 0 to 2

	75 µm	0 to 0.1

Type B filter material variation table

AS Sieve	Variation from grading before treatment (% of mass)
2.36 mm 1.18 mm 425 µm 300 µm 150 µm 75 µm	± 3 ± 1 ± 1 ± 1 ± 0.5 ± 0.1

Type C filter material

Source: Crushed rock.

Grading: To the **Type C filter material table**.

Use: In Type A drainage mats: To *1174 Drainage mats*.

Type C filter material table

Test Method	Property	Requirement
AS 1141.11.1	Maximum particle size	37.5 mm
	Maximum passing the 9.5 mm AS Sieve	5% by mass
	Maximum (D90:D10)* or (see Note)	3
AS 1141.22	Minimum wet strength	100 kN
	Maximum 10% fines wet/dry variation	30%
Note: The D90 value is determined by sieving the material using 75 mm, 53 mm, 37.5 mm, 26.5 mm, 19 mm, 13.2 mm and 9.5 mm AS sieves, as appropriate, and then plotting the results on a graph of AS sieve size v percentage passing. The plotted points to be joined by straight lines and the D90 value determined as the theoretical sieve size corresponding to 90 % passing. D10 denotes the theoretical size of a sieve through which 10% of the material would pass and is to be determined from the same graph used to determine the D90 value.		

Type D filter material

Source: Uncrushed river gravel.

Description: Rounded aggregate to AS 2758.1 Table B1 Appendix B.

Grading: To the **Type D filter material table.**

Use: In Type A and Type B drainage mats: To *1174 Drainage mats*.

Type D filter material table

Test Method	Property	Requirement
AS 1141.11.1	Maximum particle size	75 mm
	Maximum passing the 9.5 mm AS sieve	5% by mass
	Maximum (D90 : D10)	3
AS 1141.22	Minimum wet strength	100 kN
	Maximum 10% fines wet/dry variation	30%

3.4 GEOTEXTILE

General

Conformity: Prior to placing geotextiles, produce documentary evidence that the geotextile and installation process conform to the requirements of this worksection. This is a **HOLD POINT**.

Properties

Material: A non-woven type manufactured from synthetic materials other than polyamide except seamless tubular filter fabric.

General properties: Bio-stable and resistant to attack by alkalis, acids, dry heat, steam, moisture, brine, mineral oil, petrol, diesel and detergents when tested to AS 3706.

Ultra violet light considerations: Conform to the following:

- Provide geotextile resistant to ultra violet light.
- Do not leave geotextile exposed to sunlight during storage and construction for more than 21 days.
- If exposure is in excess of 21 days provide annual test results to conform with AS 3706.11 to show percentage strength retained is in excess of 60 %.

Robustness and strength: Conform to the following:

- Conform to the classifications for robustness and strength cited in AGPT04G.
- Select material based on tests and subgrade conditions for the relevant location/function.

Properties: Material type and minimum mass requirements as shown on the drawings.

Installation: Properties, functions, design and construction requirements to AUSTROADS AGPT04B/09.

Water transmission properties: Conform to the following:

- Geotextile materials for curtain drains: Polyester, polypropylene or polyethylene.
- Rate of water flow: To AGPT04G Table 4.1, under 100 mm constant head determined using the perpendicular flow test to conform with AS 3706.9.

Marking and storage

Labelling: Mark rolls with product identification and supply with data sheets and information to AS 3705.

Covering: Provide each roll of geotextile with a suitable covering to protect the fabric against moisture and ultraviolet radiation, and mark to conform with AS 3705.

Storage: Prior to installation store the geotextiles under a protective cover and supported off the ground. Protect the geotextile from damage and adhere to any other recommendations on method of storage set by the supplier/manufacturer.

Seamless tubular filter fabric

Material: Either polypropylene or polyester seamless knitted tubular filter fabric.

Arrangement: Enclose slotted pipe of 65 mm or 100 mm diameter.

Properties: Free of imperfections in weave or yarn, abrasion resistance 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.

Representative large opening size: Between 200 and 500 µm.

Fitting: To the requirements of **Procedure for fitting seamless tubular filter fabric to slotted pipe Annexure A**.

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.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Control of traffic: Conform to the following:

- Conform with worksection *1101 Control of traffic*.
- Conform with **Traffic Guidance Scheme** in *1101 Control of traffic*.

4.2 TEMPORARY DRAINAGE DURING CONSTRUCTION

Erosion control

Installation: To *1102 Control of erosion and sedimentation*.

Runoff overflows during construction

Works under construction: Provide 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
Location: Clear of watercourses and secured so that they will not cause danger or damage in the event of large runoff flows. This is a **WITNESS POINT**.

4.3 ESTABLISHMENT

Set-out
Approval : Set out the work to the location and levels shown on the drawings prior to construction. Mark any proposed changes that may arise due to actual site conditions. Seek a direction from the Superintendent for any changes that may effect the Schedule of rates. This is a **HOLD POINT**.

4.4 EXCAVATION

Existing underground services
Excavation: Do not excavate by machine within 1 m of existing underground services.

Location: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, of locating underground pipe and cables (possible within two working days). See www.1100.com.au.

Public utility authorities: If public utilities exist in the vicinity of drainage works, obtain the approval of the relevant authority to the method of excavation before commencing excavation and submit. This is a **HOLD POINT**.

Safety
Stabilisation: Provide any shoring, sheet piling or other stabilisation of the sides of trench excavation necessary to conform with statutory requirements.

Blasting operation
Particle velocity: If excavation by blasting is permitted, ensure that the peak particle velocity measured on the ground adjacent to any previously installed drainage structure does not exceed 25 mm/sec. This is a **WITNESS POINT**.

Blasting operations generally: To *1112 Earthworks (Roadways).*

Trenches
Method: Excavate trenches as follows:

- To the line, grade, width and depth shown on the drawings or as directed.
- Construct the bottom of the trench so that no localised ponding can occur.
- Remove all loose material.

Approval: Required for completed trenches prior to installation of drainage works. This is a **HOLD POINT**.

Unsuitable material
Definition: Material that does not conform with *1112 Earthworks (Roadways)* as determined by the Superintendent.

Remedial actions:

- Remove and dispose of unsuitable material at the bottom of the trench or at foundation level.
- Replace with backfill material to conform with the requirements of this worksection.
- Trim the bottom of the excavated trench or foundation parallel with the specified level and slope of the work.

Excavated material
Generally: Reuse the excavated material in the construction of embankments, backfilling or spoiled to conform with *1112 Earthworks (Roadways)*.

Backfilling
Requirements: Backfill to the relevant subsurface drainage worksections.

Materials: As specified in this worksection and to *1112 Earthworks (Roadways)*.

4.5 OUTLET STRUCTURES

Discharge and salinity prevention
Subsurface drainage pipes: Connect discharge into gully pits or to outlet structures as shown on the drawings or as directed.

Salinity prevention: Discharge on the downhill side of the embankment or in the cut area so as to reduce the risk of recharge to the subsurface water table. This is a **WITNESS POINT**.

Outlets
Location intervals: 150 m maximum

Rodent proofing
Method: Secure outlets, including those discharging into gully pits, with galvanised wire netting to conform with the drawings.

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 or approved similar treatment.

Locations: Provide marker posts to indicate the location and assist maintenance.

Outlet pipe
Type: Provide unslotted outlet pipes from curtain drains.

Levels: Ensure no point in an outlet pipe is higher than the pipe at the end of the curtain drain.

Concrete
Specification for outlet structures: Concrete to *0319 Minor concrete works*.

4.6 RECORDING OF SUBSURFACE DRAINAGE INFORMATION

Work as executed plans
Record: Keep a detailed record of all subsurface drainage pipes. Provide work-as-executed plans showing completed subsurface drainage systems.

Information sheets
Submit: Provide a subsurface drainage information sheet or sheets at the completion of construction of each drain or drainage system. This is a **HOLD POINT**.

Content: Include the following:

- Date of completion of drain construction.
- Drain number.
- Type of drain.
- Pipe size.
- Pipe type.
- Filter type.
- Grade of drain.
- Locations of cleanouts.
- Locations of outlets.
- Geotextile:
  - Sheet: Yes/No.
  - Seamless tubular filter fabric: Yes/No.
- Response Time: The time taken for water to travel from the inlet end of a drain or from a cleanout leading to a drain to the outlet end of the drain.

4.7 LIMITS AND TOLERANCES

Application
Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause/ subclause**
Filter material		
- Type A	**Type A filter material table**	**Filter material**
- Type B	**Type B filter material table and Type B filter material variation table**	**Filter material**
- Type C	**Type C filter material table**	**Filter material**

Activity	**Limits/Tolerances**	**Worksection Clause/ subclause**
- Type D	**Type D filter material table**	**Filter material**
Geotextile		
- Curtain Drains Water Transmission	> 50 l/m^2/s	**Geotextile**
Excavation by Blasting		
Peak particle velocity	≤ 25 mm/sec	**Excavation**
Outlets		
Spacing	Max 150 m	**Outlet structures for subsurface drainage pipes**

5 ANNEXURE A

5.1 SLOTTING DETAILS FOR THICK WALLED PVC PLASTIC PIPE

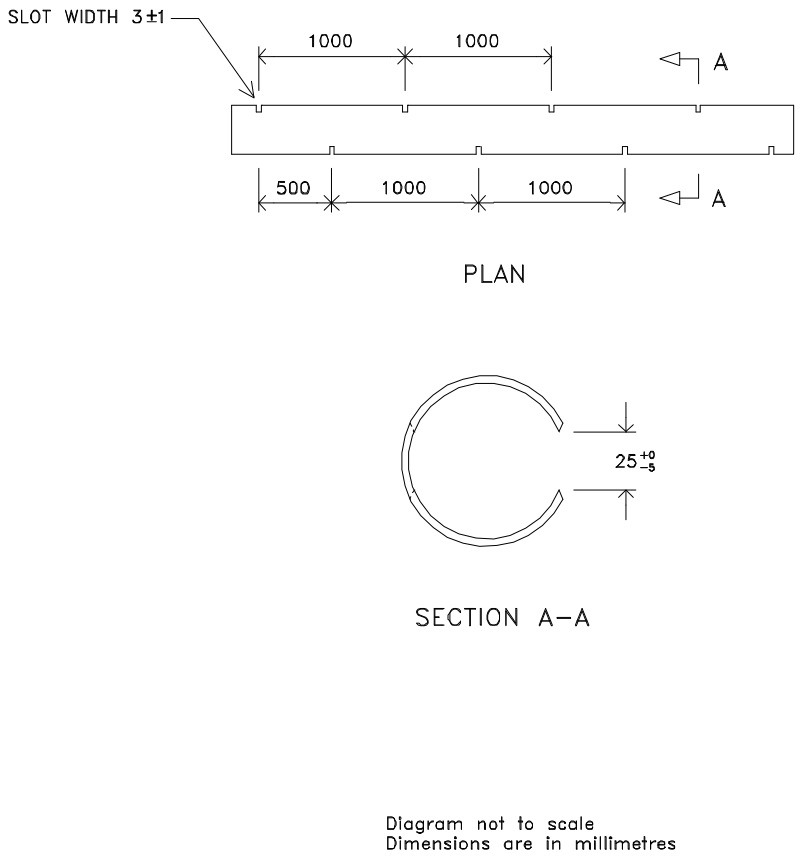


Figure A1 Slotting details for thick walled PVC plastic pipe

5.2 PROCEDURE FOR FITTING SEAMLESS TUBULAR FILTER FABRIC TO SLOTTED PIPE

Procedure

Sequence: Seamless tubular filter fabric may be fitted to slotted pipe on site immediately before the slotted pipe is to be laid in its final position in the work.

General: Conform to the following procedure for fitting seamless tubular filter fabric to slotted pipe:

- Pull the filter fabric over and onto the 'mandrel'. The 'mandrel' is 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.
- Pass the slotted pipe through the mandrel.
- When the end of the slotted pipe emerges from the mandrel, clamp the filter fabric to the forward end of the slotted pipe so that it can not 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 from the mandrel.
- After the slotted pipe has passed through the mandrel, cleanly cut the filter fabric leaving an overhang off the end of the pipe to allow 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 to make sure the filter fabric remains stretch-fitted onto the pipe when the pipe is positioned in the drain.

Precautions to be taken when using slotted pipe fitted with seamless tubular filter fabric

Protection: Do not drag slotted pipe fitted with seamless tubular filter fabric over the ground. If carrying, lift slotted pipe fitted with seamless tubular filter fabric clear of the ground and protect from damage.

Damaged seamless tubular filter fabric: If the filter fabric is damaged and its filtering properties affected, remove from the pipe and replace with undamaged filter fabric.

Loose seamless tubular filter fabric: If, at any time during the installation, the filter fabric becomes loose on the slotted pipe re-stretch it to the correct position. If re-stretching causes any damage to the filter fabric, remove the damaged filter fabric from the pipe and replace with undamaged filter fabric.

1172 SUBSOIL AND FOUNDATION DRAINS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide subsoil and foundation drains, as documented.

Performance
Requirements: Construct the works shown on the drawings or directed all in conformance with *0161 Quality (Construction)*.

1.2 CROSS REFERENCES

Worksections
Requirement: Conform to the following:
- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*
- *1112 Earthworks (Roadways)*.
- *1171 Subsurface drainage.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

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.
AS 1289.5.6.1-1998	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material

Other publications

AUSTROADS	
AGPT10-2009	Guide to Pavement Technology Part 10 – Subsurface drainage.

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
- CI: Cast Iron.
- HDPE: High Density Polyethylene.

Definitions
General: For the purposes of this worksection the following definitions apply:
- Foundation drains: For drainage of seepage, springs and wet areas within and adjacent to the foundations.
- Panel drain: Corrugated flat plastic pipe.
- Selected material zone: The top part of the Upper zone of formation in which material of a specified higher quality is required.
- Subsoil drains: For drainage of ground water and/or the pavement in cuttings.

1.5 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Documents
Submit the following for approval:
- Filter materials: Refer to **WITNESS POINTS**.
- Calculations: Survey set out of works including quantity calculations.
- Components: Submit technical details of:
  . Geotextiles to *1171 Subsurface drainage.*
  . Pipes and fittings to *1171 Subsurface drainage.*
- Execution details: Refer to **WITNESS POINTS**.
- Detailed records and Work-as-Executed drawings.

1.6 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Item/Clause title	Requirement	Notice for inspection	Release by
EXECUTION			
Subsoil / Foundation drains - Pipes	Submit bedding of compacted filter material laid to line and grade	3 working days before next activity	Superintendent
Subsoil / Foundation drains - Excavation	Inspect excavation	1 working day prior to filling	Superintendent

WITNESS POINTS table – On-site activities

Item/Clause title	Requirement	Notice for inspection
MATERIALS		
General - Filter material	Type of filter material	3 working days before ordering material
EXECUTION		
General - Location	Mark location of drains consistent with drawings or directions	7 days prior to commencing works
Subsoil / Foundation drains - Pipes	Lay on compacted bed to documented line and level	1 working day before filling
Subsoil drains - Backfilling,	Backfilling to documented level and relative compaction	1 working days before covering with geotextile
Foundation drains - Backfilling	Backfilling to documented level and relative compaction	1 working days before covering with geotextile
Geotextile - Installation	Placement of fabric conformance	1 working day before filling
Geotextile - Installation	Ensure exposure periods are within the constraints	Progressive
Cleanouts – Field testing	Perform flushing test	3 working days from completion

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Programming the works
General: Program the works as follows:
- Plan sequence of activities.
- Address time and program sequence of **HOLD POINTS** and **WITNESS POINTS**.

3 MATERIALS

3.1 GENERAL

Filter material
Description: Type A or Type B filter material to *1171 Subsurface drainage* capable of placing and compaction in the specific location and as shown on the drawings. This is a **WITNESS POINT**.

Geotextiles and pipes
Conform to: *1171 Subsurface drainage*.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General
Control of traffic: Conform to the following:

- Conform with worksection *1101 Control of traffic*.
- Conform with **Traffic Guidance Scheme** in *1101 Control of traffic*.

4.2 ESTABLISHMENT

Location
Layout: As shown on the drawings or as directed by the Superintendent. This is a **WITNESS POINT**.

Existing underground services
Excavation: Do not excavate by machine within 1 m of existing underground services.

Location: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, of locating underground pipe and cables (possible within two working days). See www.1100.com.au.

4.3 SUBSOIL DRAINS

Order of construction
Sequence: Construct subsoil drains as soon as possible after necessary earthworks are completed in the area of the drain.

Ground water: Where stabilisation of the subgrade is required, construct subsoil drains after completion of stabilisation except where excessive ground water is encountered, construct drain prior to stabilisation of the subgrade.

Excessive groundwater: Where a selected material zone is documented and excessive ground water is encountered, install subsoil drains in two stages as follows:

- Stage 1: Install standard subsoil drains below the base of the cutting prior to placement of select material in the selected material zone.
- Stage 2: Extend subsoil drain to top of the selected material zone after placement of selected material.

Excavation
Requirements: To *1171 Subsurface drainage*.

Specified level: The bottom of the trench must not be more than 50 mm below the specified level of the invert of the pipe.

Smooth: Ensure the bottom and sides of the excavation are smooth with no protrusions that will damage the geotextile fabric.

Grade: Excavate the bottom of the trench to the same grade as the design pavement surface in the direction of the trench.

Minimum grade: If required increase the trench depth to provide a minimum grade of fall in the trench of 0.5%.

Prevent ponding: Excavate the bottom of the trench to prevent localised ponding of water occurs.

Over-excavation: If the trench is excavated below the documented level, backfill the trench to the documented level with non-porous subgrade material compacted to a relative compaction of at least 95% (Standard compaction) as determined by AS 1289.5.4.1.

Two stage construction: If a subsoil drain is constructed in two stages, carry out the excavation for Stage 2 after placement and compaction of the Selected Material Zone or the stabilised subgrade layer. Excavate the Stage 2 trench to the same line and width as the Stage 1 trench and to a depth to provide a clean, full contact with the filter material placed in Stage 1. Dispose of all excavated material to waste or incorporate into fills.

Inspection: To ensure the excavation conforms with the shape, grade line, filling and compaction and removal of any protrusions. This is a **HOLD POINT**.

Pipes

Bedding: 50 mm thick compacted filter material laid to the documented line and grade. This is a **HOLD POINT**.

Filter material type: As shown on the drawings or as directed by the Superintendent.

Pipe: Place centrally within the trench on the crushed aggregate the 100 mm diameter corrugated slotted plastic piping or corrugated flat plastic piping as shown on the drawings.

Tolerance: Deviation < 100 mm from the documented line. This is a **WITNESS POINT**.

Joints: Minimise joints in the pipeline.

Joint construction: Proprietary external joint coupling. Fit the inlet end of the pipe with a proprietary PVC cap.

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. Tamp around and over the pipe to avoid damage or disturbance to the pipe.

Upper section of the trench: Backfill above the level documented for filter material backfill, with selected free draining backfill material, conforming to the requirements of *1112 Earthworks (Roadways)*.

Compaction: Compact cohesionless filter material to a Density Index of 70% determined by AS 1289.5.6.1 for the full depth of the backfill. This is a **WITNESS POINT**.

Two stage construction plug

Protection: Protect the filter material placed at the top of Stage 1 from scour and/or contamination by covering with a 50 mm thick plug of select fill material with a maximum particle size of 25 mm.
Compaction: Compact the select fill material to a relative compaction of 95% as determined by AS 1289.5.4.1.

Remove and replace: Remove this plug, any contaminated filter material and any select material covering, replace with filter material and compact to 95% relative compaction.

4.4 FOUNDATION DRAINS

Order of construction

Sequence: Construct foundation drains after completion of clearing and stripping operations, and before the commencement of embankment construction.

Excavation and pipes

Requirements: To *1171 Subsurface drainage* and **Subsoil drains**.

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. Tamp around and over the pipe to avoid damage or disturbance to the pipe.

Upper section of the trench: Backfill above the level documented for filter material backfill with suitable free draining backfill material.

Compaction: Compact cohesionless filter material to a Density Index of 70% determined by AS 1289.5.6.1 for the full depth of the backfill. This is a **WITNESS POINT**.

4.5 GEOTEXTILE

Location

Extent: As shown on the drawings or as directed by the Superintendent.

Location: At the interface between the filter material and adjoining materials.

Installation

Placement: Cover the bottom and sides of the trench with sufficient free 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 on the soil. This is a **WITNESS POINT**.

Joints: Provide laps of 500 mm at joints in the fabric.

Program: Ensure the period between initial laying out and final cover of the geotextile with drainage backfill layer does not exceed 14 days. Where possible place geotextiles just ahead of construction works and cover with materials within 48 hours. This is a **WITNESS POINT**.

Damage: Take all reasonable care to ensure that the geotextile is not damaged during installation and backfilling operations.

Remove and replace: Any geotextile fabric exposed for longer than 14 days must be removed and replaced at no extra cost.

4.6 OUTLET STRUCTURES

Discharge and salinity prevention

Subsurface drainage pipes: Connect discharge into gully pits or to outlet structures as shown on the drawings or as directed.

Salinity prevention: Discharge on the downhill side of the embankment or in the cut area so as to reduce the risk of recharge to the subsurface water table. This is a **WITNESS POINT**.

Outlets

Location intervals: 150 m maximum.

Rodent proofing

Method: Secure outlets, including those discharging into gully pits, with galvanised wire netting to conform with the drawings.

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 or approved similar treatment.

Locations: Provide marker posts to indicate the location and assist maintenance.

Outlet pipe

Type: Provide unslotted outlet pipes from curtain drains.

Levels: Ensure no point in an outlet pipe is higher than the pipe at the end of the curtain drain.

Concrete

Specification for outlet structures: Concrete to *0319 Minor concrete works*.

4.7 CLEANOUTS

Location

Details: As shown on the drawings. Do not locate pits in unsealed shoulders, drain inverts or on batter faces.

Location: At the commencement of each run of subsoil drain line and at intervals of approximately 100 - 140 m to conform with AGPT10.

Type

Clean out: Supply the standard CI caps as shown on the drawings.

Field testing

Method: After completion of backfilling, pump clean water into the cleanout at the commencement of each run until only clean water discharges at the outlet.

Flushing: The minimum rate of flow of flushing water at the inlet must be 100 l/min. This is a **WITNESS POINT**.

4.8 MARKING OF DRAINS

Completion

Records: Keep a detailed record of all trench drain installations. Mark 'Work-as-Executed' drawings of the completed drainage system. Submit within 28 days of completion of the works.

Mark: Markings location and type to conform with the relevant State Road Authority and AGPT10-09.

Pegs: Treated or painted timber 75 mm diameter with 600 mm of post above ground level. Do not use the colour white.

ID plate: Attach an identification plate to the marker post or pit lid.

4.9 LIMITS AND TOLERANCES

The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause/ subclause**
Excavation		
- Trench Grade	≥ 0.5%	**Subsoil drains**
- Compaction	> 95% (Standard compaction)	**Subsoil drains**
Laying of pipe		
Alignment	Deviation < 100 mm from the documented line at any point	**Subsoil drains**
Subsoil drain backfill		
- Layer thickness	300 mm max	**Subsoil drains**
- Compaction - Filter material Backfill material	70% Density Index for cohesionless material.	
	100% (Standard compaction)	**Subsoil drains**
Outlet spacing	150 m max	**Outlets**
Cleanout spacing	100 - 140 m approx	**Cleanouts**
Foundation drain backfill		
Backfilling - Layer thickness	300 mm max	**Foundation drains**
- Compaction Filter material Backfill material	70% Density Index for cohesionless material. > 95% (Standard compaction)	**Subsoil drains** **Foundation drains**

1173 PAVEMENT DRAINS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide sub-pavement drains, intra-pavement drains and edge drains, as documented.

Performance
Requirements: Construct the works as documented or directed by the Superintendent.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*
- *1112 Earthworks (Roadways).*
- *1141 Flexible pavement base and subbase.*
- *1144 Asphaltic concrete (Roadways).*
- *1171 Subsurface drainage.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection 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 1289.5.4.1-2007	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

Other publications

AUSTROADS	
AGPT10-2009	Guide to pavement technology Part 10 - Subsurface drainage

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:

CI: Cast iron.

HDPE: High Density Polyethylene.

Definitions
General: For the purposes of this worksection the following definitions apply:

Edge drains: For drainage of rigid pavements.

Intra-pavement drains: For drainage of pavement layers of a flexible pavement where the subbase material is a macadam crushed rock or open graded asphaltic concrete.

Panel drain: Corrugated flat plastic pipe.

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: For drainage of the pavement layers where the subbase is not a macadam crushed rock.

1.5 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Documents
Submit the following for approval:

- Filter materials: Refer to **WITNESS POINTS**.
- Components: Submit technical details of:
  - Geotextiles to *1171 Subsurface drainage.*
  - Pipes and fittings to *1171 Subsurface drainage.*
- Execution details: Proposals for timing and sequence of activities.
- Work as executed drawings.

1.6 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Item/Clause title	Requirement	Notice for inspection	Release by
EXECUTION			
Sub-pavement drains - Laying of pipe	Submit bedding of compacted filter material laid to line and grade	1 working day before covering	Superintendent
Intra-pavement drains - Laying of pipe	Provide certification that drain has adequate crushing strength	3 working days before ordering	Superintendent
Intra-pavement drains - Laying of pipe	Submit details of proposed method of securing pipes	7 days before pipe laying	Superintendent
Edge drains - Laying of pipe	Submit details of proposed method of securing pipes	7 days before pipe laying	Superintendent

WITNESS POINTS table

Item/Clause title	Requirement	Notice for inspection	Release by
MATERIALS			
General - Filter material	General - Filter material	General - Filter material	General - Filter material
EXECUTION			
Establishment - Location	Mark location of drains consistent with drawings or directions	7 days prior to commencing works	
Sub-pavement drains - Laying of pipe	Laid to documented line and level	1 working prior to Backfilling	
Sub-pavement drains - Backfilling	Backfill to documented level.	3 working days prior covering	
Edge drains - Excavation	Demonstrate proposal for strip filter if required.	3 working days	
Edge drains - Laying of pipe	Laid to documented line and level	Progressive	
Clean outs – Field testing	Perform flushing test	3 working days from completion	

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of the works
Program the works as follows:
- Plan sequence of activities.
- Address time and program sequence of **HOLD POINTS** and **WITNESS POINTS**.

3 MATERIALS

3.1 GENERAL

Filter material and impervious material
Description: Conform to *1171 Subsurface drainage*: Capable of placing and compaction and as shown on the drawings. This is a **WITNESS POINT**.

Geotextiles and pipes
General: Conform to *1171 Subsurface drainage*.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General
Control of traffic: Conform to the following:
- Conform with worksection *1101 Control of traffic*.
- Conform with **Traffic Guidance Scheme** in *1101 Control of traffic*.

4.2 ESTABLISHMENT

Location
Layout: Construct pavement drains as shown on the drawings and as directed. This is a **WITNESS POINT**.

Existing underground services
Excavation: Do not excavate by machine within 1 m of existing underground services.

Location: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, of locating underground pipe and cables (possible within two working days). See www.1100.com.au.

4.3 ORDER OF CONSTRUCTION

Sub-pavement drains
Sequence: Construct sub-pavement drains as soon as possible after earthworks are completed in the area of the drain.

Ground water: If stabilisation of the subgrade is required, construct the sub-pavement drain after completion of stabilisation except that where excessive ground water is encountered, construct sub-pavement drains prior to stabilisation of the subgrade.

Excessive groundwater: Where a Selected Material Zone is specified and excessive ground water is encountered, sub-pavement drains may be installed in two stages as follows:
- Stage 1: Standard sub-pavement drains installed below the base of the cutting prior to placement of select material in the Selected Material Zone.
- Stage 2: Extension of sub-pavement drain to top of the Selected Material Zone after placement of selected material.

Intra-pavement drains
Sequence: Construct intra-pavement drains after the completion of the layer below the crushed rock macadam or 40 mm open graded asphaltic concrete subbase and preceding the construction of the subsequent layers.

Edge drains
Sequence: Construct edge drains after the construction of the rigid pavement and before the placement and compaction of verge material.

4.4 SUB-PAVEMENT DRAINS

Excavation
Trench dimensions: 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 where two stage construction of the sub-pavement drain is required.

Trench grade: Construct the bottom of the trench at the same grade as the design pavement surface except where the grade of the roadway is less than 0.5%, increase the depth of the trench to provide a grade of 0.5% in the trench. Excavate the bottom of the trench to prevent localised ponding of water.

Two-stage construction: If a subpavement drain is constructed in two stages, 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 to a depth to provide a clean, full contact with the filter material previously placed in Stage 1.

Disposal: Dispose of all excavated material to waste or incorporate into fills.

Laying of pipe
Bedding: 50 mm thick compacted filter material laid to the documented line and grade. This is a **HOLD POINT**.

Filter material type: As shown on the drawings or as directed.

Pipe: 100 mm diameter corrugated slotted plastic piping or the corrugated flat plastic panel drain on the compacted bed as shown on the drawings.

Tolerance: Deviation < 100 mm from the documented line. This is a **WITNESS POINT**.

Joints: Minimise joints in the pipeline.

Joint construction: Proprietary external joint coupling. Fit the inlet end of the pipe with a proprietary PVC cap.

Backfilling
Filter material: Backfill the trench with filter material to the documented level. This is a **WITNESS POINT**.

Layers: 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.

Compaction: Compact cohesionless material to a Density Index of 70% determined by AS 1289.5.6.1 for the full depth of the backfill

Pipe outlets:

- Backfill the trench on the outlet section of pipes discharging through the fill batters with the nominated 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) to AS 1289.5.4.1.

Temporary plug over filter material
Requirement: In the case of sub-pavement drains of two stage construction, when it is not practical to place the pavement layers or the Selected Material Zone immediately after the construction of Stage 1.

Method: Protect the filter material placed to the top of Stage 1 from scour and/or contamination by covering with a 50 mm thick plug of compacted select fill material having a maximum particle size of 25 mm and Plasticity Index of not more than 12 as determined by AS 1289.3.3.1.

Removal: Remove this plug, any contaminated filter material and any select material covering and replace with the nominated filter material and compact immediately ahead of the placement of the pavement layer. Dispose of all excavated material to waste or incorporate in fills.

4.5 INTRA-PAVEMENT DRAINS

Excavation

Trench dimensions: Cut a 'V' shaped trench approximately 75 mm deep to the required line in the pavement layer immediately below the crushed rock macadam pavement layer. No excavation is required below a 40 mm open graded asphaltic concrete subbase layer.

Trench grade: Construct the bottom of the trench at the same grade as the roadway and ensure localised ponding of water does not occur.

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) as determined by AS 1289.5.4.1.

UPVC pressure pipe: Provide thick walled slotted unplasticised PVC pressure pipe, to conform with *1171 Subsurface drainage*, with the following:

- Crushed rock subbases having not more than 10% of material passing the 9.5 mm Australian Standard sieve and having layer thicknesses neither less than 150 mm nor more than 200 mm.
- Open graded asphalt subbases having layer thicknesses neither less than 80 mm nor greater than 100 mm.

Suitability for subbases: If the subbase requires pavement drains, provide certification that the proposed type of pavement drain has adequate crushing strength in the following locations: This is a **HOLD POINT.**

- Crushed rock subbase: Depth > 200 mm.
- Asphalt subbase: Depth > 100 mm.

Inlet cap: The inlet end of the pipe to be fitted with a cap to conform with *1171 Subsurface drainage*.

Outlet length: Provide 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 specified line and level.

Deviation: Not to deviate the pipe from the specified line by more than 100 mm at any point.

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.

Anchorage alternatives: Submit details of the proposed method of securing the pipes to the layer under the free-draining subbase. This is a **HOLD POINT**.

Alternative securing method: If the approved method of securing the pipes to the layer under the free draining subbase allows movement of the pipes, discontinue the method and submit an alternative securing method for approval.

Backfilling

Subbase: Spread subbase material, compact and trim, where appropriate, as follows:

- For crushed rock macadam subbase: To *1141 Flexible pavement base and subbase.*
- For open graded asphalt subbase: To *1144 Asphaltic concrete (Roadways).*

Prevent damage to pipes: Place, spread and compact the subbase without damage to the intra-pavement drain pipes.

Remove and replace: If any pipes are damaged remove and replace the damaged pipes.

Layers: 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.

Compaction: Compact cohesionless material to a Density Index of 70% determined by AS 1289.5.6.1 for the full depth of the backfill

4.6 EDGE DRAINS

Excavation

Trench dimensions: Trim the verge material to subgrade level and to the minimum width shown on the drawings.

Trench grade: Construct the bottom of the trench at the same grade as the roadway and ensure localised ponding of water does not occur. Where the grade of the roadway is less than 0.5 % excavate the trench to provide a minimum grade of 0.5%.

Discharge pipe: If the pipe is to discharge through the fill batter excavate a suitable trench to provide the required grade.

Strip filters: Do not use strip filters unless fully demonstrated and approved. This is a **WITNESS POINT**.

Laying of pipe

Slotted corrugated plastic pipe: Provide 65 mm diameter slotted corrugated plastic pipe enclosed in seamless tubular filter fabric to conform with *1171 Subsurface drainage*, for edge drains unless shown otherwise on the drawings or as directed.

Slotted PVC pressure pipe: If any part of a shoulder consists of material other than concrete, install slotted thick walled PVC pressure pipe.

Securely hold in place: Secure all pipes held against the vertical face of the rigid pavement.

Approval for method of securing pipes: Submit details of the proposed method of securing the pipes against the rigid pavement. This is a **HOLD POINT**.

Bedding and alignment: Lay the pipe on a prepared bed to the documented line and level.

Tolerance: Deviation < 100 mm from the documented line at any point. This is a **WITNESS POINT.**

Joints: Minimise joints in the pipeline.

Joint construction: Proprietary external joint coupling. Fit the inlet end of the pipe with a PVC cap.

Backfilling

Filter material: Cover the pipe with Type B filter material to *1171 Subsurface drainage* and as shown on the drawings.

Soaking of filter material: Mechanical compaction of this filter material is not required. Soak with water after placement of the filter material. Soak and add additional filter material as required to provide the final dimensions shown on the drawings.

Material: Backfill material to *1112 Earthworks (Roadways)* and as required for verges. Avoid damage or disturbance of the pipe.

Compaction: Relative compaction of not less than 100% (Standard compaction) to AS 1289.5.4.1.

4.7 OUTLETS

General

Requirements and specification of outlet structures: Conform to *1171 Subsurface drainage*.

Intra-pavement drain discharge: If discharge must be constructed extend each pipe using a 60° bend and unslotted pipe to discharge through the fill batter and construct an outlet structure on the discharge end to conform with the drawings.

Edge drain: If discharge must be constructed provide unslotted pipe with a 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.

Rodent proofing

Method: Secure outlets, including those discharging into gully pits, with galvanised wire netting to conform with the drawings.

4.8 CLEANOUTS

Location

Details: As shown on the drawings. Do not locate pits in unsealed shoulders, drain inverts or on batter faces.

Location: At the commencement of each run of subsoil drain line and at intervals of approximately 100 - 140 m to conform with AGPT10-09.

Type

Clean out: Supply the standard CI caps as shown on the drawings.

Field testing

Method: After completion of backfilling, pump clean water into the cleanout at the commencement of each run until only clean water discharges at the outlet.

Flushing: The minimum rate of flow of flushing water at the inlet must be 100 l/min. This is a **WITNESS POINT**.

4.9 MARKING OF DRAINS

Completion

Records: Keep a detailed record of all trench drain installations. Mark 'Work-as-Executed' drawings of the completed drainage system. Submit within 28 days of completion of the works.

Mark: Markings location and type to conform with the relevant State Road Authority and AGPT10-09.

Pegs: Treated or painted timber 75 mm diameter with 600 mm of post above ground level. Do not use the colour white.

ID plate: Attach an identification plate to the marker post or pit lid.

4.10 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause/ subclause**
Excavation Trench Grade	 ≥ 0.5%	**Sub-pavement drains** **Edge drains**
Sub-pavement drain		
Laying of pipe		
Alignment	Deviation < 100 mm from the documented line at any point.	**Sub-pavement drains**
Backfill		
Layer thickness	300 mm max	**Sub-pavement drains**
Compaction (Relative) - Filter material - Backfill material	 100% (Standard compaction) > 95% (Standard compaction)	 **Sub-pavement drains** **Sub-pavement drains**
Cleanout spacing	100 - 140 m approx	**Cleanouts**
Outlet spacing	150 m max	**Sub-pavement drains** **Intra-pavement drains** **Edge drains**
Intra-pavement drain		
Backfill	> 95% (Standard compaction)	**Intra-pavement drains**
Alignment	Deviation < 100 mm from specified line at any point.	**Intra-pavement drains**
Edge drains		
Alignment	Deviation < 100 mm from specified line at any point.	**Edge drains**
Compaction (relative) of backfill material	100% (Standard compaction)	**Edge drains**

1174 DRAINAGE MATS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide drainage mats, filter materials and pipes as shown on the drawings, as documented.

Performance
Requirements: Conform with this specification, the Drawings and as directed by the Superintendent.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*
- *1171 Subsurface drainage*.
- *1173 Pavement drains.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

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

1.4 INTERPRETATION

Definitions
General: For the purposes of this worksection the following definitions apply:

- Type A mats: Mats intended to ensure continuity of a sheet flow of water under fills, to collect surface seepage from a wet seepage area or for protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water.
- Type B mats: Mats constructed to intercept water which would otherwise enter pavements by capillary action or by other means on fills and to intercept and control seepage water and springs in the floors of cuttings.

1.5 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Components
General: Geotextiles and pipes to *1171 Subsurface drainage*.

Materials
General: Refer materials clauses for items to *1171 Subsurface drainage*.

1.6 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Item/Clause title	Requirement	Notice for inspection	Release by
Type A mats / Type B mats			
Geotextile, Damaged geotextile	Approval of condition or repair of geotextile	1 working day before next activity	Superintendent
Filter material, Thickness	Approval of thickness and layers of filter material	3 working days before placing filters	Superintendent

WITNESS POINTS table

Item	Requirement	Notice for inspection
Type A mats /Type B mats		
Filter material, Protective layer	Inspection of placement of protective layer over mat extension.	3 working days before placing materials
Discharge, Outlets	Inspection of outlet proposals	7 days before set-out of layers

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Programming the works

Program: To conform with embankment and pavement construction as follows:

- Type A mats: After the site has been cleared and grubbed and before commencement of embankment construction.
- Type B mats: After completion of the subgrade construction and before construction of the pavement.

3 MATERIALS

3.1 FILTER MATERIAL

Mat components

General: Conform to the following:

- Type A mats: Type B, C or D filter material to *1171 Subsurface drainage.*
- Type B mats: Type A or D filter material to *1171 Subsurface drainage.*

3.2 GEOTEXTILE

General

Geotextile: To *1171 Subsurface drainage.*

3.3 PVC PRESSURE PIPE

General

Thick walled unplasticised PVC pressure pipe: To *1171 Subsurface drainage.*

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Control of traffic: Conform to the following:

- Conform with worksection *1101 Control of traffic*.
- Conform with **Traffic Guidance Scheme** in *1101 Control of traffic*.

4.2 TYPE A MATS

Placement

Location: Conform to the following:

- Under embankments as shown on the drawings or as directed by the Superintendent.
- Extending 2 m beyond the toes of embankments.

Geotextile

General: Provide geotextile as follows:

- On the embankment foundation after the embankment foundation has been trimmed and any necessary trench drains installed.
- On top of and around the sides of the filter material after placement and compaction of the filter material to cover and enclose the sides of the drainage mat and filter material.

Geotextile under rock facing: Place an additional layer of geotextile on the drainage mat under the base of rock facing forming part of the embankment construction. Extend the additional layer of geotextile beyond the outside and inside faces of the bottom layer of rock.

Lap width: 500 mm minimum at each join in the geotextile.

Protection of geotextile: Secure the geotextile to prevent movement by wind or by construction plant placing subsequent layers of filter material or earth filling over the drainage mat. Protect from damage during construction of the drainage mat and during placement of subsequent layers of filter material, earth filling or rock facing.

Damaged geotextile: Replace or repair damaged geotextile. This is a **HOLD POINT**.

Filter material

Type: Type B, C or D as shown on the drawings or as determined by the Superintendent.

Location: Compacted on the geotextile.

Thickness: Conform to the following: This is a **HOLD POINT.**

- Known expected consolidation of embankment: 300 mm minimum plus allowance for the expected total consolidation of the embankment.
- Unknown expected total consolidation of the embankment foundation: 500 mm minimum.
- Layers: Provide filter material in two or more layers so that the thickness of a compacted layer is 250 mm maximum.

Protective layer: Cover the extension of the mat beyond the toe of the embankment with 300 mm filter material immediately after completion of construction of each drainage mat. This is a **WITNESS POINT**.

Discharge

Outlets: May be either of the following: This is a **WITNESS POINT**.

- Surface outlets at the toes of embankments.
- Piped outlets connected to other drainage systems conforming to *1171 Subsurface drainage*.

4.3 TYPE B MATS

Placement

Location: In cuttings as shown on the drawings or as directed by the Superintendent.

Width: The full width of cuttings and for the pavement width in other locations.

Geotextile

General: Provide geotextile as follows:

- On the subgrade after the subgrade material has been compacted and trimmed.
- On top of and around the sides of the filter material so that the filter material is completely enclosed after completion of placement and compaction of the filter material.

Lap width: 500 mm minimum at each join in the geotextile.

Protection of geotextile: Conform to the following:

- General: Secure the geotextile to prevent movement by wind or by construction plant placing subsequent layers of filter material or earth filling over the drainage mat. Protect from damage during construction of the drainage mat and during placement of subsequent layers of filter material, earth filling or rock facing.

- Damaged geotextile: Replace or repair damaged geotextile. This is a **HOLD POINT**.

UPVC pressure pipe: Lay thick walled unplasticised PVC pressure pipe on the geotextile at a distance of 200 mm from and parallel to the longitudinal edges of the drainage blanket as shown in the drawings.

Filter material

Type: Type A or D as shown on the drawings and as determined by the Superintendent.

Compaction: Compact cohesionless material to a Density Index of 70% determined by AS 1289.5.6.1.

Thickness: Conform to the following:

- As shown on the drawings or as directed by the Superintendent. This is a **HOLD POINT**.
- Layers: Provide filter material in layers so that the thickness of a compacted layer is 250 mm maximum. This is a **WITNESS POINT.**

Discharge

Outlets: To *1171 Subsurface drainage*. This is a **WITNESS POINT**.

Tolerance

Surface level: At the design level for the top of the drainage mat with a tolerance of + 0 and - 40 mm.

4.4 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Clause/ subclause**
Filter material		
Layer thickness	250 mm max	**Type A mats & Type B mats**
Compaction (Relative) Type A filter material	100% (Standard compaction)	**Type B mats**
Type B mats		
Design level at top of mat	+ 0, – 40 mm	**Type B mats**

1191 PAVEMENT MARKINGS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide pavement markings, as documented.

Performance
Requirements: Conform with this worksection, *0161 Quality (Construction)*, the drawings, specifications and directions by the Superintendent, consistent with requirements and appropriate State or Local Government legislation.

Design
Authority requirements: This worksection does not override any applicable State or Local Government legislation and is to be read in conjunction with AS 1742.3 and the Roads and Maritime Services (NSW) RMS QA Specification DCM R141 Pavement Marking (or equivalent document in other states).

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1289	Methods of testing soils for engineering purposes
AS 1289.2.1.4-2005	Soil moisture content tests - Determination of the moisture content of a soil - Microwave-oven drying method (subsidiary method)
AS 1580	Paints and related materials—Methods of test
AS/NZS 1580.107.3-1997	Determination of wet film thickness by gauge
AS/NZS 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 devices for works on roads
AS 1906	Retroreflective materials and devices for road traffic control purposes
AS 1906.3-1992	Raised pavement markers (retroreflective and non–retroreflective)
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 4049.1-2005	Solvent-borne paint - For use with surface applied glass beads
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
ASTM D3335-2009	Standard test method for low concentrations of lead, cadmium, and cobalt in paint by atomic absorption spectroscopy

Other publications
Roads and Maritime Services (NSW)

RMS Delineation manual 2008 Section 1 to 5

RMS Test method T841 2001 Field measurement of film thickness of road marking paint

RMS QA Specification DCM R141 Pavement Marking 2011

1.4 STANDARD

General
Pavement markings: To AS 1742.2.

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the definitions given below apply:
- CAP: Two part cold applied plastic material.
- Paint: In this worksection implies 'pavement marking paint'.
- Thermoplastic material: In this worksection implies 'thermoplastic pavement marking material'.

Definitions
General: For the purposes of this worksection the definitions given below 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 symbols, words, numerals and arrows, kerb markings and markings for parking.
- Pavement marking: All longitudinal linemarking, transverse lines, raised pavement markers and other markings placed on the road to control traffic movement or parking.
- 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.

1.6 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Requirement: Conform to the drawings, specified procedures and Standards.

Approvals: Submit NATA Certificates, conform to **HOLD POINTS**, **WITNESS POINTS**

Documents
Submit the following for approval:
- Proposed supplier.
- Materials and components: Submit Certification of materials as specified.
- Execution details: Refer to **HOLD POINTS**, **WITNESS POINTS**.
- Submit details of set-out.
- Components: Refer materials.
- Technical data: Equipment suitability and application measurement as specified.
  . Field testing for thermoplastics and CAP.

1.7 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/subclause	Requirement	Notice for inspection	Release by
Certificate of compliance – Material quality	Submit NATA Test Reports on materials	7 days before work is scheduled to commence	Superintendent
Establishment Surface preparation	Approval for surface preparation required	7 days before commencement of activity	Superintendent
Establishment - Surface preparation	Superintendent direction on suspension of work	Progressive	Superintendent
Removal of redundant	Submit method for	1 working day before	Superintendent

markings – Removal method	approval	commencement of activity	

WITNESS POINTS table – On-site activities

Clause title/subclause	Requirement	Notice for inspection
Paint marking - Application of paint and beads	Application of paint and beads to be checked for quality	Progressive
Thermoplastic marking – Field testing	Application of paint and beads to be checked for quality	Progressive
Two part cold applied pavement marking – Field testing	Application of paint and beads to be checked for quality	Progressive
Pavement marking tape - Application	Direction to remove pavement marking tape	Progressive
Raised pavement markers – Installation	Application of paint and beads to be checked for quality	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program for the works

Requirements: Program the works to ensure adequate resources for the following:

- Provide planning resources to collate the technical requirements for materials consistent with Authority's legislation/standards.
- Engage NATA Laboratory for material certification.
- Plan the Setting Out and Control of Traffic Activities.
- Program the work to meet the constraints of **HOLD POINTS**, **WITNESS POINTS**.

2.2 CERTIFICATES OF COMPLIANCE

Material quality

Test reports: Submit, to the Superintendent, NATA Registered Laboratory Test Reports on the quality of the materials, including paint, glass beads, raised pavement markers and thermoplastic material proposed for use. Provide only materials conforming to the requirements of the referenced worksections/standards. Testing must be within 36 months of the products use for validity. This is a **HOLD POINT**.

3 MATERIALS

3.1 PAVEMENT MARKING PAINT

Type

Waterborne paint: To AS 4049.3.

Type: Do not use Solvent-borne paint.

3.2 QUARTZ FOR NON-SKID PAVEMENT MARKINGS

Quality

Transverse markings: Incorporate quartz as follows:

- Clean, sound, hard, durable, non-plastic and free from adherent coatings and any other foreign matter.
- When placed in a cylindrical container of minimum diameter 50 mm and minimum depth of 20 mm with the surface screeded off.
- Moisture content of less than 5% when tested to conform with AS 1289.2.1.4.

Particle size distribution: To the **Particle size distribution table**.

Particle size distribution table

Sieve mesh size (µm)	% Passing
425	100
300	50-90
150	25 – 55
75	0 – 30

Transport: Package quartz to prevent damage during transportation and handling, and ensure that contamination does not occur.

3.3 THERMOPLASTIC MATERIAL

Standard

Thermoplastic marking: To AS 4049.2.

Non-profile thermoplastic pavement marking material

Sprayed or extruded thermoplastics: Generally used for longitudinal line marking and must be applied uniformly.

Screeded or preformed thermoplastic: Generally used for transverse lines and other markings.

3.4 TWO PART COLD APPLIED PAVEMENT MARKING MATERIAL

Quality

Lead content: When determined by method ASTM D3335, the lead content must be no greater than 0.25 %.

No pick up time: Measured at 23℃ and tested to AS 1580.401.8.

- 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 (contains no glass beads), maximum 5 minutes for 0.200 ± 0.025 mm applied film thickness.

Luminance: White road marking material luminance factor as delivered must be not less than 75%.

Abrasion resistance: Loss in mass must not exceed 0.3 g for 500 cycles.

Sprayed material: Generally used for longitudinal line markings.

Trowelled, screeded, sprayed or extruded material: Generally used for transverse lines and other pavement markings.

3.5 REFLECTIVE GLASS BEADS

Quality

Standard: 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 to conform to the requirements of AS/NZS 2009.

Glass beads: Conform to the following:

- Type B ‘Drop-on beads’ or type D ‘wet weather beads’.
- Supply type D wet weather beads intended for use with thermoplastic applications with a proprietary adhesive coating and clearly labelled on the packaging.

3.6 PAVEMENT MARKING TAPE

Type

Temporary markings: Strippable tape approved by the Superintendent.

Permanent pavement marking tape: Must be approved by the Superintendent.

3.7 RAISED PAVEMENT MARKERS

Type

Markers: Reflective and non-reflective markers to AS 1906.3 and the dimensions shown on the drawings.

Adhesive to wearing surface: Hot melt bitumen adhesive or an equivalent product approved by the Superintendent.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 ESTABLISHMENT

Colour

All pavement marking materials: White Y35 to AS 2700 with a luminance factor > 80% to AS 4049.3 unless otherwise specified.

Quartz: White, equivalent to or whiter than Y35, Off White to AS 2700 unless otherwise specified.

Setting out

Locations: Place all markings to conform with drawings, schedules or as directed.

Surface preparation

Clean dry surface: Apply pavement markings only to clean dry surfaces. Clean the surface to ensure a satisfactory bond between the markings and wearing surface of the pavement.

Existing material: If the existing surface is flaking or chipping, or in a condition where adhesion of the new material to the road surface cannot be guaranteed for the required life of the marking. Approval required for the extent and type of surface preparation required. This is a **HOLD POINT**.

Curing compound: If a curing compound has been applied, remove by physical abrasive means.

Wet weather: Do not carry out the pavement marking during wet weather or, if in the opinion of the Superintendent, rain is likely to fall during the process (unless otherwise directed). This is a **HOLD POINT**.

Concrete wearing surface: Lightly scabble the full area under each raised pavement marker to remove fine mortar material (laitance).

Provision for traffic and protection of work

Traffic: Provide for traffic, to conform with *1101 Control of traffic*, while undertaking the work.

Protection: Protect the pavement markings until the material has hardened sufficiently so that traffic will not cause damage.

Maintenance of pavement markings

Responsibility: Born by the Contractor for the maintenance, and replacement if necessary, of raised pavement markers and for all pavement marking during the contract period and the contract defects liability period.

4.3 PAINT MARKING

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: Apply uniformly and at the minimum dry film thickness as follows:

- Type B beads: 0.20 mm
- Type D beads: 0.30 mm. This is a **WITNESS POINT**.

Longitudinal lines

General: Conform to the following:

- Spray all longitudinal lines by an approved self propelled machine.

- Spray the two sets of lines forming a one-way or two-way barrier line pattern concurrently (unless otherwise directed by the superintendant).

Tolerances:

- Setting out: No more than 50 mm from the locations shown on the Drawings.
- Lengths: To any applicable local or state requirements and not vary by more than ± 50 mm.
- Widths: ± 5 mm.
- Gap between double lines: ± 10 mm.
- Beads for Longitudinal Lines: Conform to the following:
- Apply Type B glass beads to the surface of all longitudinal lines at a minimum application rate of 0.50 kg/m^2 immediately after the application of the paint.
- Set the actual application rate to overcome any loss of beads between the bead dispenser and the sprayed line.

Transverse lines

Tolerances:

- Setting out: No more than 50 mm from the locations shown on the drawings.
- Widths: ± 10 mm.
- Lengths: ± 10 mm.

Other markings

Dimensions: Conform to any applicable local or state requirements for the following:

- Arrows.
- Chevrons.
- Painted medians.
- Painted left turn islands.
- Speed markings.

Tolerance: Each dimension ± 50 mm.

Arrows and speed markings: Place square with the centreline of the traffic lane.

Hand spraying: Hand spraying with the use of templates (where necessary) to control the pattern and shape is to be permitted for transverse lines, symbols, legends, arrows and chevrons.

Beads for other markings:

- Type B glass beads to be similarly applied to all other paint markings at a minimum application rate of 0.30 kg/m^2 immediately after application of the paint by a method approved by the Superintendent.
- Type D glass beads to be similarly applied to all other markings at a minimum application rate off 0.5 kg/m^2.

Pavement marking appearance: Straight or with smooth, even curves where applicable. All edges to have a clean, sharp cut off.

Faulty application: Remove any marking material applied beyond the defined edge of the marking and leave a neat and smooth marking on the wearing surface of the pavement.

Field tests

Wet film thickness: To AS/NZS 1580.107.3 Method B, comb gauge.

Beads application: Check the application rate of glass beads by the method described in Annexure A.

4.4 QUARTZ APPLICATION

Anti-Skid material

Minimum application rate: To the **Application rate for quartz table**.

Surface application: Apply the quartz prior to the application of glass beads.

Application rate for quartz table

Material	**Transverse Lines**
0.4 – 0.7 white crushed quartz: - If stirred into the paint prior to application - If applied	 > 500 g/litre > 200 g/m²

4.5 THERMOPLASTIC MARKING

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: No more than six hours for hydrocarbon resins and four hours for wood and gum resins.

Rejection: Should over-heating occur and/or the time expire for molten materials, discard the thermoplastic material.

Tack coat

Requirement: If the wearing surface of the pavement is smooth or polished.

Application: In conformance with the recommendations of the thermoplastic manufacturer.

Timing: Immediately before the application of the thermoplastic material.

Longitudinal lines

General: Conform to the following:

- Spray all longitudinal lines (or extruded in the case of profiled markings) by a self propelled machine approved by the Superintendent.
- Spray the two sets of lines forming a one-way or two-way barrier line concurrently.
- Apply the thermoplastic material uniformly with a cold film thickness of 3.0 mm.

Tolerances:

- Setting out: No more than 50 mm from the locations shown on the drawings.
- Lengths: To any applicable local or state requirements and not vary by more than ± 50 mm.
- Widths: ± 5 mm. Negative tolerance of 10 mm is allowable for no more than 5% of the length of line.
- Gap between double lines: ± 10 mm.
- Thickness: ≥ 1.8 mm, sprayed or extruded.

Beads for longitudinal lines: Conform to the following:

- Apply Type B glass beads by air propulsion or gravity feed to the surface of all longitudinal lines at a net application rate of 0.30 kg/m^2 immediately after application of the thermoplastic material.
- Set the actual application rate to overcome any loss of beads between the bead dispenser and the sprayed line.
- Apply Type D glass beads at a minimum rate of 0.5 kg/m^2.

Transverse lines

Tolerances:

- Setting out: No more than 50 mm from the locations shown on the drawings.
- Widths: ± 10 mm.
- Lengths: ± 10 mm.
- Thickness: 3 mm ± 1 mm, screeded.

Other marking

Dimensions: Conform to any applicable local or state requirements for the following:

- Arrows.
- Chevrons.
- Painted medians.
- Painted left turn islands.
- Speed markings.

Tolerance:

- Each dimension ± 50 mm.
- Thickness: 3 mm ± 1 mm, screeded.

Application of thermoplastic materials and beads

Arrows and speed markings: Place square with the centreline of the traffic lane.

Application: Uniformly apply the thermoplastic material Cold film thickness: 3.5 mm.

Screed application: Apply the screeded thermoplastic material using a mobile applicator, approved by the Superintendent, using templates to control the pattern.

Pavement marking appearance: Straight or with smooth, even curves where applicable. Provide a clean, sharp cut off. to all edges.

Faulty application: Remove any marking material applied beyond the defined edge of the marking and leave a neat and smooth marking on the wearing surface of the pavement.

Beads

Scope: Other than longitudinal lines.

Application:

- Uniformly apply Type B glass beads to screeded markings at a minimum application rate of 0.30 kg/m^2 immediately after application of the thermoplastic material by a method approved by the Superintendent.
- Apply Type D glass beads at a minimum application rate of 0.50 kg/m^2.

Field testing

Thickness of thermoplastic material: Check the thickness of the cold film of thermoplastic material applied to the road pavement by measurement, using a vernier or suitable dry film thickness gauge. Measure the thickness of the thermoplastic material applied to a metal test plate and take the mean of at least six readings distributed over the test area.

Glass beads application rate: Check the application rate of glass beads applied to the surface of the markings by the method described in **Annexure A.** This is a **WITNESS POINT**.

4.6 TWO PART COLD APPLIED PAVEMENT MARKING

Apply primer: If the surface is concrete or is smooth or polished or where recommended by the manufacturer. Apply to the manufacturer's recommendations

Uniformly apply anti-skid material and glass beads onto the two part cold applied material while fluid and immediately after it has been applied to the pavement.

Separate bead applications: For longitudinal lines.

Method: Must ensure the retention of the beads in the material.

Application rate: As specified in the following table:

Table Application rates – two part cold applied pavement materials and glass beads

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) - Rate retained in the painted surface	 Type D-HR (adhesive coated) ≥ 400 g/m^2	 Type B ≥ 300 g/m^2	 Type B ≥ 300 g/m^2
1.0 – 2.0 mm anti-skid material	≥ 200 g/m^2		
0.4-0.7 mm anti-skid material		≥ 200 g/m^2	≥ 200 g/m^2
* Glass beads must be coated with a compatible coupling agent to form an improved adhesive bond with thermoplastic or PMMA (two part cold applied) road marking material.			

Longitudinal lines
Tolerances:
- Setting out: No more than 50 mm from the locations shown on the drawings.
- Lengths: To any applicable local or state requirements and not vary by more than ± 50 mm.
- Widths: ± 5 mm. Negative tolerance of 10 mm is allowable for no more than 5% of the length of line.
- Gap between double lines: ± 10 mm.

Transverse lines
Tolerances:
- Setting out: No more than 50 mm from the locations shown on the drawings.
- Widths: ± 10 mm.
- Lengths: ± 10 mm.

Field testing
Verify the thickness of the unbeaded material applied to the road pavement using Test Method RMS T841. This is a **WITNESS POINT**.

4.7 PAVEMENT MARKING TAPE

Application
Application: To conform with the manufacturer's recommendations.

Removal: When directed remove pavement marking tape to conform with the manufacturer's recommendations. This is a **WITNESS POINT**.

4.8 RAISED PAVEMENT MARKERS

Installation
Adhesive preparation: Freshly heat and mix the adhesive to the Manufacturer's instructions. Do not allow the adhesive to cool and do not reheat prior to use.

Application of adhesive: Spread the adhesive uniformly over the underside of the raised pavement marker to a depth of approximately 10 mm.

Adhesion of marker to pavement: Conform to the following:
- Press the raised pavement 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 raised pavement marker until the adhesive has set. This is a **WITNESS POINT**.

Rough surfaces
Locations: Newly laid coarse sprayed bituminous seals, and where directed by the Superintendent.

Adhesion of marker: Conform to the following:
- Apply an initial pad of adhesive of diameter 20 mm larger than the diameter of the base of the raised pavement marker.
- Apply the adhesive to fill the 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, as described above, and then press down the raised pavement marker onto the adhesive pad on the pavement surface to ensure good adhesion.

Tolerances:
- Longitudinal displacement: ± 20 mm.
- Lateral displacement: ± 20 mm.
- Directional: ± 4°.

4.9 REMOVAL OF REDUNDANT MARKINGS

Removal method
General: Conform to the following:
- Remove pavement markings without significant damage to the surface.
- Remove the markings in a 'block type manner, so as to avoid 'ghosted' images.
- Black out of markings only as a temporary measure and complete the removal within 48 hours.

- Submit the method of removal for approval by the Superintendent at least 24 hours before commencement of the work. This is a **HOLD POINT**.

4.10 LIMITS AND TOLERANCES

Application
Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause/subclause**
Setting out	≤ 50 mm from specified location	**Paint marking**
Longitudinal Lines		
- Length	To any applicable local or state requirements and not vary by more than ± 50 mm.	**Thermoplastic marking and Two part cold applied pavement marking material**
- Width	± 5 mm	**Thermoplastic marking and Two part cold applied pavement marking material**
Transverse lines		
- Length and width	± 10 mm.	**Thermoplastic marking and Two part cold applied pavement marking material**
Arrows, chevrons, painted medians, speed markings etc.	Each dimension ± 50 mm.	**Thermoplastic marking and Two part cold applied pavement marking material**
Application of paint		
- Film thickness	Depends on the beads to be used: For type B beads—minimum 0.2 mm dry film; For type D beads—minimum 0.3 mm dry film	**Pavement marking**
Application of thermoplastic		
- Longitudinal lines—Cold Film Thickness	≥ 1.8 mm, sprayed or extruded.	**Thermoplastic marking**
- Transverse Lines, Symbols, Arrows etc. Cold film thickness	3 mm ± 1 mm, screeded.	**Thermoplastic marking**
Glass beads		
- Volume used in operation	Minimum type B—0.30 kg/m^2 Minimum type D—0.50 kg/m^2	**Pavement marking**
- CAP	**Table Application rates** – Two part cold applied pavement materials and glass beads	**Two part cold applied pavement marking**

5 MEASUREMENT AND PAYMENT

5.1 MEASUREMENT

General

Payments made to the Schedule of Rates: To *0152 Schedule of rates – supply projects* all activities associated with completing the work detailed in this Worksection on a schedule of rates basis in accordance with **Pay Items 11911.1** to **1191.6**.

Lump Sum prices: Not acceptable.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology

The following methodology will be applied for measurement and payment:

- No additional payment is to be made for maintenance and replacement of pavement markers in accordance with **Maintenance of pavement markings**.
- Provision for traffic is measured and paid in accordance with this worksection and not *1101 Control of traffic*.

5.2 PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
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 centre line 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 -1191.2(1) Transverse lines -1191.2(2) Arrow -1191.2(3) Symbols -1191.2(4) Chevrons -1191.2(5) Kerbs -1191.2(6) Traffic Islands -1191.2(7) Legends	 Linear metres Each Each m² m m² Each or m²	Determine the extent of the painted surface by direct measurement of the markings as applied. All costs associated with the setting out of the work, all material, supply and application and traffic control.
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 -1191.4(1) Transverse lines -1191.4(2) Arrow -1191.4(3) Symbols	 Linear metres Each Each	Determine the extent of the thermoplastic material applied by direct measurement of the markings as applied. All costs associated with the setting out of the work, tack coating, supply and installation of all material and the provision for

Pay items	Unit of measurement	Schedule rate scope
-1191.4(4) Chevrons -1191.4(5) Kerbs -1191.4(6) Traffic Islands -1191.4(7) Legends	m² m m² Each or m²	traffic.
1191.5 Raised pavement markers (all applications)	'Each' raised pavement 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.

6 ANNEXURE A

6.1 GLASS BEADS

Types of glass beads

Type A beads (premix): Type A beads are mixed into road-marking material by the manufacturer prior to application, and are intended to provide retroreflectivity throughout the life of the marking. Mix these beads at a rate of not less than 30% by mass.

Type B beads (drop-on): Type B glass beads are applied under gravity or pressure as a surface application to a wet film of pavement marking to provide initial retroreflectivity.

Smooth substrate: Apply on a smooth substrate.

Application: A nominal rate of 270–300 g/m^2 may be appropriate, while a coarse surface substrate usually requires a higher application rate to achieve the required level of retroreflectivity.

Coated: These beads have a moisture-proof coating to facilitate flow and reduce the risk of 'caking''

Type C beads (intermix): Type C beads are mixed into thermoplastic road-marking material by the manufacturer prior to application, and are intended to provide retroreflectivity throughout the life of the marking.

Mix: Intermix these beads at a rate of not less than 20% by mass.

Type C: Type C beads may also be used for surface applications to a wet film of pavement marking to provide initial retroreflectivity. Apply on a smooth substrate. A nominal rate of 350 g/m^2 may be appropriate, while a coarse surface substrate usually requires a higher rate of application to achieve the required level of retroreflectivity. These beads are not moisture-proof coated, and, if used for surface applications, could 'cake' during handling.

Type D beads (large wet-weather beads): Type D glass beads are applied under gravity or pressure as a surface application to a wet film of pavement marking to provide initial retroreflectivity.

Substrate: Apply on a smooth substrate.

Application: A nominal rate of 500 g/m^2 may be appropriate, while a coarse surface substrate usually requires a higher rate of application to achieve the required level of retroreflectivity.

Coating: These beads have no moisture-proof coating and are, therefore, also suitable for intermixing into thermoplastic road-marking material to provide retroreflectivity in both dry and wet conditions, throughout the life of the marking. Intermix at a rate of not less than 20% by mass.

Measurement of application rate of spherical glass beads

Scope: Adopt the following procedure for field measurement of the rate of application of spherical glass beads on to wet paint or thermoplastic surfaces.

Spherical glass beads: To AS/NZS 2009.

Measurement: Use the following method of field measurement:

- Turn off the paint or thermoplastic supply valves and operate the glass bead dispenser for exactly 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 millilitres 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 the correct figure given in **Volume of glass beads (ml) required in 10 seconds of operation table**.

Volume required for 0.30 kg/m^2: The **Volume of glass beads (ml) required in 10 seconds of operation table** shows the correct volumes of glass beads required to give a net application rate on the marked line of approximately 0.30 kg/m^2 for different line widths and road speeds.

Volume required for 0.30 kg/m^2: The glass bead volume figures given in the **Volume of glass beads (ml) required in 10 seconds of operation table** are calculated for an actual application rate of 0.34 kg/m^2 . These figures 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.

Volume required for 0.50 kg/m^2: For the calibration of application rates to suit type D 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:
1 Tolerance of + 10% is be permissible when measuring the above volume.
2 When two or more glass bead dispensers are to be used, each dispenser is be checked separately to make up the totals shown.
3 Glass beads weigh approximately 1.53 g/ml.

1192 SIGNPOSTING

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Provide signs and support structures for Regulatory, Warning and Guide signs, proprietary Street Name and Community Facility Name Signs and adjust existing signs, as documented.

Performance

Requirements: Supply, erect and adjust the signs and support structures to conform with this worksection and as shown on the drawings.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

AS/NZS 1163-2009	Structural steel hollow sections.
AS 1214-1983	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: 2011	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°, 60° and 85°.
AS 1627	Metal finishing – Preparation and pre-treatment of surface
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 1742.5-1997	Street name and community facility name signs
AS 1743-2001	Road signs—Specifications.
AS 1744-1975	Forms of letters and numerals for road signs.
AS/NZS 1866: 1997	Aluminium and aluminium alloys—Extruded rod, bar, solid and hollow shapes.
AS/NZS 2311: 2009	Guide to painting of buildings.
AS 2700-2011	Colour standards for general purposes.
AS/NZS 3678:2011	Structural steel—Hot-rolled plates, floorplates and slabs.
AS/NZS 3679	Structural steel.
AS/NZS 3679.1:2010	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

1.4 STANDARDS

General
Standard: To AS 1742.

Road signs: To AS 1743.

Letters and numerals for road signs: AS 1744.

1.5 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Documents
- Proposed supplier.
- Materials and components: Submit alternatives for non-reflective materials where relevant.
- Execution details: Submit details of set-out.

1.6 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table.

Clause/subclause	Requirement	Notice for inspection	Release by
Street and community facility name signs			
Approval	Details of manufacturer materials and attachment systems	1 week prior to commencement of manufacture	Superintendent
Regulatory, warning and guide signs			
General	Evidence that materials and parts proposed comply with worksection requirements	1 week prior to engaging supplier	Superintendent
Retro-reflective material for background and legend	Details of material and compatibility in application and durability	1 week prior to ordering	Superintendent
Sign support structures			
General	Details of suppliers and evidence of structural conformity	1 week prior to engaging supplier	Superintendent
Attachment of signs	Details of proposed attachment systems	2 weeks prior to fabricating attachment systems	Superintendent
Footing reinforcement			
Steel reinforcement cages	Evidence of material conformity	1 week prior to fabrication	Superintendent
Off-site requirements			
Inspection	Notice of availability of	2 working days	Superintendent

Clause/subclause	Requirement	Notice for inspection	Release by
	sign structures for inspection		
Establishment			
Existing underground services	Locate services and protect against damage	1 week prior to erection	Superintendent
Location	Details of set-out	1 week prior to erection	Superintendent

WITNESS POINTS table – On site activities

Clause/subclause	Requirement	Notice for inspection
Footing reinforcement		
Steel reinforcement cages	Splicing location and method	3 working days before splicing bars
Clearing		
General	Clear vegetation after set-out on advice from Council's Tree Preservation Officer	3 working days before clearing
Sign structure footings		
Excavation	Excavation as shown on drawings and as directed, including disposal of material	1 working day before next activity
Erection		
Sign damage	Repair or replace damaged signs	1 week before installing signs
Adjustment of existing signs and support structures		
General	Conform to Drawings and Superintendent direction	1 week before adjusting signs

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program for works

Schedule: Signposts materials and on site locations.

Planning: Program the works to ensure adequate resources such as for control of traffic and locating existing underground services.

3 MATERIALS

3.1 STREET AND COMMUNITY FACILITY NAME SIGNS

Drawings

Information: Show the following information on drawings:

- Sign and legend selection and details.
- Support structures.
- Locations and mounting heights.

Standards

General: To AS 1742.5.

Road name: To AS/NZS 4819.

Speed control: To AS 1742.4.

Signage system
Local authority requirements:

- Conform to Council's adopted signage system.
- Incorporate the Council's logo, as supplied by the Superintendent.

Proprietary sign requirements
Manufacture and installation: To the requirements of AS 1742.5 Street Name and Community Facility Name Signs, to the following details:

Approval
Submission: Submit details of the manufacturer for all sign materials and sign attachment systems prior to commencement of sign manufacture. This is a **HOLD POINT**.

3.2 REGULATORY, WARNING AND GUIDE SIGNS

Drawings
Information: Show the following information on drawings:

- Sign and legend selection.
- Support structures of the following types:
  - Standard round galvanised steel posts of size 50, 65 or 80 mm nominal bore, fitted with a cap for waterproofing.
  - Purpose-designed steel structures as shown on the Drawings and manufactured to AS 4100.
- Anchor bolt assemblies.
- Locations and mounting heights.

Standards
Sign and legend dimensions and details: To AS 1743.

General
Supplier: Advise the names of the proposed suppliers of signs for the Superintendent's approval. Use suppliers who have previously established, or can now establish, their competence to carry out the work to conform with this worksection.

Proof of quality: Supply documentary evidence that all materials and parts proposed for use comply with the requirements of this worksection. This action is a **HOLD POINT**.

Temporary signs: Install temporary signs for the control of traffic nominated in *1101 Control of traffic*.

Sign blanks
Aluminium quality: Free of cracks, tears and other surface blemishes and the edges true and smooth.

Aluminium sheet alloy thickness of Sign blanks: 1.6 mm.

Type and temper: Type 5251 or Type 5052 and Temper H38 or Temper H36 to AS 1743.

The dimensions of the sign blank: ± 1.5 mm of the dimensions specified.

The 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 if size permits otherwise, construct a multipiece sign.

Multipiece sign: Construct as follows:

- Minimise the number of sheets butted with 1 mm maximum gap at any point along the joint.
- Cover all joints by a backing strip of the same material and colour as used for the sign blank and with a minimum width of 50 mm over the full length of the joint.
- Fix the backing strip to each sheet with rivets, colour matched and at 200 mm maximum spacings.

Aluminium extrusion as backing strip: The aluminium extrusion used for mounting may be used as the backing strip for horizontal joints where it complies with the spacing requirements.

Face treatment: Chemically clean and etch or mechanically abrade the face of each sign blank. If the sign blank is to receive a paint background, spray paint the face with a compatible primer.

Back treatment: Uncoat the back of each sign blank and render the surface finish dull and non-reflective either by mechanical or chemical means and free of scratches and blemishes.

Mounting: Supply the signs with square holes or aluminium extrusion backing for mounting purposes, at the centre spacings as shown on the drawings.

Aluminium extrusion backing

Design section: Include the special aluminium extruded sections, as shown on the drawings, for mounting purposes.

Aluminium Type: 6063-T5 to AS/NZS 1866.

Fixing: Fix the aluminium extrusion at the centre spacings as shown on the drawings and fix to the sign blank with colour matched rivets at 200 mm maximum spacings.

Rivets

Type: Domed head and shank of aluminium alloy with a steel mandrel.

Colour matching: Paint head and shank with alkyd enamel over an etch primer prior to insertion.

Retro-reflective material for background and legend

Approval: Required for the material and compatibility, both in application and durability. This is a **HOLD POINT**.

Standard: To AS 1743 for Class 1, Class 2 and Class 2A materials. Unless shown otherwise on the Drawings, provide Class 2 material.

Application: Apply retroreflective material to the sign blank to conform with the manufacturers recommended methods so that it is completely adhered without bubbles, cracks or blemishes.

Non-reflective background material—Background paint

Paint system:

- Primer: One coat 2-pack epoxy.
- Finishing coats: Two coats 2-pack polyurethane (B20) or acrylic polyurethane (B44).
- Standard: To AS/NZS 2311 clause 5.2.

Application: Apply the paint using conventional air spray application to give a uniform cover free of blemishes. A minimum dry film thickness of 38 microns is required when tested to conform with AS 1580.108.2.

Colours: To AS 1743 from one of the following AS 2700 colours:

- Red: R13 Signal Red.
- Yellow: Y14 Golden Yellow.
- Brown: X65 Dark Brown.
- Blue: B11 Rich Blue.
- Standard Green: G12 Holly Green.
- Freeway Green: Emerald.

Background colours: From one of the following AS 2700 colours:

- White—Gloss.
- ‘Dark’ Green—Matt Colour No G61.
- ‘Tourist’ Brown—Matt Colour No X65.
- ‘Dark Grey’—Matt Colour No N64.

Exact colorimetric values: To AS 2700.

Gloss levels:

- Matt coatings: Between 12 % - 15 % of gloss as determined by AS/NZS 1580.602.2, using an 85° head
- Gloss coatings: Between 85% - 95% of gloss as determined by AS/NZS 1580.602.2 using a 20° head.

Non-reflective background material—Background sheet material

Quality: Adhesive cast vinyl sheet material or other equivalent approved material can be provided in place of background paint. Provide material of uniform density compatible with the material provided for the legend, both in application and durability.

Colours and gloss: Provide uniform colours and gloss levels and conform to the requirements as above.

Application: Apply sheet material to the sign blank in accordance with the manufacturers recommended methods so that it is completely adhered without bubbles, cracks or blemishes.

Non-reflective material for legend—Legend screening ink

Quality: Provide high quality screening ink, full gloss, non-fade, non-bleed and scratch resistant type of ink compatible with the material to which it is applied. Provide screening ink with durability at least equal to the material to which the screening ink is applied.

Application: Apply screening ink legends to the background material in conformance with the manufacturers recommended methods.

Non-reflective material for legend—Legend sheet material

Quality: Adhesive cast vinyl sheet material or other equivalent approved material can be provided in place of screening ink. Provide material of uniform density and compatible with the material provided for the background both in application and durability.

Application: Apply sheet material legends to the background material in conformance with the manufacturers recommended methods so that it is completely adhered without bubbles, cracks or blemishes.

Non-reflective material for legend—Colours and finish

General: The requirements of **Regulatory, warning and guide signs** also apply to non-reflective materials for legends but additional colours complying with AS 2700 may be specified.

Reference markings

Identification code:

- 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: Between 6 and 10 mm.

Code location: At the rear face to the bottom left hand corner of rectangular signs and on or below the horizontal centre line to the left hand rear edge of other shaped signs.

Information required:

- Sign reference number.
- Manufacturer's Name.
- Month and Year of Manufacture.
- Manufacturer and Class of Retro-Reflective Material.

Proprietary signs: The requirements for reference markings do not apply to proprietary street name or community facility name signs.

Protection of signs

Protection: Protect the signs from damage during storage and transportation to site.

3.3 SIGN SUPPORT STRUCTURES

General

Scope: Provide materials, fabrication of components and protective treatment of the sign support structures and anchor bolt assemblies, and the supply and fabrication of footing reinforcement cages.

Approved supplier: Provide the following for approval:

- Names of the proposed suppliers of sign support structures.
- Proof of competence: Suppliers who have previously established, or can now establish, their competence to carry out the work to conform with this worksection.
- Proof of quality: Supply documentary evidence that all materials and parts proposed for use conform with the requirements of this worksection.
- Fabrication details proposed. This is a **HOLD POINT.**

Structure details: Provide details of the sign support structures under the Contract on the drawings.

Fabrication

Standards: Fabricate purpose-designed steel structures from steel sections to AS/NZS 1163, AS 3678 and AS/NZS 3679.1.

Splices: Conform to the following:

- Restrict splices in members to a maximum of one splice per member.
- Provide splices of full penetration butt welds.

Welding to AS 1554.1: Category SP for sign structure welds and Category GP for anchor bolt assemblies.

Anchor bolts: Fabricate anchor bolt assemblies for purpose-designed structures.

Finish: Finish all steelwork free from pitting, sharp corners and projections and clean of mill scale, loose rust and foreign particles.

Preparation for galvanising: Provide the following:

- Chemical clean to AS 1627.1.
- Abrasive blast cleaning to AS 1627.4.
- Grade: Sa 2 ½ to AS 1627.9.

Protective treatment

Galvanizing:

- Prefinished: Standard galvanised steel posts.
- Hot dip galvanizing after fabrication: All steel components including brackets and anchor bolt assemblies as follows:
  - Average minimum coating thickness of 85 microns and a bright finished surface free from white rust and stains, to AS/NZS 4680.
- Bolts and nuts: To AS 1214.

Splices in galvanized posts: Paint splices in standard galvanized steel posts by using an organic zinc-rich primer, or inorganic zinc silicate paint, in accordance with the repair requirements in Clause 8 of AS/NZS 4680.

Attachment of signs

Typical systems: Provide posts and other components with the required sign attachment holes or fittings to suit the typical attachment systems as shown on the drawings. Attach sign panels to each supporting member at each extrusion section or bolt hole in the sign panel.

Contractor's responsibility: Submit details of the proposed attachment systems for approval. This is a **HOLD POINT**.

3.4 FOOTING REINFORCEMENT

Steel reinforcement cages

Standards: To AS/NZS 4671.

Evidence of quality: Supply evidence that all materials conform with the requirements of this worksection. This is a **HOLD POINT**.

Cleanliness: Provide steel reinforcement free from loose or thick rust, grease, tar, paint, oil, mud, millscale, mortar or any other coating, but not to a smooth polished condition.

Accuracy: Bend reinforcement to the dimensions and shapes shown on the drawings. Do not permit heating of reinforcement for purposes of bending unless Grade 400 deformed bar reinforcement is specified.

Full bars: Furnish all reinforcement in the lengths indicated on the drawings. Splicing of bars will only be permitted with the approval of the Superintendent as to the location and method of splicing. This is a **WITNESS POINT**.

Splicing: Measure splicing in reinforcing fabric as the overlap between the outermost wire in each sheet of fabric transverse to the direction of splice, but not less than the pitch of the transverse wires plus 25 mm.

Welded splices and tack welding of bars: To AS 1554.

3.5 OFF-SITE REQUIREMENTS

Identification

Purpose-designed structure: Provide information as follows:

- Locations: The post column one metre above base plate, the outreach arm, and the sign support vertical fixing.
- Information shown:
  - Sign reference number.
  - Manufacturer's name.
  - Month and year of manufacture.
  - Drawing Number.

Marking: Legible, durable and applied by etching, stamping, engraving or welding.

Warranty: This marking is additional to date stamping required under **Sign structure warranty**.

Inspection

Pre-delivery Inspection: All purpose-designed structures covered by this worksection are subject to an inspection at the Contractor's Works prior to acceptance.

Notice: Notify the Superintendent of the availability of the sign structures for pre-storage or pre-delivery inspection. This is a **HOLD POINT**.

Inspection certificate

General: The Superintendent will issue the Contractor with a Certificate listing particulars of the items inspected.

The Certificate will indicate either:

- The sign structures satisfy the requirements of the worksection and are to be accepted; or
- The grounds for rejection of the goods.

Storage

Storage: Store the sign support structures and reinforcement cages until required to be incorporated into the Works or required by the Superintendent.

Store completed reinforcement cages under a waterproof shelter and supported above the surface of the ground, and protected from damage and from deterioration due to exposure.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

Minimise inconvenience

Minimise delay: Provide for traffic to conform with *1101 Control of traffic* while undertaking the work and organise the work to avoid or minimise delays and inconvenience to traffic, both vehicular and pedestrian.

Premature sign exposure

Secure 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 Superintendent directs that the sign is to be uncovered.

4.2 ESTABLISHMENT

Existing underground services

Services laid in proximity to the signs: Locate prior to placement of footings and erection of signs and protect services from damage. This is a **HOLD POINT**.

Location: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, for locating underground pipe and cables (possible within two working days). See www.1100.com.au.

Alignment

General: Comply with the following:

- Align signs approximately 5 degrees away from a right angle to the direction of traffic they are intended to serve.
- On curved alignments, determine the angle of placement by the course of approaching traffic rather than the orientation of the road at the point where the sign is located.

Location

General: Locate the signs as shown on the drawings or as directed by the Superintendent.

On site: Set out the work to ensure that all signs and support structures are placed as shown on the drawings or as directed by the Superintendent.

Submissions: Submit details of the set out and the proposed disposition and alignment of each sign support structure. This is a **HOLD POINT**.

4.3 CLEARING

General

Clearing vegetation: Following set out approval and advice from Council's Tree Preservation Officer clear and remove any trees and undergrowth within 3 m of the sign support structure and along a driver's line of sight to the front of the sign. This is a **WITNESS POINT**.

4.4 SIGN STRUCTURE FOOTINGS

Details

Construction: Construct the footings for a simple pipe support, or the footings for each post of a purpose-designed sign support structure, as shown on the drawings or as directed.

Excavation

Excavation and disposal: Neatly excavate footings to the depth and width shown on the drawings. Do not excavate by machine within 1 m of existing underground services. Dispose of the material from the excavation in an approved manner. This is a **WITNESS POINT**.

Anchor bolt assemblies

General:

- Accurately place and provide firm support.
- Provide anchor bolt assemblies with levelling nuts under the sign structure baseplates to allow adjustment of the structure after installation.
- Protect all exposed bolt threads from damage or adhesion of concrete during footing construction.

Steel reinforcement

General: Place steel reinforcement as shown on the drawings.

Concrete quality

Concrete in the footings of sign support structures: To *0319 Minor concrete works* and having a minimum compressive strength:

- 20 MPa at 28 days for pipe support footings.
- 32 MPa at 28 days for purpose-designed support footings.

Ready mixed concrete

Standard: If ready mixed concrete is used, mix and deliver to AS 1379.

4.5 ERECTION

Position and support

General: Accurately position and support all components during erection.

Top of post

Requirements: To conform with the following:

- Extend the top of each pipe support post beyond the upper extrusion section or bolt holes on the sign panels to enable 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 except where sign shape or the arrangement of sign panels dictates otherwise.

Sign damage

Protection: During erection, support and brace sign panels and protect the sign face from damage.

Repair: Repair signs damaged during erection to a standard equivalent to the original sign or replaced by the Contractor at the Contractor's cost. This is a **WITNESS POINT**.

Treatment of damaged areas

Protective treatment: To conform with the following:

- Scratched and slightly damaged areas not exceeding 2500 mm^2 on any one structure: Repair with an organic zinc-rich primer, or inorganic zinc silicate paint, to the repair requirements of AS/NZS 4680.
- Totally-damaged coating areas exceeding 2500 mm^2: Regalvanize.

4.6 ADJUSTMENT OF EXISTING SIGNS AND SUPPORT STRUCTURES

General

Adjustment of existing signs: Where shown on the drawings and where directed by the Superintendent, adjust existing sign panels and sign support structures. This is a **WITNESS POINT**.

Scope:

- Minor adjustments of sign panels and/or sign support structures.
- Dismantling of signs and sign support structures
- Relocation or replacement of sign support structures including footings and re-erection of signs.

4.7 SIGN STRUCTURE WARRANTY

General

Scope: Supply of any structure under this worksection.

Warranty period:12 months following the date of dispatch from the Contractor's Works to the Site.

Failed or defective structures: Obligations:

- Remove any sign structure which has failed in service or found defective within 12 months of the date of dispatch.
- Make good the defect or arrange to have the defect made good, and subsequently return and re-erect the good unit at the original location at no charge to the Principal.
- Unless otherwise agreed, process and return defective structures within 30 calendar days from the date the Contractor is notified by the Principal of the defect.

Warranty exclusion: 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 is not covered by warranty provisions.

Date of dispatch mark: In order to facilitate checking of warranty claims, legibly stamp, etch or engrave the date of dispatch from the Contractor's Works to the Site on all separate items of the sign structure.

Application: This warranty to apply notwithstanding any defects liability period provided for in the General Conditions of Contract.

4.8 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	Limits/Tolerances	Worksection Clause Reference
Sign blank		
Dimensions	± 1.50 mm of specified dimensions	**Regulatory, warning and guide signs**
Bow	< 0.5% of maximum dimension	**Regulatory, warning and guide signs**
Butt gap in multipiece sign	< 1 mm	**Regulatory, warning and guide signs**
Rivet spacing in backing strip	< 200 mm	**Regulatory, warning and guide signs**
Backing strip width	> 50 mm	**Regulatory, warning and guide signs**
Extrusion Backing		
Rivet Spacing	< 200 mm	**Regulatory, warning and guide signs**
Background Paint		
For matt coatings, gloss level	Between 12% - 15%	**Regulatory, warning and guide signs**

Activity	Limits/Tolerances	Worksection Clause Reference
For gloss coatings, gloss level	Between 85% - 95%	**Regulatory, warning and guide signs**
Reference marking		
Height of Coding	Between 6 mm - 10 mm	**Reference markings**
Sign Support Structures		
Protective Treatment thickness	> 85 microns	**Sign structures and anchor bolt assemblies**
Paint coating over Splices in standard galvanised posts	> 100 microns	**Sign structures and anchor bolt assemblies**
Damaged surface of galvanised surfaces:		
- Coating with zinc rich paint	Area < 2500 mm^2	**Erection**
- Regalvanise	Area > 2500 mm^2	**Erection**
Clearing		
Trees and Undergrowth to be cleared	< 3 m from sign support structure	**Clearing**
Concrete in footings of sign support structures		
Strength		**Sign structure footings**
- Pipe support footings	20 MPa at 28 days	**Sign structure footings**
- Purpose-designed support footings	32 MPa at 28 days	

1193 GUIDE POSTS

1 GENERAL

1.1 RESPONSIBILITIES

General

General: Provide guide posts including supply of materials, protective treatment, erection and attachment of delineators, as documented.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

AS 1604	Specification for preservative treatment.
AS 1604.1-2010	Sawn and round timber.
AS 1742	Manual of uniform traffic control devices
AS 1742.2-2009	Traffic control devices for general use
AS/NZS 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 2311: 2009	Guide to the painting of buildings.
AS 2858: 2008	Timber – Softwood – Visually stress – graded for structural purposes.
AS 3730	Guide to the properties of paints for buildings.
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.

1.4 STANDARDS

General

Standard: To AS 1742.2.

1.5 INTERPRETATION

Definitions

General: For the purposes of this worksection the definitions given below apply:

- Delineator: The small retroreflectors or panels of retroreflective sheeting that are attached to guideposts to provide a coherent pattern of delineation of the edges of the carriageway as an aid to night driving.
- Flexible guide post: A guide post that deflects when impacted by a vehicle and then returns to the vertical position, without maintenance intervention.
- Guide post: Posts 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 under some circumstances, by providing a gauge with which to assess available sight distance.

- Rigid guide post: A guide post which either fails by fracturing or remains intact and straight, but not vertical, when impacted by a vehicle.
- Semi-flexible guide post: A guide post which fails by bending when impacted by a vehicle and can be straightened with maintenance intervention.

1.6 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Documents
Requirement: Submit the following for approval:

- Materials:
  - Natural durability class and grade of timber posts.
  - Technical specifications and certificates of proprietary non-timber posts.
- Drawings: Set out for post locations.
- Execution details: Refer to **WITNESS POINTS – On-site activities**.

1.7 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause/subclause	Requirement	Notice for inspection	Release by
MATERIALS			
Proprietary posts (Non timber) – Proposed supplier	Proposal for supplier and manufacturer details	Two weeks before manufacture	Superintendent
EXECUTION			
Establishment – Existing underground services	Check for services	5 working days	Superintendent
Establishment – Location of guide posts	Locations shown on drawings or as specified	Two weeks before installation	Superintendent
Installation of guide posts – Guide posts on concrete pavements	Provide fixing details	5 working days	Superintendent
Installation of guide posts – Proprietary guideposts	Provide manufacturers anchorage instructions	5 working days	Superintendent

WITNESS POINTS table – On-site activities

Clause/ subclause	Requirement	Notice for inspection
MATERIAL		
Timber posts - Finish	Timber treatment inspection	1 working day - progressive
EXECUTION		
Installation of guide posts - Backfilling	Firm embedment in ground	Progressive
Delineators - Fixing	Arrangement of delineators relative to traffic direction	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Pre-planning

Schedule: Posts, treatment and locations.

Planning: Program the works to ensure adequate resources such as for the control of traffic and locating existing underground services.

3 MATERIALS

3.1 PROPRIETARY POSTS (NON-TIMBER)

Proposed supplier

Proposal: Provide the details of the proposed guide post including the following:

- Type of material.
- Manufacturer's recommended installation procedure.
- Technical specifications.
- Test certificates including post strength, flexibility, impact and heat and cold resistance and durability.
- Performance guarantee statement endorsed with the warranty period and the expected service life. This is a **HOLD POINT**.

Specification

Surface of posts: Durable gloss or semi-gloss opaque white. Whiter than Y35 Off White of AS 2700S. Smooth and easily cleaned finish.

Dimensions

Minimum height above ground surface: 1000 ± 100 mm.

Minimum width of the above ground section of the guide post: One face of 100 ± 5 mm.

Thickness: 50 ± 5 mm.

Anchorage

Certification: Ensure the guide posts resist bending, twisting and displacement due to wind and/or impact forces.

Resistance: They must be effective in resistance to vertical removal by persons other than personnel using recommended removal tools.

Physical properties and performance

Durability: No deterioration in physical properties of the guide post material after a minimum of 720 hours under accelerated weatherometer conditions.

Heat resistance: Flexible guide posts must not deflect more then 50 mm after being heated as in Heat resistance test.

Cold resistance: Semi-flexible and flexible guide posts must show no signs of fractures, cracks or splits when cooled as in Cold resistance test.

Rigidity: At 23℃ (± 2℃) the guide post must not be able to rotate in a clamp suited to the post profile.

Markings

Traceability: Each post must be legibly and indelibly marked with the following:

- Name of the supplier.
- Month and year of manufacture.

Letter Size: Must be between 5 and 10 mm high.

Placement: Place the markings on at least one side of the guide post and 500 mm from the top of the guide post.

Ground level for installation: Clearly mark guide posts 1000 mm from the top to show the ground level for installation.

End treatment

Top cap: Guide posts manufactured from thin walled hollow sections or sheet material of less than 10 mm thickness must each be fitted with a cap on the top of the guide post.

Dimensions: Caps must cover the whole top of the guide post with minimum dimensions 100 mm by 25 mm.

Type: The cap must be the same colour and durability as the guide post and be rounded with no sharp edges.

Attachment: Cap must be attached so that it cannot be dislodged from the guide post by a force of 500N pulling on the cap in a direction away from the post.

Plastic: The tops of guide posts manufactured from plastic must incorporate rounded edges and corners.

3.2 TIMBER POSTS

Description

General: Conform to the following:

- All surfaces: Smooth and free from obvious saw marks.
- Dimensions: 90 x 45 mm finished size x 1400 mm long.
- Post top: Slope the 90 mm face 10 mm off- square.

Natural durability class of the species supplied: To AS 5604.

Preservation treatment: Hazard class H4 to AS 1604.1 Table 1 to the following extent:

- 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.

Grade: Structural grade No.4 to AS 2082.

Softwood

Preservation treatment: Hazard class H4 to AS 1604.1 Table 1.

Grade: Structural grade No.5 to AS 2858.

Finish

Preparation: Stop holes, cracks and other imperfections with white putty after the primer coat.

Paint:

- Primer:
  - Wood primer, latex, one coat: To AS 3730.17. If posts are preservative treated, apply a first coat of solvent-borne primer followed by the latex primer.
- Undercoat:
  - Undercoat, latex exterior, one coat: To AS 3730.18.
- Top coat:
  - Gloss latex exterior, one coat: To AS 3730.10.

This is a **WITNESS POINT**.

Application: To AS 2311 Section 6.

Colour: White.

3.3 DELINEATORS

General

Standard: To AS/NZS 1906.2.

Type: Provide one of the following for each post:

- Corner-cubed: 80-85 mm diameter.
- Class 1A retroflective sheeting: Minimum 0.01 m^2 (minimum width 50 mm).

Delineator location: Centrally locate delineators between the edges of the guide posts and placed so that the top of each delineator is between 50 and 100 mm from the top of the guide post.

Fixings: Fix the delineators to the guide post so that they are weatherproof and vandal resistant and so that they can be replaced if necessary without damaging the guide post.

Impact damage: Corner cube delineators that can be damaged by vehicular impact must not be used on flexible or semi-flexible guide posts.

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.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 ESTABLISHMENT

Safety

Control of traffic: To *Control of traffic*.

Precautions: Take all necessary steps to prevent people and stock from stepping into the post holes during the erection of the guide posts.

Existing underground services

Excavation: Do not excavate by machine within 1 m of existing underground services.

Location: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, for locating underground pipe and cables (possible within two working days). See www.1100.com.au. This is a **HOLD POINT**.

Location of guide posts

Standard: To AS 1742.2 and as shown on the drawings.

Placement: Place the guide posts at a uniform distance from the pavement edge and as follows:

- If the shoulder is adjacent to an embankment or at the surrounding natural surface level, place the guide posts such that the inside edge is in line with the outside edge of the shoulder
- If the shoulder is located in a cutting, place the guide posts on the road pavement side of the table drain in such a manner as not to impede the flow of water in the drain. This is a **HOLD POINT**.

4.3 NON TIMBER POST TESTS PROCEDURES

Heat resistance – Flexible guide posts

Heat: Condition guide posts at 60℃(± 2℃) for 2 hours in an oven.

Test procedure: Conform with the following:

- Remove the guide post from the oven.
- clamp the base so that the guide post is vertical with the top of the guide 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.
- Subject the post to 3 cycles of bending through 180° all within 2 minutes of its removal from the oven.
- Finish the bending in a right angle.
- Release the post.
- Record the horizontal deflection at the top of the post from a vertical line 30 seconds after release from the bent position.

Tolerance: Deflection must not exceed 50 mm.

Physical condition: The post must show no signs of fractures, cracks or splits.

Cold resistance – Flexible not metallic guide posts

Cool: Condition the guide post at 0℃ (± 2℃) for 2 hours in an ice bath.

Test procedure: Conform with the following:

- Remove the guide post from the ice bath.
- 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 a semi-flexible guide post.
- Release the post from the clamp 60 seconds after removing it from the ice bath and place the guide post in the ice bath for an additional 60 seconds.
- Repeat the bending and ice bath four times.
- Release the post from the bent position and immediately record the horizontal deflection at the top of the guide post from a vertical line 60 seconds after release.

Tolerance: The deflection must not exceed 50 mm.

Physical condition: The post must show no signs of fractures, cracks or splits.

4.4 INSTALLATION OF GUIDE POSTS

Positioning

General: Set guide posts vertically in the shoulder pavement as follows:

- Embedded depth:
  - Rigid and timber guide posts: 500 mm.
  - Flexible and semi-flexible guide posts: 350 mm.
- Shoulder irregularities: Vary this depth so as to give uniform display of guide posts to a height of approximately 1000 mm above ground level, with the tops evenly graded.
- Install each guide post with the 100 mm axis at right angles to the centre line of the road.

Vertical alignment

Allowance: Make allowance in the height of guide posts above the ground for the effects of superelevation and other road geometry in order to keep the guide posts within the range of the beam of vehicle headlights.

Backfilling

General: Backfill guide posts firm in the ground as follows:

- Compact in layers not more than 150 mm for the full depth of the guide posts up to ground level.
- Density of the compacted backfilling: Not less than that of the adjacent undisturbed ground.

This is a **WITNESS POINT**.

Guide posts on concrete pavements

Submission: If the guide posts are installed on concrete pavements, provide details of fixing the guide posts to the concrete. This is a **HOLD POINT**.

Proprietary guideposts

Resistance to impact: Provide proprietary guideposts that, when installed in the ground conforming with the recommendations of the manufacturer, resist overturning, twisting and displacement from wind and impact forces. Provide manufacturers instructions for anchorage. This is a **HOLD POINT**.

4.5 DELINEATORS

Standard

Quality: Provide delineators to AS/NZS 1906.2.

Fixing

Timber posts: Attach ‘Corner Cubed’ delineators to each guide post using one way, anti-theft screws.

Proprietary posts: Provide a delineator fastening system that is not dislodged or rendered inactive under vehicular impact.

Position: Mount the delineators so that the top of the reflector is 50-100 mm below the top of the guide post.

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. This is a **WITNESS POINT**.

4.6 REMOVAL AND DISPOSAL OF EXISTING GUIDE POSTS

General

Extent: As shown on the drawings or as directed.

Removal: Include extracting all posts and other in-ground components and materials.

Backfilling: Backfill all holes after removal of existing guide posts and compact to the relative compaction of the surrounding shoulder material in layers of maximum depth of 150mm. Provide imported backfill material with similar characteristics to the shoulder material.

Disposal: All existing guide posts that are removed must be removed from site or otherwise disposed of as directed. Recycle existing posts manufactured from recyclable materials.

1194 NON-RIGID ROAD SAFETY BARRIER SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Provide non-rigid road safety barriers and terminals as documented.

Performance

Requirements: Supply and erect non rigid safety barriers and terminals to AS/NZS 3845 as shown on the drawings or as directed to conform with *0161 Quality (Construction)*.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1163 Rigid road safety barrier systems.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

AS 1214-1983	Hot-dip galvanised coatings on threaded fasteners (ISO metric course thread series)
AS 1237	Plain washers for metric bolts, screws and nuts for general purposes
AS 1237.1-2002	General plan
AS 1237.2-2002	Tolerances
AS/NZS1594:2002	Hot-rolled steel flat products
AS 1627	Metal finishing – Preparation and pre-treatment of surfaces
AS1627.4-2005	Abrasive cleaning of steel
AS1627.5-2003	Pickling
AS/NZS 1906	Retroreflective materials and devices for road traffic control purposes
AS/NZS 1906.2:2007	Retroreflective devices (Non pavement application)
AS 2858-2008	Timber–softwood – visually stress-graded for structural purposes
AS 2311-2009	Guide to the painting of buildings
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
AS/NZS 3845:1999	Road safety barrier systems
AS/NZS 4680:2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

1.4 STANDARDS

General

Standard: To AS/NZS 3845.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the abbreviations given below apply:

- MELT: Modified eccentric loader terminal.

Definitions

General: For the purposes of this worksection the definitions given below apply:

- Clear zone: The horizontal width of space available for the safe use of an errant vehicle which consists of the verge area and is measured from the nearside edge of the left-hand traffic lane. In the case of a divided road, it is also measured from the offside edge of the right-hand traffic lane to the edge of the pavement for opposing traffic.
- MELT: A public domain gating terminal.
- Non-rigid road safety barrier system: A road safety barrier system where elements are designed to move substantially in a crash, and where energy is absorbed by movement of the road safety barrier system and deformation of the vehicle.
- Thrie-beam: The triple corrugated beam component of a public domain non-rigid road safety barrier system.
- Transition beam: The corrugated beam used for the changeover from a thrie-beam road safety barrier system to a W-beam road safety barrier system.
- W-beam: The double corrugated beam component of a public domain non-rigid road safety barrier system.

1.6 SUBMISSIONS

Approval

Submissions: To the Superintendent's approval.

Documents

Submit the following for approval:

- Drawings:
  - . Set out details
  - . As built drawings
- Materials:
  - . Steel.
  - . Timber.
  - . Wire rope safety barrier systems.
  - . Plastic.
- Manuals: Installation and maintenance manuals for all proprietary barrier and end treatment systems used in the works.

1.7 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Item/Clause title	Requirement	Notice for inspection	Release by
Steel			
Certificates of compliance	Provide documentary evidence of conformity of steel components	1 week prior to erection	Superintendent
Protective treatment	Provide manufacturers certificate of compliance for galvanising	1 week prior to erection	Superintendent
Timber			
Certificates of	Provide documentary	1 week prior to erection	Superintendent

compliance	evidence of conformity of timber components		
Wire rope safety barrier systems			
Proprietary item	Submit compliance certification	1 week prior to erection	Superintendent
Existing underground services			
Location	Locate services underground	5 working days prior to erection	Superintendent
Establishment			
Method statement	Process description for the installation of road safety barrier systems	1 week prior to erection	Superintendent
Location of barriers	Set out to drawings or as directed	2 working days prior to erection	Superintendent
End treatment of road safety barriers			
MELT	Submit alternative MELT locations	1 week prior to ordering	Superintendent
Installation of wire rope safety barrier systems			
Manufacturers published requirements	Submit tension certificates and testing	Same day as tensioning	Superintendent

WITNESS POINTS table – On-site activities

Item	Requirement	Notice for inspection
Establishment		
Sequence of construction	Erection after pavement activities	1 week before installation – progressive
Alternative method of setting posts	Alternative method due to obstructions	1 week before setting posts
Erection of steel posts		
Driving equipment	Equipment and procedure for erection	1 week before installation
Damage to posts	Assessment by Superintendent for replacement	3 working days before removal of damaged post
Erection of road safety barrier systems		
Excessive damage to rails	Assessment and rejection by Superintendent	1 working day after perceived damage

2 PRE-CONSTRUCTION PLANNING

2.1 CERTIFICATES OF COMPLIANCE

Certificates of compliance

Certificates of compliance: Provide certificates from a NATA registered laboratory. All phases of any particular test to be performed at one laboratory. All relevant test results to accompany the Certificate and be within twelve months of the submission date.

2.2 SCHEDULING

Program of works

Requirement: Program the works as follows:

- Plan set out procedure and document.
- Identify underground services and submit any alternatives required for post re-location.
- Plan proprietary products and program availability.

3 MATERIALS

3.1 STEEL

Certificates of compliance

Certificates of compliance: Do not erect steel road safety barrier components until the Contractor has produced documentary evidence that the steel components conform to the requirements of this worksection. This is a **HOLD POINT**

Quality

Standard: W-beam and Thrie beam elements to AS/NZS 1594.

Steel components: Supply all steel components for public domain non-rigid road safety barrier systems, W-beam and Thrie-beam, to AS/NZS 3845 and of the type shown on the Drawings.

Flat washers: To AS 1237.1 and AS 1237.2.

Curving steel rail: Factory curved to conform with drawings. Carry out curving so that the galvanizing is not damaged.

Protective treatment

Treatment and galvanising: Unless otherwise stated for a specific proprietary safety barrier system or device, treat all surfaces of all ferrous metal components including posts, blockout pieces, rail elements, anchor plates, connectors and terminal pieces after fabrication to AS 1627.4 or AS 1627.5 and finish by hot-dip galvanizing to AS 4680. Galvanize all ferrous bolts, nuts, and washers to AS 1214, unless otherwise specified as high strength bolts.

Certificate of compliance: For galvanized steel components provide a manufacturers certificate of compliance certifying that the zinc coating mass conforms to AS/NZS 4680 or, for components of proprietary safety barrier system's or devices, to the manufacturer's recommendations. This is a **HOLD POINT**.

W-beam and Thrie-beam barriers

Standard: To AS/NZS 3845.

Storage

Protection: Store all materials, whether fabricated or not, so that damage and corrosion are prevented as follows:

- Store at least 200 mm above ground on platforms, slabs or other supports.
- Storage to prevent 'white rust' from freshly galvanised material.

Rejection: Rusted or bent or damaged steel will be rejected.

3.2 TIMBER

Certificates of compliance

Certificates of compliance: Do not erect timber road safety barrier components until the Contractor has produced documentary evidence that the timber components conform to this worksection. This is a **HOLD POINT**.

Quality

Location: Use timber posts only in W-beam terminal sections, as shown on the drawings.

Standard: Type, grade, size and treatment level to conform with AS/NZS 3845.

Quality: All surfaces smooth and free from obvious saw marks.

Storage: Do not store any timber posts/blockout blocks on top of the steel sections.

Finish

Preparation: Stop holes, cracks and other imperfections with white putty after the primer coat.

Paint: Conform to the following:

- Undercoat: Undercoat, latex exterior, one coat: To AS 3730.18.
- Top coat: Gloss latex exterior, one coat: To AS 3730.10.

Application: To AS 2311 Section 6.

Colour: Grey.

3.3 WIRE ROPE SAFETY BARRIER SYSTEMS

Proprietary Item

Conformance: Supply tensioned wire rope barrier systems as shown in the drawings.

Certification: Submit compliance certification by the manufacturer that the proposed wire rope barrier system meets all specified criteria. This is a **HOLD POINT**.

3.4 PLASTIC

General

Standard: Retroreflective materials to AS 1906.

Other items: Other plastic components to comply with the manufacturer's recommendations.

4 EXECUTION

4.1 EXISTING UNDERGROUND SERVICES

Location

Services laid in proximity to the barrier system: Locate prior to placement of footings and protect services from damage. This is a **HOLD POINT**.

Location: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, for locating underground pipe and cables (possible within two working days). See www.1100.com.au.

4.2 PROVISION FOR TRAFFIC

General

Requirement: To *1101 Control of traffic*.

Material stacks: Locate any temporary stacks of new or surplus material associated with the works clear of the traffic flow and behind the line of the safety barrier system being removed, under construction or for construction.

Works program: Manage the sequence for construction to ensure that there are no traffic hazards or safety issues for road users. This includes exposed ends of barriers and when leaving partially completed works at the end of the day.

4.3 QUALITY REQUIREMENTS

General

Standard: Construct non-rigid road safety barrier to AS/NZS 3845 except where explicit departures are shown on the drawings.

Waste: Remove all waste material from the site. Burning, burial or other disposal of waste material on site is not permitted.

4.4 ESTABLISHMENT

Sequence of construction

General: Erect road safety barriers after the construction of the base on concrete pavements and after the placing of the initial layer of asphaltic concrete or sprayed seal on a flexible pavement, unless otherwise approved. This is a **WITNESS POINT**.

Method statement

Submit: Prior to the installation of any road safety barrier system, submit a process description for the installation of road safety barrier systems. This is a **HOLD POINT**.

Location of barriers

Set out: Locate all road safety barriers and terminal sections to conform with the drawings or as directed by the Superintendent. Peg or paint mark the start and finish points and line of safety barrier, transitions and terminals including the line of flare if applicable. This is a **HOLD POINT**.

Post accuracy: Stand posts vertically and space so that no post movement is necessary to align holes or for any other reason when the safety barrier is erected.

Alternative methods of setting posts

Post depths: Set the posts to the full depth as shown on the drawings.

Alternative: If this is not possible due to the presence of an underground obstruction, submit an alternative method of setting the posts prior to carrying out the works. This is a **WITNESS POINT**.

4.5 ERECTION OF STEEL POSTS

Positioning of posts

Location: As shown on the drawings.

Top of the posts: To AS/NZS 3845 unless otherwise shown on the drawings.

Level of the posts: On terminal ends, level the posts to conform to the extended crossfall of the main pavement unless otherwise shown on the drawings.

Tolerance: Line the tops of posts within ± 20 mm of the heights specified. Ensure a smooth line both horizontally and vertically.

Foundation and testing

Foundations: Erect steel posts by driving, or by other means as directed, to AS/NZS 3845.

Open section: Point the open section of the post in the same direction as adjacent traffic.

Post holes: Compact the bottom of the holes to achieve the same density as the surrounding soil. Support the posts true to line and level whilst the holes are backfilled with clean, well graded, non-cementitious sub-base or base course granular material and compact to achieve the same density as the surrounding material.

Ground tolerance: 3 mm maximum movement in any direction when force tested to AS/NZS 3845.

Driving equipment

Equipment: Submit proposed details of driving equipment and helmet for driving steel posts and procedure to prevent damage to posts if installing by driving, for approval. This is a **WITNESS POINT**.

Damage to posts

Acceptable condition: No obvious deformation as a result of driving.

Repairs: Repair any damage that occurs to the posts within 24 hours using an organic zinc-rich primer to conform with the repair requirements of Clause 8 of AS/NZS 4680.

Rejected posts: Replace any post deemed excessively damaged and rejected by the Superintendent. This is a **WITNESS POINT**.

4.6 ERECTION OF TIMBER POSTS

Positioning of posts

Location: As shown on the drawings.

Top of the posts: To AS/NZS 3845 unless otherwise shown on the drawings.

Level of the posts: On terminal ends, level the posts to conform with extended crossfall of the main pavement unless otherwise shown on the drawings.

Tolerance: Line the tops of posts within ± 20 mm of the heights specified. Ensure a smooth line both horizontally and vertically.

Polystyrene foam

Wrap posts: Wrap the section of the timber posts to be cast into a reinforced concrete footing in 12 mm thick polystyrene foam sheeting before concrete casting.

Concrete Footings

Minimum compressive strength: 32 MPa at 28 days to conform with *0319 Minor concrete works*.

Footing size: 600 mm diameter to AS/NZS 3845.

Tolerance of footing: - 0 to + 50 mm depth.

Overbreak: Fill over-excavation and excessive depth with 32 MPa concrete at no cost to the Principal.

Reinforcing fabric

Specification: Wire fabric reinforcing as shown on the drawings.

4.7 ERECTION OF ROAD SAFETY BARRIER RAILS

Blockouts, rail laps and stiffening pieces

Blockouts: Erect steel blockout pieces with the open section pointing in the same direction as adjacent traffic.

Rail laps: Arrange all rail laps 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.

Minor damage to galvanising

Protection: Handle and erect road safety barrier rails and blockout pieces to prevent damage to the galvanising.

Repairs: Repair any minor damage to the galvanising within 24 hours using an organic zinc-rich primer to conform with the repair requirements of Clause 8 of AS/NZS 4680.

Excessive damage to rails or blockout pieces

Rejected: Replace any road safety barrier rails or blockout pieces deemed excessively damaged and rejected by the Superintendent. This is a **WITNESS POINT**.

Erection procedure

Initial tightening: Tighten road safety barrier rail attachment bolts and splice bolts sufficiently to erect the barrier.

Levelling: Make adjustments to the rails using the slotted holes provided to produce a smooth regular line, free of any kinks or bumps.

Top of rails: Overall line of the top of the safety barrier rails to conform with the vertical alignment of the road pavement.

Splice bolt tightening

Tightening: When the alignment both vertically and horizontally is obtained fully tighten the splice bolts. The bolt head (not the shoulder) must be in full bearing with the rail.

4.8 END TREATMENT OF ROAD SAFETY BARRIERS

Leading, trailing terminals

Locations: At both approach and departure ends of the road safety barrier, as detailed on the drawings.

Terminal sections

Locations: The approach and departure ends of double sided road safety barriers, as detailed on the drawings.

MELT

Locations: At approach end locations of road safety barriers as shown on the drawings.

Variation: Where the 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. Submit locations prior to ordering. This is a **HOLD POINT**.

Double sided safety barrier

Terminal sections: Locate terminal sections at the approach and departure ends of double sided road safety barriers as detailed on the drawings.

Connections to rigid barriers

Construction details: Connect non-rigid road safety barrier connections to rigid road safety barriers or bridge parapets as detailed on the drawings and specified in *1163 Rigid road safety barrier systems.*

4.9 INSTALLATION OF WIRE ROPE SAFETY BARRIER SYSTEMS

Manufacturer's published requirements

Installation: Install Wire Rope safety barrier systems to conform with the manufacturers specified requirements.

Concrete footings: Install all posts in concrete footings with suitable sockets including covers to the sockets. Do not use driven posts.

Intermediate blocks or tension bays: Install intermediate blocks or tension bays at the dimensions recommended by the manufacturer.

Footings: Installation to conform with the following:

- The manufacturers published requirements.
- Uniform shape.
- Unless specified otherwise by the manufacturer, no protrusion above the finished surface level by more than 20 mm.

Wire rope tension: Submit certification that the wire rope has been tensioned to conform with the manufacturer's published requirements. The certificate must include the date, time, ambient air temperature, tension force and signature and name of the individual managing the work at the time. This is a **HOLD POINT**.

4.10 DELINEATORS

Fixing

Standard: To AS 1906.2.

Locations: Fix delineators with brackets to the road safety barrier, to the details and at the locations shown on the drawings beginning at the first post and then to conform with the **Table Location of delineators**.

Table Location of delineators

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

Arrangement and colour

Direction of traffic: 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.

4.11 AS BUILT HANDOVER REQUIREMENTS

General

Manuals: Provide installation and maintenance manuals for all proprietary barrier and end treatment systems used in the works.

As built drawings: Include:

- Drawings.
- Proprietary safety barrier systems or end treatments: Detail the system, name and post spacing.
- Non proprietary end treatments: Detail the end treatment name and post types. If timber posts are used, detail the timber species and stress grade.

4.12 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause/ subclause**
Vertical alignment		
Tops of steel posts.	± 20 mm	**Erection of steel posts**
Tops of timber posts	± 20 mm	**Erection of timber posts**
Post movement	≤ 3 mm	**Erection of steel posts**
Concrete footings		
Diameter	0 to 50 mm	**Erection of timber posts**

1195 BOUNDARY FENCES FOR ROAD RESERVES

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide boundary fences for road reserves, as documented..

Performance
Requirements: Conform with drawings, this worksection, directions by the Superintendent all to conform with *0161 Quality (Construction)*.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1111 Clearing and grubbing.*
- *1192 Signposting.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection 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 – 2000	Bolts.
AS 1111.2 – 2000	Screws.
AS 1112 – Various	ISO Metric hexagon nuts.
AS/NZS 1163 – 2009	Structural steel – Hollow sections.
AS 1214 – 1983	Hot-dip galvanised coatings on threaded fasteners (ISO metric coarse thread series).
AS 1237	Plain washers for metric bolts, screws and nuts for general purposes.
AS 1237.1 – 2002	General plan.
AS 1237.2 – 2002	Tolerances.
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 – various	Specification for preservative treatment.
AS 1720 – various	Timber structures.
AS 1725	Chain-link fabric security fencing and gates.
AS 1725.1 – 2010	Security fences and gates – General requirements.
AS 1725.2 – 2010	Tennis court fencing – Commercial.
AS 1725.3 – 2010	Tennis court fencing – Private/residential.
AS 1725.4 – 2010	Cricket net fencing enclosures.
AS 1725.5 – 2010	Sports ground fencing – 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 2858 – 2008	Timber – Softwood – Visually stress – graded for structural purposes.
AS 3600 – 2009	Concrete structures.
AS/NZS 3750.9 – 2009	Paints for steel structures – organic zinc – rich primer.
AS/NZS 4680 – 2006	Hot-dip galvanised (zinc) coatings on fabricated ferrous articles.
AS/NZS 4792 – 2006	Hot-dip galvanised (zinc) coatings on ferrous hollow sections applied by a continuous or a specialised process.

1.4 STANDARDS

General

Standard: To AS 1725.1.

Security fences and gates: To 1725.1.

Tennis courts: To AS 1725.2 and AS 1725.3.

Cricket court: To AS 1725.4.

Sports ground: To AS 1725.5.

1.5 SUBMISSIONS

Approval

Submissions: To the Superintendent's approval.

Execution: Written approval for access to properties.

Materials: Posts, wire products, concrete, timber, gates.

1.6 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title / item	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Material selection – Material approval	Submit source, type, Certificate of compliance and manufacturer for each type of material	One week before ordering each type	Superintendent
EXECUTION			
Establishment			
- **General**	Confirm approval for access and work on adjacent property	One week before commencing site work	Superintendent
- **Temporary fencing**	No fence to be removed where risk of egress or ingress of stock	One week before commencing site work	Superintendent
- **Temporary fencing**	Maintain rabbit-proof fence at night and weekends	During works	Superintendent
- **Removal and disposal of surplus material and rubbish**	Approval required for burn off for combustible materials	Prior to burning	Superintendent
- **Clearing and grubbing**	Confirm approval for tree removal	One week before next activity	Superintendent
Erection of posts			
- **General**	Dial before you dig to check for underground services	3 working days prior to commencing digging or driving	Superintendent
– Depth of posts	Method of installing and	One week before	Superintendent

	proposed type of posts to be used	manufacture or order	
Erection of wires - General	Approval for any proprietary fasteners	One week before manufacture or order	Superintendent
Flood gates - general	Approval to proceed with flood gates and type	One week before fabricating flood gates	Superintendent
Stock grids - General	Approval for type and location of grid	One week before fabricating flood gate	Superintendent

WITNESS POINTS table – On site activities

Item	Requirement	Notice for inspection
MATERIALS		
Steel posts - Fence posts	Welding sites to be cleaned and painted	Progressive
Steel posts - Strainer posts / **Intermediate posts**	Dimension alternatives	3 working days before commencing works
Gates - General	Fitting alternatives	3 working days before fabrication
EXECUTION		
Establishment		
- **General**	Take precautions against damage and injury to animals or persons	Progressive
- **Removal of existing fencing**	Approval to cut posts in rock off at ground level	Before removing fence
- **Removal and disposal of surplus material and rubbish**	All surplus material to be removed	Progressive
- **Clearing and grubbing**	Vary fencing to avoid tree removal	One week before activity
- **Connections to existing fences**	Submit detail of proposed connection	One week before making connection
Erection of posts – Depth of posts	Check diameter of posts	One week before activity
Gates - Erection	Double gates to be directed	One week before ordering
Flood gates – Small water courses	Prevent erosion	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 MATERIAL SELECTION

Material approval

Submit: For each type of material required for supply, submit details of the source, manufacturer and type as applicable including the certificate of compliance. No material is to be delivered or used in the works until approved. This is a **HOLD POINT**.

Certificate of compliance

General: Identify the item, record the product certification, inspection or test records that verify conformance.

2.2 PROGRAMMING

General

- Schedule components and materials to be supplied.

- Program the construction to conform to contract requirements.
- Obtain approvals for access affecting work adjacent to the road reserve.

3 MATERIALS

3.1 STEEL POSTS

Steel tubes

Standard: To AS 1725.1 and AS/NZS 1163 and galvanized to AS/NZS 4792.

Type: Medium-quality pipe tube grade (C250L0) to the dimensions as shown on the drawings.

Fence posts

Standard: To AS 1725.1.

Type: Medium – quality.

Splicing: Any splicing required must be butt welded and located in the concrete not less than 150 mm below ground level.

Welding: Clean and paint all welding with a cold galvanizing compound (zinc rich paint). This is a **WITNESS POINT**.

Post extensions: To AS 1725.1 for barbed wire attachment.

Connections: If connections are not welded and are subjected to movement, protect the galvanised coatings from scratching caused by the connecting members.

Top caps: Fit each post with a galvanised steel cap to prevent the ingress of water.

Star posts (Rural fencing)

Type: 'STAR' pattern ('Y' bar section) drilled to suit the spacing of the wires shown on the drawing(s).

Protection: Black varnished or hot-dip galvanized to AS/NZS 4680.

Total weight: Total weight of 290 posts each 1.65 m long must be at least one (1) tonne.

Pipe rail for pipe rail fencing

Standard: To AS 1725.1.

Type:

- Nominal diameter: 32 mm.
- Outside diameter: 42.4 mm
- Alternatively, as shown on the drawings.

Joints: Only permitted for continuous top rail fencing greater than 6000 mm intervals. Tight fitting internal swagged or external sleeve joints or screwed and socket joints or butted together centrally over post within the fitting.

Strainer posts

Standard: To AS 1074 and galvanized to AS/NZS 4680.

Type: Medium grade tube.

Dimensions:

- Minimum diameter: 150 mm.
- Minimum wall thickness: 4 mm.
- Submit any alternate sizing. This is a **WITNESS POINT**.

Holes: Provide a set of 12 mm holes to suit the spacing of the wires shown on the drawings.

Intermediate posts

Standard: To AS 1074 and galvanized to AS 4680.

Type: Medium grade tube.

Dimensions:

- Minimum diameter: 150 mm.
- Minimum wall thickness: 4 mm.
- Submit any alternate sizing. This is a **WITNESS POINT**.

3.2 CHAIN WIRE AND WIRE NETTING

General

Standard: To AS 1725.1 and AS 2423.

Zinc coating: Uniform, continuous, free from imperfections, thoroughly adherent and applied to the wire before the mesh is woven.

Weight: Zinc coating weight ≥ 290 g/m^2 of wire surface.

PVC coating: Coated in black PVC after galvanizing where specified.

Wire netting used in rabbit-proof fencing

Type: 105 x 4 x 1.4 (1.065 m wide, 38 mm mesh, 1.40 mm diameter wire) unless documented elsewhere.

Wire netting used in gullies and creek crossings

Type: 90 x 5 x 1.6 (0.965 m wide, 51 mm mesh, 1.60 mm diameter wire) unless documented elsewhere.

Wire netting standard use

Type: 105 x 4 x 1.4 (1.05 m wide, 40 mm mesh, 1.40 mm diameter wire) unless documented elsewhere.

Chain wire used in Manproof fencing

Type: 15 m/1800 x 50 x 3.15/W10Z/HG/KK/HD (rolled length, width, pitch, diameter, metallic coating grade, protective coating system code, selvedge type, service duty) unless documented elsewhere.

3.3 GATES

General

Standard: To AS 1725.1 and hot dip galvanized to AS/NZS 4680.

Type: Galvanized tubular steel 3.6 m wide, 1.5 m or 1.2 m (as documented to match the height of the fence) in height.

Fittings: Substantial hinges, catch, drop bolts and locking chains unless otherwise shown on the drawings or as directed. This is a **WITNESS POINT**.

Joints: Fully welded fillet welds, minimum 6 mm exposed surface width and cleaned.

Rabbit proofing

Gates: Rabbit-proof mesh to a height of at least 900 mm above ground level.

3.4 REINFORCED CONCRETE POSTS

Precast strainer posts

Standard: To AS 3600.

Dimensions: 150 ×150 mm square in section and heights as shown on the drawings.

Holes in posts: 12 mm diameter holes to suit the spacing of the wires shown on the drawings.

Reinforcing steel: Reinforce longitudinally with at least 4 bars of 12 mm diameter, also suitable stirrup reinforcement to control diagonal cracking. As shown on the drawings.

Cover: Longitudinal reinforcement minimum cover = 20 mm. End cover on reinforcement = 20 mm.

Concrete strength: Minimum 28 day compressive strength of 32 MPa.

Precast intermediate posts

Dimensions: 100 x 100 mm square section and heights shown on drawings.

Reinforcing steel: Longitudinal reinforcing bars may be 9 mm diameter.

Similar: Cover, concrete strength and holes as for strainer posts.

3.5 PRESTRESSED CONCRETE POSTS

Strainer posts

Tendons: Provide at least 2 high tensile tendons tensioned to conform with the drawings.

Cover: At least 20 mm minimum longitudinal cover.

Cross section: Rectangular section 150 x 100 mm or as shown on the drawings.

Concrete: Minimum 28 day compressive strength of 32 MPa.

Grooves for wire: At least 5 mm deep and 5 mm wide at the surface of the post and to suit the spacing of the wires shown on the drawings.

Intermediate posts

Tendons: Provide a single high tensile tendon tensioned to conform with the drawings.

Cross section: 100 x 60 mm rectangular.

Grooves: At least 5 mm deep and 10 mm wide at the surface of the post and to suit the wires shown on the drawings.

3.6 TREATED TIMBER POSTS AND BRACES

General

Hardwood: To AS 2082.

Sawn timber: To AS 2858 and AS 1720 Grade F5.

Treatment: To AS 1604 hazard class H4, containing no mixtures or compounds of the elements chromium and arsenic.

Strainer posts, intermediate posts and bracing: As shown on drawings.

3.7 WIRES

Plain wire

Standard: To AS 2423.

Type: Low tensile fencing wire (Class W02 or greater, with coating type Z, ZA or E).

Diameters: As shown on the drawings.

High tensile plain wire

Standard: To AS 2423.

Type: High tensile fencing (Class W02 or greater, with coating type Z, ZA or E).

PVC coated wire

Core wire: As per plain or high tensile wire above and as specified on the drawings.

Standard: Apply coating to AS 2423.

Barbed wire

Standard: To AS 2423.

Type: Low tensile barbing wire 2.5 mm diameter galvanized drawn annealed steel wire (Class W02 or greater with coating type Z, ZA or E), with clusters of four barbs spaced between 75 and 110 mm.

Alternative: High tensile barbed wire (Class W02 or greater with coating type Z, ZA or E) of 1.6 mm diameter with clusters of barbs spaced between 75 and 110 mm.

Cable wire

Type: Three pairs of 2×3.15 mm galvanized iron wire tightly twisted around posts.

Location: As shown in the drawings.

Tie wire

Standard: To AS 2423.

Type: Low tensile (Class W02 or greater, with coating type Z, ZA or E) wire, 2 mm diameter galvanized wire.

3.8 MISCELLANEOUS HARDWARE

General

Standards: Conform to the following:

- Bolts and screws: To AS/NZS 1111.
- Cup head bolts: To AS/NZS 1390.
- Hexagon nuts: To AS 1112.
- Plain washers: To AS 1237.1 and AS 1237.2.
- Hot-dipped Galvanized threaded fasteners: To AS 1214.

Type: Commercial grade bolts, nuts and washers.

3.9 CONCRETE BACKFILLING

Backfilling

Concrete strength: 20 MPa minimum 28 day compressive strength to conform with the requirements of *0319 Minor concrete works*.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 ESTABLISHMENT

General

Access: Liaise with property owners, Council and Superintendent to get written approval to access properties for the activities of clearing, fence construction, removal and disposal of materials. This is a HOLD POINT.

Damage: The Contractor will be held responsible for any loss, damage, or injury to buildings, goods, crops, livestock, property of any kind or persons due to negligence by the Contractor. This is a **WITNESS POINT**.

Quality: Erect all fencing in a workmanlike manner, a sound, strong and neat appearance when complete.

Uniform grade: If minor irregularities occur in the ground levels, the vertical alignment of the fence is not to follow these irregularities. The fence must align to a uniform grade between definite changes in the natural slope of the ground.

Survey pegs: Leave all survey pegs undisturbed and adjust the post spacing where necessary to avoid pegs.

Stock proof: Maintain the fencing at all times in a condition secure against movement of stock, and take all necessary precautions to prevent people or stock from injury due to fencing activities.

Removal of existing fencing

Location: Remove existing fencing as shown on the drawings.

Posts in rock: Seek approval to neatly cut off at ground level. This is a **WITNESS POINT**.

Backfilling of old holes: Backfill all holes left after removal of old fence and compact firmly in layers of maximum depth 150 mm.

Rabbit-proof fence: Replace any buried netting with similar fencing and remove all traces of the old netting.

Temporary fencing

Stock fence: If there is a risk of egress or ingress of stock, do not remove fencing. Seek direction from Superintendent to supply temporary fencing. This is a **HOLD POINT**.

Rabbit-proof fence: Ensure that at night, weekends or other times when work is not being carried out, the whole of the fence is maintained in a rabbit-proof condition. Seek direction from Superintendent to supply temporary fencing. This is a **HOLD POINT**.

Type: Temporary fencing as documented and shown on the drawings for the new fencing. Use the same erection methods as for the final fencing.

Removal and disposal of surplus material and rubbish

Contractor's responsibility: Remove or otherwise dispose of all surplus material, offcuts, timber, roots and other debris resulting from the fencing contract to the satisfaction of the Superintendent. This is a **WITNESS POINT**.

Fire damage: Do not burn combustible materials without prior approval. If permitted, burn in conformance with local legislation. Thee Contractor is responsible for any damage which may result from the lighting of fires associated with the work. Do not burn any pre treated timber. This is a **HOLD POINT**.

Clearing and grubbing

Clearing: Clear a width of one metre on either side of the fence line, and for the full length of the line. Remove: All logs, boulders, stumps, roots, undergrowth and rubbish and dispose in conformance with *1111 Clearing and grubbing* except where directed otherwise.

Trees: Remove trees within this area only as directed by the Superintendent and approved by Council. This is a **HOLD POINT**.

Survey marks: Protect survey marks during the clearing operations.

Trees retained: If trees on or adjacent to the fence line are to be retained, arrange the fencing at the trees as directed. This is a **WITNESS POINT**.

Trees on fence line: Do not strain wire around or against any trees left in the fence line. Provide strainer posts on both sides of each tree.

Damage: Undertake clearing operations to ensure no damage to trees and native shrubs outside the limits of clearing specified.

Connections to existing fences

Submit: A proposal for connection arrangement where new fencing intersects with existing fencing. This is a **HOLD POINT**.

4.3 ERECTION OF POSTS

General

Steep locations: Erect all posts vertically except in unusually steep locations where posts may be erected perpendicular to the surface of the ground.

Contact: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, of locating underground pipe and cables (possible within two working days). See www.1100.com.au.

Locations: Obtain locations of water, sewer, stormwater, gas, electricity and telephone services. The Utility Authorities: In addition contact names listed in *0136 General Requirements (Construction)* to verify the location of services. This is a **HOLD POINT**.

Concrete for footings and base strips: Crown the top surface at each post to shed water away from the post.

Depth of posts

Method: Submit installation method and proposed type of post for approval. This is a **HOLD POINT**.

Sinking depths: Posts must be sunk or driven to the **Posts depth table**.

Posts depth table

Type of post	**Depth (mm)**	
	Earth	**Rock**
Concrete strainer posts	900	*600
Concrete intermediate posts	600	*450
Treated timber strainer posts	900	600
Treated timber intermediate posts	600	450
Galvanised steel strainer posts	900	*600
Galvanised steel intermediate posts	600	*450
Other steel posts	450	450
* NOTE Permitted only in cases where posts of the correct length are supplied, otherwise the depth of sinking must be the same as for earth.		

Damaged posts: If a post becomes significantly damaged or cannot be driven vertically, remove the post. Erect the same post, if undamaged, or a new post into neatly cut holes backfilled to the full depth with earth (where sunk in earth) or cement mortar or concrete (20 MPa) where in rock.

Posts sunk in earth: If posts are not driven into the earth, the diameter of hole must permit sufficient compaction of the backfill. Backfill earth in layers of 150 mm maximum depth for the full depth of the hole ensuring the relative compaction of the rammed material equals the original undisturbed ground.

Rock holes: Provide posts erected in rock holes with sufficient diameter to permit tight refilling with cement mortar or concrete.

Diameter: 250 mm unless otherwise shown on the drawings. This is a **WITNESS POINT**.

Strainer posts

Locations: Provide strainer posts at ends of fencing, angles, intersections with other fencing, gates and at intermediate points.

Distances between strainer posts: 120 metres 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 at intermediate points.

Drawings: Other strainer post arrangements as shown on the drawings.

Bracing: Conform to the following:

- Timber posts: Round timber as shown on the drawings.
- Other than timber posts: Medium weight galvanised steel tube to dimensions shown on the drawings.

Distance: Between intermediate point strainer posts < 120 m except in the case of fencing for the retention of cattle < 90 m.

Reinforced concrete posts

Foundation: Erect in neatly cut holes sunk in earth, or in rock where this is encountered.

Strainer posts: Backfill to the full depth of the hole with concrete of minimum compressive strength of 20 MPa at 28 days to the requirements of *0319 Minor concrete works*.

Intermediate posts: Backfill to the full depth of the hole with earth, where post is sunk in earth or with cement or concrete (20MPa at 28 days) where the post is sunk in rock.

Cement mortar: 1 cement : 2 sand.

Cutting: Cutting concrete posts is not permitted. To take advantage of the reduced sinking depth for rock, provide posts manufactured in shorter lengths to suit the depth of sinking.

Prestressed concrete posts

Erection: Either as for the reinforced concrete posts or driven in earth using a suitable post driver to hold the post vertical and in position during driving. Driving prestressed posts is not permitted except where shown on the drawings.

Protect whilst driving: Provide a steel cap with a plywood cushion not less than 12 mm thick to protect the top of the post during driving.

Cutting: Cutting concrete posts is not permitted. To take advantage of the reduced sinking depth for rock, provide posts manufactured in shorter lengths to suit the depth of sinking.

Steel posts

Driving: If not erected in rock, drive steel posts with suitable driving equipment taking care not to damage the tops of the posts during driving.

Damage to protection: Repair any damage to protective coating using an organic zinc-rich primer in conformance with AS 3750.9.

Rock: Erect posts in neatly cut holes and backfill to the full depth of the hole with cement mortar or 20 MPa concrete.

Treated timber posts

Erect: Similar to reinforced concrete posts or driven in earth using a suitable post driver. Ensure no damage to the post during driving.

Stiff earth: Drive posts in to holes of a diameter 50 mm less than the nominal maximum post diameter. Drive posts with the small diameter end down. If not driven, erect with butt end down.

4.4 ERECTION OF WIRES

Installation

Placement: Place all wires as shown on the drawings.

Side fixed wires: Place on the property owners side of the posts.

Fasten and strain: Securely fasten and strain wires to the following nominal tension between strainer posts using a wire strainer and gauge.

Table for wire tensions

Wire diameter (mm)	Type	Tension (kN)
4.0	Plain wire	1.8

Wire diameter (mm)	Type	Tension (kN)
2.5	H.T Plain wire	1.3
2.5	Barbed wire – L.T	1.3
1.6	Barbed wire – H.T	1.3

Strainer posts: Fix plain and barbed wire at strainer posts as shown on the drawings.

Secure end: Wrap wire at least four times around the tension side of the line.

Top strand: Tie barbed wire in position at the top of reinforced concrete intermediate posts and steel posts as shown on drawings. For timber posts fix to the top of the post using a galvanised staple minimum 40 mm long.

Fixing wires: Fix wires to the posts as shown on the drawings or by using proprietary galvanised fastening clips as approved. This is a **HOLD POINT**.

Prestressed concrete: Securely fasten wires so that they seat firmly in the grooves provided on the side of the posts.

Tie wire: Stretch tight and fit snugly against the side of the post to prevent movement of the wire. Wrap the ends of the tie wire at least twice around the line wire and neatly cut off. Form all joints in wire as figure-of-eight knots as shown on the drawings.

4.5 ERECTION OF NETTING AND CHAIN WIRE MESH

Netting

Side: Erect wire netting on the same side of the fence as the line wire.

Type: As shown on the drawings.

Attachment: Attach to the fence using 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. Tie to the wires immediately on each side of every post at intervals not exceeding 1.0 m.

Chain wire mesh

Location: Where documented, or shown on the drawings.

Side: Erect chain wire mesh on the outside of the posts.

Fastened: With two turns of the wire to each cable wire on both sides of each post and at intervals of not more than 900 mm between posts and to each post midway between cable wires.

Rabbit-proof fencing

Erect: As for netting and as shown on drawings.

Netting position: Erect wire netting on the side of the fence remote from the roadway in the case of road reserve boundary fences. In other cases, erect the netting as directed.

Fixing of netting: Fix netting with approved tie wire or fixing clips.

Straining and tying: Loosely tie the netting to fence wires then carefully strain without disturbing or breaking the mesh, and then tie to the wires immediately on each side of the post and at intervals not exceeding 1 m.

Bottom section: Bury, or lay flat on the ground, the bottom section of the netting as shown on the drawings.

Burying: If burying the net, excavate the trench prior to running the netting out.

Lap/Trench: Erect the netting so there is a 200 mm lap laid on the ground surface, or trenched 215 mm into the ground as shown on the drawings for the type of fence erected.

Strainer posts: At each strainer post brace attach additional netting adjacent to the strainer post to a height of the top wire 450 mm wide from the post as shown on the drawings.

4.6 GATES

Erection

Swing: Erect gates so that they swing away from the road.

Single gates: Supply single gates unless other wise shown on the drawings or as directed. This is a **WITNESS POINT**.

Level surface: At the location of gates and swing area, level the surface nearly horizontal.

Hanging: Hang the gates and provide with connections and fittings as documented or shown on the drawings.

4.7 FLOOD GATES

General

Waters: Make suitable provision for the passage of flood waters past the fence at all watercourses. Provide flood gates of the type indicated on the drawings, or as directed. This is a **HOLD POINT**.

Prevent: Erect flood gates to prevent the accumulation of flood debris, while remaining stock-proof or rabbit-proof.

Small watercourses

Type: Provide flap gate and support frame as shown on drawings or as directed.

Opening: Waterway area at least twice that of the culvert opposite to which it is placed, or as otherwise directed.

Width: < 3.0 m.

Construction detail: Provide a flap of hardwood frame with lapped corner joints each secured by two M6 galvanized bolts. Cover the frame with a 1 mm galvanised sheet secured to the frame by 25 x 2.8 mm galvanised 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 galvanised cup head bolts.

Erosion: Protect the lower edge of the opening from the effects of erosion of the creek bed by installing hardwood sheeting to a minimum depth of 300 mm below the existing ground level and as shown on the drawings. This is a **WITNESS POINT**.

Gullies and creeks

Location: Provide flood gates in gullies and creeks at the locations indicated on the drawings, or as directed.

Construction detail: Suspend a 9 mm galvanised 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. Provide end connections incorporating a thimble and wire rope grips. Provide turnbuckles 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. Provide netting with sufficient length to lie on the ground for a distance of not less than 1.0 m on the downstream side.

Netting ballast: 150 mm diameter treated timber securely fixed to the netting with 25 mm galvanised staples at the downstream end of the netting.

Trim: Trim the sides of the gully, as necessary, to ensure that the flood gate is stock-proof or rabbit-proof.

Flow: Make sure the flood gate has sufficient movement of the suspended portion 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, as shown on the drawings.

4.8 STOCK GRIDS

General

Location: Where shown on the drawings, or as directed. This is a **HOLD POINT**.

Bedding: Evenly bed the grid base on a continuous layer of 50 mm thick compacted sand or other granular material with a maximum size of 5 mm. Compact bedding material to achieve a density index as determined by AS 1289.5.6.1 of not less than 70%.

Raised abutments: Install grids on raised abutments with approach ramps where possible.

Alternative: Grid may be placed over an excavated pit, in which case adequate drainage must be provided.

Transition: Ensure smooth transition from grid to ground.

Dispose: Dispose of any excavated material.

Single lane grids: No crossfall.

Two lane grids: Each half of the grillage must have a crossfall conforming to the cross fall of the approach road.

Extent of work: The cattle grid construction includes all activities associated with the cattle grid including any adjustments to the fencing as shown on the drawings.

Advance signposting: To AS 1742.2 and *1192 Signposting* on each approach to the cattle grid.

4.9 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause Reference**
Steel posts	Type: Medium quality Star posts: Weight of 290 posts 1.65 m long > 1 tonne Pipe rail: Diameter nominal = 32 mm Strainer posts: Diameter = 150 mm Wall thickness > 4 mm	**Materials – Steel posts**
Zinc coating	Zinc coating weight ≥ 290 g/sq m of wire surface	**Materials – Chain wire netting**
Reinforced concrete posts	Concrete strength > 32 MPa at 28 days	**Materials – Reinforced concrete posts**
Prestressed Concrete posts	Strainer longitudinal cover > 20 mm Concrete strength > 32 MPa at 28 days	**Materials – Prestressed concrete posts**
Depth of posts	See Table Post depth	**Erection of posts**
Backfill	Concrete strength > 20 MPa at 28 days	**Erection of posts**
Strainer posts	Distance between strainer posts < 120 m Except for cattle retention < 90 m	**Erection of posts**
Wires	Table for wire tensions	**Erection of wires**
Flood gates	For small watercourses width < 3.0 m	**Flood gates**

1196 STREET LIGHTING

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide road lighting and electrical systems as documented.

Designer
Qualifications: Use only persons appropriately experienced and qualified to undertake the lighting and electrical design work on the systems documented.

Authority requirements
General: Liaise with and comply with the requirements of the local network distributor.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1151 Road openings and restoration.*
- *1152 Road openings and restoration (utilities).*
- *1391 Service conduits*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS/NZS 1158	Lighting for roads and public spaces
AS/NZS 1158.3.1:2005	Pedestrian area (Category P) lighting - Performance and design requirements
AS/NZS 1158.6:2010	Luminaires
AS 1798-1992	Lighting poles and bracket arms - Preferred dimensions
AS 3600-2009	Concrete structures
AS 4100-1998	Steel structures
AS/NZS 4676:2000	Structural design requirements for utility services poles
AS/NZS 4680:2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.
AS/NZS 4782	Double-capped fluorescent lamps - Performance specifications
AS/NZS 4782.2:2004	Minimum Energy Performance Standard (MEPS)
AS/NZS 4783	Performance of electrical lighting equipment - Ballasts for fluorescent lamps
AS/NZS 4783.2:2002	Energy labelling and minimum energy performance standards requirements
AS/NZS 4847	Self-ballasted lamps for general lighting services
AS/NZS 4847.2:2010	Minimum Energy Performance Standards (MEPS) requirements

Other publications
AUSTROADS

AGRD04-09	Guide to road design Part 4 – Intersections and crossings - General
AGRD06B-09	Guide to road design Part 6B – Roadside environment.

1.4 STANDARDS

General

Standard: Conform to the following:

- AS/NZS 1158 series.
- AGRD04 Guide to road design Part 4 – Intersections and crossings - General
- AGRD06B Guide to road design Part 6B – Roadside environment.

1.5 SUBMISSIONS

Approval

Submissions: To the Superintendent's approval.

Compliance certificate: Submit a compliance certificate stating that all works have been completed as specified to this worksection and the local network provider

General: Carry out verification tests and measurements to show compliance with the documentation.

1.6 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
Provision of traffic	Traffic guidance scheme	2 weeks	Superintendent
Luminaires	Manufacturers information		Superintendent
Lighting supports	Anchor bolt assembly approval	1 working day	Superintendent

2 PRE-CONSTRUCTION PLANNING

2.1 NETWORK DISTRIBUTION

General

Approvals: Obtain documented approval of the design from the local network distributor.

3 MATERIALS

3.1 GENERAL

Standards

Materials: All materials to the Network Distributors standards.

3.2 FOOTINGS

Concrete

Concrete, reinforcement and formwork: To *0319 Minor concrete works* and the requirements of the street lighting column manufacturer.

Compressive strength of concrete: 25 MPa.

Anchor bolts

Anchor bolt assemblies: Hot dip galvanised after fabrication in accordance with the drawings and the manufacturers recommendations.

Welding: To AS/NZS 1554.1 Category GP.

Hot dip galvanised: To AS/NZS 4680 with minimum thickness 100 µm and a bright finished appearance free from all galvanising defects.

Treatment prior to galvanising: To AS 1627.1 and AS 1627.4 (class 2.5 Blast).

Galvanised bolts, nuts and washers: To AS 1214.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Control of traffic: Conform to the following:

- Conform with *1101 Control of traffic*.
- Conform with **Traffic Guidance Scheme** in *1101 Control of traffic*. This is a **HOLD POINT**.

4.2 ESTABLISHMENT

Protection of services and utilities

Locate and protect services: Insure that all services and utilities have been located and protected prior to carrying out any excavation work.

Repair at Contractor's cost: Any damages incurred as a result of the Contractor's failure to locate a service or utility to be repaired at the Contractor's cost.

4.3 LIGHTING DESIGN

General

Standard: To AS/NZS 1158 series and Austroads AGRD06B.

Lighting category: To AS/NZS 1158.3.1.

4.4 LUMINAIRES

General

Standard: Lighting to AS/NZS 1158.6.

Proprietary equipment: Provide manufacturers information for luminaires, fittings and accessories. This is a **HOLD POINT**.

Minimum energy performance standards

Performance of electrical lighting equipment: To AS/NZS 4783.2 and AS/NZS 4782.2.

Self-ballasted lamps: To AS/NZS 4847.2.

Lamps

Lamps: Provide all luminaires complete with lamps and accessories.

Lighting control system

Control: Provide local or integrated photo electric control of each luminaire.

Installation

Mounting: Mount luminaires on proprietary supports as documented.

Completion

Replacement of lamps: At the time of practical completion verify the operation of all luminaires. Replace lamps which have been in service at the time of practical completion for a period > 50% of the lamp life as published by the lamp manufacturer.

4.5 LIGHTING SUPPORTS

General

Free standing luminaires: Provide columns for free standing road lighting luminaires including in situ reinforced concrete footings as specified.

Luminaires on network power poles: Mount luminaires with proprietary hardware on network power poles to confirm with network distributors standards.

Footings for street lighting columns

Location: Construct concrete footings at the locations for street lighting columns as shown on the drawings.

Excavation: Excavate footings neatly from solid material. Compact to 90% maximum dry density.

Dimensions: Construct footings to the dimensions and embedment details as shown on the drawings.

Anchor bolt assembly: Locate accurately and firmly support the anchor bolt assembly.

Concrete supply and placement: To *0319 Minor concrete works*.

Electrical conduits: Ensure all conduits have large radius bends through the footing. No elbow bends.

Approval: Do not place concrete until the formwork and anchor bolt assembly location have been approved. This is **HOLD POINT**.

Columns

General: Conform to the following standards for fabricated columns:

- AS 1798 for public lighting poles.
- AS 3600 for concrete structures.
- AS 4100 for steel structures.
- AS/NZS 4676 for structural design of columns.
- AS 4680 for hot-dipped galvanized (zinc) coatings on ferrous articles.

4.6 POWER SUPPLY

Connection

Local network system: Provide power supply and connection to each luminaire from the local network distributor's low voltage system to conform with the network distributor's standards.

Earthing: Provide earthing to meet the requirements of the local power supply authority.

1341 WATER SUPPLY – RETICULATION (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide water supply transfer, distribution and reticulation works in the location, to the lines, levels, grades and using the materials as documented.

Precedence
Precedence: The technical requirements of, or any standard drawing provided by, the Water Authority, used in conjunction with and in conflict with this worksection, take precedence.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0257 Landscape – roadways and street trees.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1102 Control of erosion and sedimentation.*
- *1112 Earthworks (Roadways).*
- *1152 Road opening and restoration (Utilities).*
- *1392 Trenchless conduit installation.*

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

Standards

AS 1141	Methods for sampling and testing aggregates
AS 1141.22-2008	Wet/dry strength variation
AS 1141.32-2008	Weak particles (including clay lumps, soft and friable particles) in coarse aggregates
AS 1214-1983	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS 1281-2001	Cement mortar lining of steel pipes and fittings
AS 1289	Methods for testing soils for engineering purposes
AS 1289.4.3.1-1997	Soil chemical tests - Determination of the pH value of a soil - Electrometric method
AS 1289.4.4.1-1997	Soil chemical tests - Determination of the electrical resistivity of a soil - Method for sands and granular materials
AS 1289.5.6.1-1998	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 1432-2004	Copper tubes for plumbing, gas fitting and drainage applications
AS/NZS 1477: 2006	PVC pipes and fittings for pressure applications
AS/NZS 1554	Structural steel welding
AS/NZS 1554.1:2011	Welding of steel structures
AS 1579-2001	Arc-welded steel pipes and fittings for water and waste-water
AS 1627	Metal finishing—Preparation and pre-treatment of surfaces

AS 1627.4-2005	Abrasive blast cleaning of steel
AS 1646-2007	Elastomeric seals for waterworks purposes
AS 1657-1992	Fixed platforms, walkways, stairways and ladders—Design, construction and installation
AS/NZS 2032:2006	Installation of PVC pipe systems
AS/NZS 2033:2008	Installation of polyethylene pipe systems
AS 2129-2000	Flanges for pipes, valves and fittings
AS/NZS 2280:2004	Ductile iron pipes and fittings
AS/NZS 2566	Buried flexible pipelines
AS/NZS 2566.2:2002	Installation
AS/NZS 2638	Gate valves for waterworks purposes
AS/NZS 2638.1:2011	Metal seated
AS/NZS 2638.2:2011	Resilient seated
AS 2832	Cathodic protection of metals
AS 2832.1-2004	Pipes and cables
AS 2832.2-2003	Compact buried structures
AS/NZS 3500	Plumbing and Drainage
AS/NZS 3500.1:2003	Water services
AS/NZS 3518:2004	Acrylonitrile butadiene styrene (ABS) compounds, pipes and fittings for pressure applications
AS 3571	Plastics piping systems - Glass-reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin
AS 3571.2-2009	Pressure and non-pressure water supply (ISO 10639:2004, MOD)
AS 3600-2009	Concrete structures
AS 3681-2008	Application of polyethylene sleeving for ductile iron piping
AS 3688-2005	Water supply - Metallic fittings and end connectors
AS/NZS 3690:2009	Installation of ABS pipe systems
AS 3705-2012	Geotextiles - Identification, marking, and general data
AS/NZS 3750	Paints for steel structures
AS/NZS 3750.4:1994	Bitumen paint
AS/NZS 3750.19:2008	Metal primer - General purpose
AS/NZS 3862:2002	External fusion-bonded epoxy coating for steel pipes
AS/NZS 3879:2011	Solvent cements and priming fluids for use with unplasticised PVC (PVC-U and PVC-M) and ABS and ASA pipes and fittings
AS 3952-2002	Water supply–Spring hydrant valve for waterworks purposes
AS 3996-2006	Access covers and grates
AS/NZS 4020:2005	Testing of products for use in contact with drinking water
AS/NZS 4087:2011	Metallic flanges for waterworks purposes
AS/NZS 4129:2008	Fittings for polyethylene (PE) pipes for pressure applications
AS/NZS 4130:2009	Polyethylene (PE) pipes for pressure applications
AS/NZS 4158:2003	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS 4321-2001	Fusion-bonded medium-density polyethylene coating and lining for pipes and fittings
AS/NZS 4331	Metallic flanges
AS/NZS 4331.1:1995	Steel flanges
AS/NZS 4441:2008	Oriented PVC (PVC-O) pipes for pressure applications
AS/NZS 4680:2006	Hot-dipped galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4765:2007	Modified PVC (PVC-M) pipes for pressure applications
AS 4794-2001	Non-return valves—Swing check and tilting disc
AS 4795	Butterfly valves for waterworks purposes
AS 4795.1-2011	Wafer and lugged
AS 4795.2-2011	Double flanged
AS 4796-2001	Water supply - Metal bodied and plastic bodied ball valves for property service connection
AS 4809-2003	Copper pipe and fittings - Installation and commissioning
AS 4956-2008	Air valves for water supply
AS 5081-2008	Hydraulically operated automatic control valves for waterworks purposes
AS 6401-2003	Knife gate valves for waterworks purposes
ASTM A240/A240M:2012	Standard specification for chromium and chromium-nickel stainless steel plate, sheet and strip for pressure vessels and for general applications

ASTM A276:2010	Standard Specification for Stainless Steel Bars and Shapes
BS 3416-1991	Specification for bitumen-based coatings for cold application, suitable for use in contact with potable water

Other publications

Plastics Industry Pipe Association (PIPA)

POP001: 2011	Electrofusion jointing of PE pipe and fittings for pressure applications
POP003: 2011	Butt fusion jointing of PE pipes and fittings - recommended parameters
POP007: 2006	Metal backing flanges for use with polyethylene (PE) pipe flange adaptors
POP102: 2009	Solvent cement jointing of PVC pipe
POP202: 2008	PVC and PE pressure pipe installation on curved alignments

Water Services Association of Australia (WSAA)

WSA 03: 2011	Water Supply Code of Australia version 3.1

1.4 STANDARDS

General

Standard: To WSA 03 Part 2.

PVC installation: To AS/NZS 2032.

PE installation: To AS/NZS 2033.

ABS installation: To AS/NZS 3690.

Copper pipe and fittings installation: To AS 4809.

1.5 INTERPRETATIONS

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- ABS: Acrylonitrile Butadiene Styrene.
- DI: Ductile Iron.
- GRP: Glass Reinforced Plastic.
- PE: Polyethylene.
- PVC: Polyvinyl Chloride.

Definitions

General: For the purposes of this worksection the definitions given in WSA 03 and the following apply:

- Commissioning: Running the plant and equipment to make sure there is flow through the reticulation system, carrying out any necessary testing and adjustments until it is ready and suitable for normal starting and running under service conditions.
- Inadequate foundation material: Material beneath or adjacent to the proposed drainage structures which the Superintendent deems to be of insufficient strength to support the structure and loads on the structure, or material whose characteristics the Superintendent deems would adversely affect the performance or construction of the drainage structure.
- Nominal size (DN): Dimensionless whole number, which is indirectly related to the physical size, in mm of the bore or outside diameter of the end connections.
- Pre-commissioning: Preparation of plant or equipment so that it is in a safe and proper condition and ready for commissioning and operation. It includes all aspects of plant operation such as safety, electrical, mechanical and instrumentation.
- Section: A length of pipeline which can be effectively isolated for testing, e.g. by means of main stop valves.
- Selected material zone: The top part of the upper zone of formation in which material of a specified higher quality is required.
- Water Agency: An authority, board, business, corporation, Council or local government body with the responsibility for planning or defining, design, construction and maintenance requirements for a water supply and/or sewerage systems.

1.6 SUBMISSIONS

Approvals

Submissions: To the Superintendent's approval. Submit the following for approval:

- Calculations: Survey set out of water supply works and quantity calculations.

- Components: Pipes and fittings.
- Work-as-executed drawings: Include water supply system information sheets and works.
- Execution details: Refer to **HOLD POINTS**.
- Materials: Off-site certificates of components.
- Samples: For conformity testing to relevant standards.
- Technical data: Product information.

1.7 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/ Item	Requirement	Notice for inspection	Release by
MATERIALS			
General			
Authorised products and materials	Submit for approval alternative products and materials.	2 weeks before ordering	Superintendent
Recycled materials	Submit for approval proposed recycle material	2 weeks before ordering	Superintendent
EXECUTION			
Establishment			
Excavation near underground services – Public utilities within the excavation for water supply systems	Approval from relevant Authority for the method of excavation.	1 week	Superintendent
Excavation near underground services – Marking	Locate and mark existing underground services	3 working days	Superintendent
Excavation near underground services – Protection of other services	Give notice of any interference to the works caused by an existing service and submit a proposed work method statement.	1 week	Superintendent
Excavation for water supply systems			
General – Confirm surrounding soil type with design	Confirm surrounding soil type with design.	1 week	Superintendent
General – Excavation across improved surfaces	Approval from the land owner prior to commencing any excavation across improved surfaces	1 week	Superintendent
Support of excavation - Trench instability	Submit for approval the proposal to provide adequate permanent stability of the ground affected by trenching	1 week before relevant action	Superintendent
Bedding for pipes			

Clause title/ Item	Requirement	Notice for inspection	Release by
Trench floor preparation	Test for bearing capacity > 50 kPa	3 working days	Superintendent
Pipe laying, jointing and connecting			
Installation of pipes Existing asbestos cement pipe cutting and disposal	Submit method statement for approval	2 working days	Superintendant
Wrapping of ductile iron pipelines	Rectify any damage to sleeving before backfilling trench	2 working days	Superintendent
Embedment and backfill			
Pipe embedment and support	Present the laid and jointed pipes for approval prior to the commencement of trench backfilling	2 working days	Superintendent
Embankment fill	Submit proposal for construction of embankments	1 week	Superintendent
Acceptance testing			
General - Unsatisfactory test	Rectify any faults even when results are compliant	1 week	Superintendent
Connections to existing water mains			
General - Verify on site measurements	Submit a proposal to adjust work to fit the connection to the existing as required.	3 working days	Superintendent
General - Connection and/or charging the new mains	Submit request to charge the new mains	5 working days	Water Agency - Superintendent
Restoration of surfaces			
General - Original condition requirement	Restore progressively and as soon as possible after the section of works is completed	2 working days	Superintendent

WITNESS POINTS table

Clause title/ Item	Requirement	Notice for inspection
MATERIALS		
General		
Compliance with manufacturers recommendations	Inspect material and products at time of delivery.	2 working days
Pipes and fittings		
General - Certification	Provide product or material certification prior to delivery to the works	3 working days
Valves and hydrants		
General - Certification	Provide product or material certification prior to delivery to	1 week

Clause title/ Item	Requirement	Notice for inspection
	the works	
EXECUTION		
Establishment		
General – Set out	Confirm the set out locations immediately prior to construction.	3 working days
General – Crossings authority approvals	Approval from relevant Authority and payment of fees.	2 weeks
Temporary drainage during construction	Approval from appropriate Authority for any discharge to sewers, stormwater drains or watercourses.	2 weeks
Excavation for water supply systems		
Inadequate foundation material - Notice	Give notice of any area of the foundation that may contain inadequate foundation material	1 week
Inadequate foundation material - Rock foundation	Excavate for an additional depth. Backfill and compact the additional excavation.	1 week
Trench excavation – Trench size for pipelines	Conformance with documentation	1 week
Trench excavation – Trench widths	Method for approval	1 week
Pipe laying, jointing and connecting		
Installation of pipes	Submit and provide ITP	1 week
Under pressure cut-in connection to pressure pipes ≥ DN 80	Clean and inspect pipe and give notice if badly corroded or damaged.	3 working days
Thrust and anchor blocks and restrained joints	Give notice if the allowable bearing pressure of the ground and the design pressure of the pipeline differ from actual pressures on site	1 week
Welding of steel pipelines	Submit proposal for approval	1 week
Acceptance testing		
General - NATA	Provide NATA certified test results for water mains and structures testing	2 working days progressive
General - Notice	Give notice for compaction testing, hydrostatic pressure testing, block testing and water quality testing	3 working days progressive
Visual inspection - Requirement	Inspect for compliance with the documents	2 working days
Visual inspection - Verify products and materials	Provide purchasing records	3 working days
Connections to existing water mains		
General – Acceptance testing	Complete acceptance testing to the satisfaction of the Water Agency	Prior to connection to existing mains
Restoration of surfaces		
Backfill - Disposal of surplus	Submit for approval surplus	2 working days progressive

Clause title/ Item	Requirement	Notice for inspection
material	material proposal	

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program so that it conforms with the approved products and materials.
- Authorities: Arrange approvals and conform to the local environmental requirements e.g. protection of the environment and heritage areas.
- Control of erosion and sedimentation: Provide a erosion and sediment control plan prior to commencing of works.

3 MATERIALS

3.1 GENERAL

Authorised products and materials

Products and materials: Provide only products and materials authorised by the Water Agency, the drawings and this specification. Submit for approval any alternative products and materials. This is a **HOLD POINT**.

Unauthorised material: Remove unauthorised or non-conforming materials from the site within 24 hours.

Conformance with manufacturer's recommendations

Requirement: Handle, transport and store materials in conformance with the manufacturer's recommendations and in a manner to prevent damage or deterioration or excessive distortion. Inspect all products and materials at the time of delivery and reject products and materials not in conformance with this specification and the manufacturers recommendations. This is a **WITNESS POINT**.

On site storage: Store in protective crating or packaging until immediately before use, stack piping to avoid ovalisation, support all fittings and pipes off the ground.

Damaged or defective materials: Do not use damaged or defective materials, including coatings and linings, outside the manufacturer's recommended limits and the following:

- Faded/discoloured plastics, plastic coated pipes, fittings and appurtenances.
- PVC pipes and fittings scored deeper than 10% of wall thickness or more than 1 mm.
- PE pipes and fittings scored deeper than 10% of wall thickness.
- GRP pipes and fittings scored deeper than 1 mm or with impact damage.
- DI and steel pipes and fittings with damage to linings in excess of 20% of the lining thickness.
- Plastics coated pipes, fittings and appurtenances with damage to coating in excess of 20% of the coating thickness.

3.2 PIPES AND FITTINGS

General

Certification: Submit product or material certification before delivery to the works. This is a **WITNESS POINT**.

Standard: All pipe, joint seals, flange gaskets and lubricant for drinking water supply to AS/NZS 4020.

Products and materials: Conform to the **Material properties schedule**.

Material properties schedule

Material properties	Mat 1	Mat 2	Mat 3
Material type			
Nominal size (DN)			
Pipe series			

Material properties	**Mat 1**	**Mat 2**	**Mat 3**
Pressure classification (PN)			
Material classification number (as necessary)			
Joint type			
Length and form of pipes			
Type, materials and classes of fittings			
Internal and external corrosion protection: - Fittings - Pipes			
Proof stress tests: - Fittings - Pipes			
Classification of flanges			
Means of tapping			
Identification of drinking and non-drinking pipe systems			
Gasket types and tightening sequence			
Type: Centrifugally cast (CC) or filament wound (FW)			

Ductile iron (DI) water mains

Standard: To AS/NZS 2280.

DI pipe: Cement mortar lined to AS/NZS 2280.

Epoxy coating: To AS/NZS 3862 (or thermal-bonded polyethylene to AS/NZS 4158).

Elastomeric seals: To AS 1646.

Flanges: To AS/NZS 4087 and AS 2129.

Bolts and nuts for flanged joints: To AS 2129, galvanized to AS 1214 or stainless steel to ASTM A276.

Corrosion protection of fittings: As shown on the drawings and the following:

- Thermal-bonded coated: To AS/NZS 4158, or
- Sleeved: To AS 3681. Do not allow exposure to sunlight for more than 7 days.

Fitting without flanges: Pipelines ≤ Class 35.

Steel water mains

Standard: To AS 1579 and the following:

- Steel pipe rated pressure: Hydrostatically tested.
- Fittings rated pressure: May be non-hydrostatically tested.

Pipe and fittings: Cement mortar lined to AS 1281.

Buried steel pipe and fittings: External coat with fusion bonded polyethylene (medium density) to AS 4321.

Pipe jointing: As shown on the drawings and the following options:

- Elastomeric seal: To AS 1646.
- Butt welded, welded spigot and socket, or welded using a welding collar and with the application of a polyethylene heat shrink sleeve over the weld, or wrapped.
- Flanges: To AS/NZS 4087.

- Bolts and nuts for flanged joints: To AS 2129.

PVC water mains

PVC pipe: To AS/NZS 1477.

PVC-O pressure pipe: To AS/NZS 4441.

PVC-M pressure pipe: To AS/NZS 4765.

PE pressure pipe: To AS/NZS 4130.

PVC curved alignments: To POP202.

Elastomeric seals: To AS 1646.

Handling and storage: To AS/NZS 2032, record time in storage and type of shelter protection from UV damage.

Jointing: Solvent cement jointing of PVC mains to AS/NZS 3879 and POP102 available from http://www.pipa.com.au/images/pdf/POP102.pdf.

Polyethylene (PE) water mains

Standard: To AS/NZS 4130.

Fittings: To AS/NZS 4129.

Mechanical couplings: Self restraining.

Stub flanges and backing rings: To POP007.

PE curved alignments: To POP202.

Butt fusion jointing: To POP003.

Electrofusion jointing: To POP001.

Flanges: To AS 2129, AS/NZS 4331.1 and AS/NZS 4087.

Property service pipe: PE 100, PN 16, series 1.

Glass reinforced plastic (GRP)

Standard: To AS 3571.2.

Surge cycles: Refer to the manufacturer when the water temperatures are likely to exceed 35°C.

GRP fittings: To AS 3571.2.

Acrylonitrile butadiene styrene (ABS)

Standard: To AS/NZS 3518.

Joints: Conform to manufacturer's recommendations using solvent cement to AS/NZS 3879.

Pipe class: Provide for cyclic loading.

Copper pipe and fittings for property service

Standard: To AS 1432. Bendable temper pipe in the range of DN 6 to DN 200 for Type A or Type B.

Capillary and compression fittings: Conform to AS 3688 and de-zincification resistant with silver brazed joints or solder insert capillary joints.

3.3 VALVES AND HYDRANTS

General

Requirement: Provide valves and hydrants in conformance with the drawings, the schedules and the specification.

Certification: Provide product or material certification before delivery to the works. This is a **WITNESS POINT**.

All pipe, joint seals, flange gaskets and lubricant for drinking water supply: To AS/NZS 4020.

Extended spindle: To AS/NZS 2638.1 Test J and AS/NZS 2638.2 Test M and the following:

- Welding: To AS/NZS 1554.1 Category GP. Do not weld cast iron (including grey and ductile iron) components.
- Bitumen coat: To AS/NZS 3750.4.
- Synthetic resin base coat: To AS/NZS 3750.19.
- Thermal bonded polymeric coatings: To AS/NZS 4158.

Valves and hydrants: Conform to the **Valves and hydrants schedule**.

Valves and hydrants schedule

Valves and hydrants properties	**Val 1**	**Val 2**	**Val 3**
Location			
Spacing			
Type			
Class			
Sizing			
End connections			
Gearing			
Valve chamber			
Installation requirements			
Identification, colour and marking			
Bypass/Rider/Crossing			
Operation (eg. electric etc)			
Supports required			
Scours and pump branches: - Size - Fittings			

Flanges: To AS 2129 and AS/NZS 4087.

Socket joint configurations: Elastomeric joint seal to AS 1646.

Stop valves

Resilient seated valves: To AS/NZS 2638.2.

Metal seated valves: To AS/NZS 2638.1.

Scour valves: Connect to pipelines with a flanged joint.

Gaskets: 3 mm thick insertion rubber.

Gate valves:

- Anti-clockwise rotation of the input spindle for closure.
- Provide spindle cap.
- Knife gate valve: To AS 6401.

Butterfly valves: To AS 4795.1, AS 4795.2 and the following:

- Do not use in reticulation mains.
- Direction for closing: Anti-clockwise.
- Do not use where throttle of flow is required.
- Installed with trunnions horizontal and gearing operated from the surface.
- Chamber required where gearbox is not sealed.

Resilient seated ball valves for property services: To AS 4796.

Control valves

Automatic inlet control valves: To AS 5081 and the following:

- Compatible with the existing system, e.g. electrically or hydraulic actuated, fully modulating or two-state open/closed control.

Air valves: To AS 4956 and the following:

- Small orifice: DN 15, 20 and 25.
- Large orifice: DN 50, 80, 100, 150 and 200.
- Double orifice type with integral isolating valve of minimum size DN 80.

Non-return valves: To AS 4794 and the following:

- Pressure class: PN 16.
- Provide lifting lugs: ≥ DN 250.
- Swing check type of ductile cast iron or steel body, cover and disc or bronze body and disc seat rings.
- Clear swinging leaf to provide an unobstructed waterway.
- Do not use wafer style non-return valves.
- Maintenance: Provide body cover of sufficient size and in a location that allows removal of the valve flap and the seat for inspection without removal of the valve body.
- No flow switch: Provide extended spindle of minimum grade 316 stainless steel to ASTM A240/A240M and fitted with an adjustable counterweight together with a proximity switch to indicate a no-flow condition and with the following features:
  - Eccentric cam operated limit switch type.
  - Minimum rating of 10 amps, 240 V AC, 50 Hz.
  - Oil tight and dust proof to IP 65.
  - Suitable for 25 mm conduit entry.
  - Mounted on rigid adjustable brackets of stainless steel in conformance with ASTM A240/A240M and free of sharp edges and exposed corners.

Maintenance facilities

Scours and pump-out branches: Provide scours and pump out branches for maintenance in conformance with WSA 03 clause 8.6 including the following:

- Size: To WSA 03 Table 8.4.
- Location.
- Swabbing points: Provide adequate drainage facilities for dewatering and flushing operations at proposed swabbing points.

Disinfection facilities: Provide chlorination installation in conformance with WSA 03 clause 8.9 and Appendix I and including the following:

- Fittings as permanent fixtures.
- Identification and appropriate location of hydrants if used for disinfection purposes.
- Fittings for transfer and distribution mains.
- Discharge points.

Hydrants

Spring hydrants: To AS 3952.

Access: Locate the top of spring hydrants between 100 mm and 200 mm below finished surface level. Provide hydrant risers of various heights if required.

Surface fittings

Access covers: To AS 3996, **Access covers and frames schedule** and the following:

- Coating to AS/NZS 3750.4 or BS 3416 for all cast iron solid-top covers and frames other than recessed parts. Do not apply to sealing and threaded surfaces. Make sure coating is dry to touch when handled.
- Single part round covers ≥ DN 375: 0.3 ± 0.03 mm gap between the edge of the cover and the inside edge of the frame.
- Multi-part covers: ≤ 4 mm between either part and the frame.

Access covers and frames schedule

Requirements	**A1**	**A2**	**A3**	**A4**
Cover number				
Load class				
Size				

Requirements	A1	A2	A3	A4
Aesthetics				
Security				
Seals				
Cover orientation				
Handling				

Jointing components
Jointing lubricant: To AS/NZS 4020.

Joint seals: To AS 1646.

3.4 STEEL AND CONCRETE

Steelwork
Structural steelwork, including ladders, brackets, and covers: To AS 1657.

Abrasive blast cleaning: To AS 1627.4 Class 2.5.

Protection: Hot-dip galvanize to AS/NZS 4680.

Concrete
Premixed, normal class concrete: To *0319 Minor concrete works*.

3.5 PROTECTION AGAINST DEGRADATION

General
Detail: Protect pipeline system items (e.g. pipes, fittings, appurtenances, elastomeric seals) of pipeline systems including the following:

- Eliminate contact between dissimilar metals to prevent galvanic corrosion.
- Fully seal conduits for plastic pipes and fittings in contaminated ground.
- Fully seal conduits for all elastomeric seal jointed pipes and fittings in contaminated ground.
- Control trench fill and pipe embedment materials.
- Mitigate stray current or telluric effects on buried steel pipelines in conformance with WSA 03 clause 4.8.6.
- Cathodic protection for buried steel pipelines to AS 2832.1 and AS 2832.2 and in conformance with WSA 03 clause 4.8.5.

3.6 BEDDING, EMBEDMENT AND FILL MATERIAL

General
Bedding and embedment material: To AS/NZS 2566.2, **Bedding, embedment and fill material schedule** and free of noxious weeds and dangerous chemicals.

Bedding, embedment and fill material schedule

Material	Mat 1	Mat 2	Mat 3
Grading			
Resistivity (AS 1289.4.4.1)			
pH (AS 1289.4.3.1)			
Wet strength (AS 1141.22)			
Wet strength/dry strength variation (AS 1141.22)			
Weak particles (AS 1141.32)			
Aggregate type			

Material	Mat 1	Mat 2	Mat 3
Nominal size of aggregate (mm)			
Mix proportions			
Size for stabilisation (mm)			
28 day compressive strength (MPa)			
Maximum moisture content at delivery			
Trafficable or non-trafficable areas			

Recycled material: Submit for approval any recycled material proposed. This is a **HOLD POINT**.

Geotextile

Properties: Non-woven fabric, unaffected by bacteria and fungi, marked to AS 3705.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 ESTABLISHMENT

General

Tolerances: Install water mains, in-line structures, property services and meters in conformance with the documentation and the following:

- Water mains horizontal: ± 100 mm lateral displacement from the design alignment.
- Appurtenances and structures horizontal: Lateral displacement ± 100 mm from the design alignment and ± 200 mm along the water main axis.
- Property services horizontal: ± 100 mm displacement along the water main axis.
- Water meters horizontal: ± 100 mm displacement from design position.
- Water mains, property connections and structures vertical: ± 50 mm minimum cover.
- Hydrant risers, access chambers, shrouds and aqueduct verticality: 30 H (mm): 1000 V (mm).
- Structures higher than 5 m verticality: 50 H (mm).

Set out: Confirm the locations immediately before construction. This is a **WITNESS POINT**.

Space allocations: Conform to any space allocation agreements, local agreements with road owners or other utility service provider.

Water mains in easements: Conform to documented requirements including the following positions of the main within the easement:

- 1/3 of the width into the easement on the side away from any buildings.
- Position centrally if there are buildings on both sides and if the easement runs through narrow walkways.
- Where there is a crossfall, position the main on the low side.

Protection: Provide protection from external factors such as external loading, third party intrusion as documented including the following:

- Encasement in conformance with WSA 03 clause 5.4.9.2.
- Precast reinforced concrete removable slabs.
- Concrete encasement.
- Service duct.

- Security fencing.
- Protection barriers.

Overhead power lines and transmission towers: Alignment, electrical protection, corrosion protection, and construction details as documented for the following locations:

- Welded steel pipelines simultaneously run parallel and close to high voltage power lines for more than 1 km parallel and within 500 m of powerlines > 50 kV.
- Metal pipelines are located within 5 m of a transmission tower.
- Metal pipeline access is within 50 m of a transmission tower.

Above ground water mains: Provide above ground water main components as documented including pipeline items, supports, restraints, loading protection, maintenance and access requirements, protection from exposure conditions.

Document: Record details of contact with all affected customers. Resolve questions and complaints promptly.

Road opening permits: Obtain a road opening permit before starting any works within a road or road reserve.

Crossings Authority approvals: If a pipeline crosses a main or state road, creek or involves features shown on the drawings, under the control of any Authority, carry out the work in conformance with the requirements of that Authority including obtaining any approvals and paying any fees as appropriate. This is a **WITNESS POINT**.

Temporary drainage during construction

General: For each part of the system, complete the erosion and sedimentation control measures before starting the works.

Control of erosion and sedimentation: Conform to *1102 Control of erosion and sedimentation*. Make adequate provision for runoff flows at drainage works under construction or surrounding areas/structure. Submit plan to WSA 03 clause 11.5.5.4.

Dams and diversions: Do not dam up or divert existing watercourses (either temporarily or permanently). Submit for approval if required.

Dewatering: Keep all excavations free of water, provide dewatering including any equipment required. Make sure no damage is caused to adjacent structures and services. Obtain approval for any discharge to sewers, stormwater drains or watercourses by the appropriate authority. This is a **WITNESS POINT**.

Material and equipment: Locate material and equipment clear of watercourses or secure to prevent danger or damage in the event of large runoff flows.

Stabilisation of topsoil areas: Immediately following earthworks where required, stabilise the topsoil with hydroseed to *0257 Landscape – roadways and street trees,* **Hydroseeding**.

Excavation near underground services

Public utilities within the excavation for water supply systems: Obtain approval of the relevant Authority for the method of excavation before commencing excavation. This is a **HOLD POINT**.

Location: Contact DIAL BEFORE YOU DIG, and the names listed in *0136 General Requirements (Construction),* to identify location of underground utility services, pipes and cables.

Marking: 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. This is a **HOLD POINT**.

Protection of property and environment: To WSA 03 clause 11.5 and the following:

- Protection of other services: Give notice of any interference to the works caused by an existing service and submit a proposed work method statement. This is a **HOLD POINT**.
- Disused or redundant water mains: Carry out works as documented and to WSA 03 clause 11.5.2.

4.3 EXCAVATION FOR WATER SUPPLY SYSTEMS

General

Topsoil: Remove topsoil in conformance with *1112 Earthworks (Roadways)* before undertaking stormwater drainage excavation.

Excavation level: Excavate trench or foundation for water supply works to the designed level of the bottom of the bedding or foundation. Remove all loose material.

Confirm surrounding soil type with design: Give notice if not consistent with the design. This is a **HOLD POINT**.

Location: Carry out all excavations for structures and pipelines to the lines, grades and forms shown on the drawings.

Authority requirements: Conform with the requirements of the appropriate Authority including drainage, dewatering, silt control, noise abatement, proximity to existing buildings and generally for the amenity of adjacent owners.

Safety fencing: Provide safety fencing along the edges of open excavations to statutory requirements.

Access to properties: Provide fenced walkways and vehicular crossings across trenches to maintain access at all times from the carriageway to individual properties or within individual properties and give notice to all affected occupiers.

Existing services: Locate, protect and repair, as necessary, all services within the extent of the works.

Protection of trees: Conform to WSA 03 clause 13.3 including:

- Approval from the tree owner and council for tree removal or working within allowed distances.
- Do not store materials or products against trees, under tree canopies or over root zones.
- Fence off trees to keep machinery away as required or use boring or hand excavation.
- Protect roots: Conform to the following:
  - Cleanly cut tree roots ≤ 60 mm diameter. Obtain approval for cutting larger roots.
  - Damaged roots: Treat as documented in the environmental management plan or as directed.

Blasting: Not permitted.

Excavation across improved surfaces: To *1152 Road openings and restoration (Utilities)* and the following:

- Obtain approval from the land owner before starting any excavation across improved surfaces. This is a **HOLD POINT**.
- Saw cut neat straight lines ≥ 150 mm beyond the outer limits.

Cover over pipelines

Minimum cover: Provide mains pipelines with the minimum depth of cover as documented and in conformance with WSA 03 Table 7.2, measured vertically from the finished ground level to the top of any socket.

Less than minimum cover: Lesser cover may be provided where special protection of the pipelines is documented.

Greater than minimum cover: Greater cover may be provided where special situations occur, where there is conflict with other services or to meet grading requirements.

Maximum cover : Conform to the following:

For pipe ≤ DN 375: 1.2 m.

For pipe > DN 375 < DN 600: 1.5 m.

Inadequate foundation material

Notice: Give notice of any area of the foundation including the sides of the trenches that may contain material that is inadequate to support the proposed drainage structure. This is a **WITNESS POINT**.

Confirmation of inadequate foundation material: Remove and dispose of inadequate foundation material to *1112 Earthworks (Roadways).*

Replacement of material: To **Bedding, embedment and fill material**.

Rock foundation: If rock is encountered at the foundation level, excavate for an additional depth. Backfill and compact the additional excavation with material conforming with the **Bedding, embedment and fill material**. This is a **WITNESS POINT**.

Support of excavation

Trench support stabilising: Provide any shoring, sheet piling or other stabilisation of the sides of trench excavations necessary to conform to statutory requirements.

Support: All trenches of depth > 1.5 m or in unstable ground strata.

Trench support system: Do not disturb adjacent structures and services.

Compaction of pipe embedment and trench fill material: Provide below any trench support and against native ground.

Permanent trench support system: Cut off the support system below ground surface.

Trench instability: Submit for approval the proposal to provide adequate permanent stability of the ground affected by trenching. This is a **HOLD POINT**.

Excavation requirements for under pressure cut-in connection to pressure pipes ≥ DN 80

Excavate below and behind the host pipe: ≥ 100 mm.

Host pipe: Support during excavation and drilling.

Excavation: Keep sides of excavation vertical ≥ 150 mm above the pipe. Satisfy minimum cover requirements as documented at all times.

Trench excavation

Requirements: Conform to the following requirements for trench excavation:

- Minimum cover requirements as documented.
- Maintain trench excavation in a stable condition.
- Minimise the length of the open trench at any one time.
- Align the trench centreline with the design pipeline centreline.

Trench size for pipelines: Excavate the trench to WSA 03 clause 5.6 and the following:

- Buried flexible pipelines or embankment method in general: To AS/NZS 2566.2.
- PVC: AS/NZS 2032.
- PE: AS/NZS 2033.
- ABS: AS/NZS 3690.

This is a **WITNESS POINT**.

Minimum trench width: 300mm

Embankment installation condition: To AS/NZS 2566.2. Prior to placement of bedding and laying pipes, place and compact embankment fill to a height above the top of the bed zone of at least 0.7 times the external diameter of the pipe and for a minimum lateral distance outside each trench wall of 2.5 times the external diameter of the pipe. Place earthworks to 1112 *Earthworks (Roadways)*.

Trench installation condition: Complete the embankment to the underside of the selected material zone prior to the commencement of the excavation.

- Trench width: Do not excavate > 500 mm over the minimum trench width. This is a **WITNESS POINT**.

Bitumen and concrete surfaces: Carefully cut, by sawcutting or other means approved by the Superintendent, a neat straight line free from broken ragged edges.

Widen for fittings: Widen the trench where necessary for the installation of valves and fittings and protective coating systems.

Maximum trench depth: Excavate no more than 50 mm below the invert of the pipe.

Easement: Do not excavate outside the easement.

Clearance for on-site works: Provide clear space ≥ 500 mm in all directions from the workface where works such as welding or corrosion protection are required.

Stockpile: Provide stockpiles as follows:

- Do not stockpile excavated materials against the walls of any building or fence.
- Maintain 600 mm minimum between the edge of any excavation and the inner toe of stockpiles.
- Stockpile excavated topsoil separately reuse for surface restoration after backfilling.
- Remove any surplus excavated material not required for reuse for topsoil or backfill.

Trenchless technology

Requirement: If using trenchless technology as an alternative, submit proposal for trenchless installation in conformance with *1392 Trenchless conduit installation*.

Existing road crossings: If shown on the drawings, use trenchless methods for the installation of the mains.

Encasement pipe: As shown on the drawings. Extend the encasement pipe 1.0 m behind the back of the kerb on either side of the carriageway.

Support cradles: Position the carrier pipe on support cradles centrally located within the encasement pipe.

Ductile iron cement lined (DICL) carrier pipe: Polyethylene sleeving is not required for any length of DICL carrier enclosed within the encasement pipe.

4.4 BEDDING FOR PIPES

Trench floor preparation

Foundation: Before placing embedment, test the proposed foundation in conformance with WSA 03 clause 13.11, clause 14.1 and Appendix G and the following:

- Bearing capacity > 50 kPa.
- Minimum trench depth: + 0 mm, - 50 mm.

Non-conformance: Where this is not achieved give notice for directions. This is a **HOLD POINT**.

Refill of excessive excavation: To WSA 03 clause 13.10 and **Bedding, embedment and fill material**.

Compaction: Compact all fill and disturbed areas to the density of the natural ground.

Preparation: Remove all debris and water before placing bedding.

Bedding and pipe support

Pipes other than PVC/PE: Provide non-cohesive granular bedding with minimum thickness of 75 mm below the barrel and socket of the pipe.

PVC pipes: To AS/NZS 2032 Figure 5.1.

PE pipes: To AS/NZS 2033 Figure 5.1.

Concrete support: Do not place bedding material until concrete has obtained its initial set.

Compaction of beddings: Provide compaction of bedding to WSA 03 Table 19.1.

Protect: Do not walk on the centreline of the compacted bedding.

4.5 PIPE LAYING, JOINTING AND CONNECTING

Installation of pipes

Water main: Maintain the cleanliness and dryness inside all items during construction by using exclusion caps, plugs or blank flanges. Remove any dirt and foreign matter if pipes flood at any time.

Dual water supply area: Submit and provide Inspection Test Plan (ITP) to WSA 03 Appendix K. This is a **WITNESS POINT**.

Examine: Clean and examine all pipeline system items before installation. Inspect each joint seal for fit and flaws. Do not use damaged, dirty or incorrect seals.

Cut pipes: Chamfer where required and provide witness marks on the unmarked length of any cut pipes. Do not score pipes when providing the witness mark. Treat cut pipes in conformance with the manufacturer's recommendations.

For field cuts of ductile iron or steel: Make sure that working fire fighting equipment is on the site before making field cuts.

Petrol engined pipe cutter: If using a petrol engined pipe cutter in an excavation, make sure that a safe atmosphere is maintained in the excavation at all times.

Witness mark on cut pipes: If pipes are cut in the field, make a clearly identifiable witness mark on the pipe at the length specified by the manufacturer from the end of the pipe, except for butt welded PE pipes.

Butt fusion of PE pipes: To POP001.

Electrofusion of PE pipes: To POP003.

Witness marks on PVC/PE pipes: Do not use PVC/PE pipes with scored witness marks.

Witness marking depth: If the same manufacturer does not make spigots and sockets, refer to the socket manufacturer for the correct marking depth.

Laying: Following the preparation of pipe bedding, lay and join pipes in locations and sizes as documented and to WSA 03 clause 15.1.4.

Laying sequence: Lay pipes on continuously rising grades from scour valve to air release valve, despite any minor irregularities in the ground surface.

Lift and re-lay construction: Supply affected properties with a temporary water service including a ball valve.

Horizontal and vertical separation of crossing pipelines: Maintain minimum separation of crossing pipelines. Fill with embedment material and compact.

Maintenance: Install valves, hydrants and other appurtenances for easy access for maintenance and repair.

Prevent flotation: To WSA 03 clause 15.6.

Existing asbestos cement pipe cutting and disposal: Submit method statement for approval. This is a **HOLD POINT.**

Horizontal and vertical deflections of pipes

Limits of deflection: To the pipe manufacturer's recommendations.

Remove temporary pegs and stakes: Do not point load pipes.

Curving of PE/PVC pipe: If documented, bend pipes in conformance with POP202 and with a uniform radius along the length of the pipe in conformance with the manufacturer's recommendations. Join pipes directly before making the curve. Do not use temporary pegs or stakes to restrain the pipe during curving.

Under pressure cut-in connection to pressure pipes ≥ DN 80

Inspection of host pipe: Clean pipe and inspect for corrosion, pitting, scoring, other surface damage. Give notice if pipe is badly corroded or damaged. This is a **WITNESS POINT**.

Inspect valve: Make sure the wedge can be fully withdrawn into the bonnet of the valve without damage during cut-in operation.

Disinfection of fittings and equipment: Remove surface deposits on all equipment with a pressurised washing system and biodegradable detergent. Spray or flood all connection fittings and equipment with a solution of sodium hypochlorite of concentration > 1% or 80/20 ethanol/water solution.

Installation of off-take clamp and valve and cut-in operation: To WSA 03 clause 15.5.4, 15.5.5 and 15.5.6.

Submission: Record pipe pressure, depth, condition of coating, pipe and lining.

Thrust and anchor blocks and restrained joints

Restraints: Provide thrust or anchor blocks in conformance with the drawings and the following:

- Position thrust and anchor blocks to bear against undisturbed material in the direction of the thrust and over the specified bearing area, allow movement at the joint. Do not encase any part of the joints.
- Provide a membrane between the fitting and the concrete to prevent damage to the coating of the fitting.
- Make sure that thrust and anchor blocks are central to the fitting and do not interfere with any other services.
- For DI pipes follow manufacturer's recommendations.

Notice: Give notice if the allowable bearing pressure of the ground and the design pressure of the pipeline are different to the actual pressures on site. This is a **WITNESS POINT.**

Concrete: 20 MPa in conformance with *0319 Minor concrete works.*

Cast-in situ concrete structures and slabs: Tolerance ± 0.5% of specified dimension or 5 mm, which ever is greater.

Concrete thrust, anchor blocks and bulkheads: Tolerance + 5%, - 2% of specified dimension.

Tapping of mains, property services and water mains

Pre-tapped connectors: Install pre-tapped connectors in conformance with the drawings.

Install tapping: To WSA 03 clause 15.8.

Marking

Non-detectable marking tape: Lay tape on top of the pipe embedment material before trench filling.

Detectable marking tape: Lay tape on top of the pipe embedment to form a continuous connection between valves, hydrants. Connect bare wires to a nut or bolt of a valve or hydrant.

Tracer wire: Provide 2 mm diameter 316 stainless steel tracer wire in trenchless installations.

Appurtenance location marking: Provide location marker posts, plates or other as shown on the drawings.

Time: Fix marking as soon as practicable after each valve or hydrant is installed.

Temporary cover: Temporarily cover marking plates for hydrants using masking tape or other approved cover and remove on satisfactory completion of the pressure testing of the pipeline.

Distance: Permanently mark the plate with the distance to the valve or hydrant in metres, to an accuracy of 0.1 m, with legible numbers a minimum 80 mm high.

Wooden posts: If there is evidence, by rotting or termite activity, that the integrity of the posts will be affected, do not use.

Post length: Set sufficient length firmly in place under saturated ground conditions.

Post projection: When installed, in conformance with the following:

- Generally: 1000 mm above the ground.
- If tall grass or crops are likely to obscure the post: 1500 mm above the ground.

Finish: Paint posts with 2 coats of white water based enamel for exterior use.

Pavement markers: Two-way reflective raised pavement markers to the road pavement and kerb.

Valve chambers for large diameter mains

Spindle top: ≤ 350 mm below finished surface level (FSL).

Location: Give notice if location of valve, hydrant, chamber or surface fitting is shown in a roadway, driveway, paved area or any other restricted areas.

Pavement marking: [complete/delete]

Chamber covers and frames: Install covers to AS 3996 and the following:

- No warps or twists in covers and frames.
- No abrupt irregularities to surface.
- Gradual irregularities: No more than 3 mm.
- Unformed surfaces: Dense, uniform and free from blemishes.
- Exposed edges: Minimum 4 mm radius.
- Road pavements, footpaths and other paved surfaces: Finish flush with the surface.

Tolerance: Conform to the following:

- Cover dimensions: – 3 mm, + 0 mm.
- Frame dimensions: ± 3 mm.

Plastic covers: Avoid lateral movement, cracking and subsidence when installing plastic covers and frames.

Bored pipes under roads, driveways etc

Joints: Provide a continuous pipe under the road carriageway or limit to a single joint.

Grouting: Provide gravity or pressure grouting commencing from the downhill end of the bore, achieve full penetration and complete filling of the void.

Insulators: Insert plastic slippers between the water main and the bored hole in conformance with manufacturers recommendations.

Unsupported bore: Complete all pipework and grouting within 24 hours.

Flanged joints

Support: Fully support matching pipe and valve/fitting during installation.

Sequence: Tighten bolts in the specified sequence using a torque wrench.

PE pipe: Provide a butt welded PE stub flange adaptor with a stainless steel backing ring in conformance with POP007.

Welding of steel pipelines

Welding: To AS/NZS 1554.1 Category SP.

Field welding of flanges: Submit proposal in conformance with WSA 03 clause 15.20.2. This is a **WITNESS POINT**.

Wrapping of ductile iron pipelines

Polyethylene sleeving: Enclose a pipeline or a section of pipeline, in layflat polyethylene sleeving and plastic tape adhesive in locations as shown on the drawings and in conformance with manufacturer's recommendations.

Material: High impact resistance polyethylene sleeving in conformance with the following

- To AS 3681.
- 50 mm wide plastic adhesive tape.

- Width of the sleeving when flat: To the manufacturer's recommendations for the size and type of the pipeline being encased.
- Do not exceed 48 hours exposure to direct sunlight.

Protection: Protect the sleeve from damage during application and the backfilling of the trench.

Field joints: Provide 250 mm minimum overlap of sleeving at each field joint.

Sleeving ends: Hold in position with at least three circumferential turns of adhesive tape.

Excess material: Neatly draw up loose, excess polyethylene sleeving material around the pipe barrel, fold into an overlap on top of the pipe and hold in place with strips of plastic tape at approximately one-metre intervals.

Bends, tapers and similar fittings: Cover with polyethylene sleeving as documented for the pipes.

Valves, hydrants and irregular shaped fittings and joints: Hand wrap using flat polyethylene sheets secured with plastic adhesive tape, or other suitable material, to provide an adequate seal.

Damage to sleeving: Rectify any damage to the polyethylene sleeving before backfilling of the trench. This is a **HOLD POINT**.

Steel bolts and nuts corrosion protection

General: Wrap all galvanized steel bolts and nuts, used for below ground installation of flanges, bolted gland joints, mechanical joints, tapping bands in conformance with the manufacturer's recommendations.

Requirement: Make sure steel bolts and nuts are dry, clean and free from rust, immediately before wrapping.

Tape: Synthetic fibre open weave cloth impregnated with saturated hydrocarbons approved by the Superintendent.

Joints

General: Except where solvent cement joints are needed to make up or install fittings, conform to the following:

- Location: As shown on the drawings.
- Elastomeric seal joints:
  - Either roll-on or skid type.
  - Apply only lubricant to manufacturer's recommendations in making the joint.
- Mechanical joints: Fixed flange, bolted gland type, or a PE pipe system specific joint type.

Witness mark: Make the joint so that the witness mark is no more than 3 mm from the end of the socket.

Solvent cement joints: To AS/NZS 3879 and manufacturer's recommendations.

Jointing pipes of different materials

General: If jointing PVC pipes to ductile iron pipes, make joints by inserting a PVC spigot into a ductile iron socket. Do not insert ductile iron spigots into PVC/PE sockets.

Compatibility: Confirm the compatibility of the PVC pipe, joint seal and DI socket.

Alternative: Multi-fit mechanical couplings or flanged adaptor couplings, but not stainless steel leak/repair clamps, may be used to join pipes of different materials. If jointing PE pipes with mechanical couplings, provide joint restraint.

Appurtenances

Compatibility with pipework: Provide proper sealing between the pipe flanges and the valve.

Concrete lining in pipework: Do not chip away or reduce to provide clearance from the working parts of valves.

Installation: Make sure that valves and hydrants are installed to facilitate maintenance.

4.6 EMBEDMENT AND BACKFILL

Pipe embedment and support

Notification of pipeline laid and jointed: Present the laid and jointed pipes for approval before trench backfilling. This is a **HOLD POINT**.

Material for embedment: Conform with **Bedding, embedment and fill material**.

Uniform placement: Place embedment material uniformly along and around the whole length of the pipe barrel, couplings and other appurtenances with no distortion, dislodgement or damage to the water main. Maintain more than 50% of the specified bedding depth under all projections.

Compaction: Compact in layers no more than 150 mm thick for minimum compaction of embedment. Conform to AS/NZS 2566.2 and WSA 03 Table 19.1.

Compaction techniques: Do not use equipment or methods that would produce horizontal or vertical earth pressures that would cause damage or distortion of the water main.

Flooding compaction: Submit proposal for flooding compaction for approval where required and in conformance with WSA 03 clause 16.3.1.

Removal of trench supports: Lift temporary trench support systems progressively above each layer of embedment. Compact layers against undisturbed native soil.

Concrete embedment and encasement

Location: Concrete embed and encase pipes in conformance with the drawings including construction joints and reinforcement as detailed.

Encasement: Set pipes to line and level on bags of natural fibre filled with sand and cement mix or on concrete blocks or saddles. Make sure pipes do not move or deform while placing concrete.

Contraction joint: Provide at the junction of encased pipeline and the concrete encased section.

Concrete: 20 MPa in conformance with *0319 Minor concrete works.*

Cast-in situ concrete structures and slabs: Tolerance ± 0.5 % or 5 mm, whichever is greater.

Concrete thrust, anchor blocks and bulkheads: Tolerance + 5%, - 2%.

Reinforced concrete: Tolerances to AS 3600.

Drainage: Provide a 75 mm diameter drain hole in the concrete bulkhead above the top of the encasement bedding or foundation. Place crushed gravel or rock in and at the upstream end of the drain hole as follows:

- 10 to 20 mm size within 150 mm in all directions upstream and above the invert of the drain hole.
- 2 to10 mm size for a further 150 mm surround.

Trench fill

Fill: Place and compact trench fill using material to **Bedding, embedment and fill material**, avoid subsidence over or near the trench and damage to adjacent pavements and structures.

Non trafficable areas: Use excavated material as trench fill as follows:

- Excavated material: Free of organic material, containing no rock or hard clay > 75 mm and able to be compacted in conformance with WSA 03 Table 19.1.
- Cohesionless soil excavated material: Do not use in cohesive soil locations.

Placement: Conform to the following:

- Damage: Make good any damage caused by subsidence.
- Do not impact load water main.
- Do not place fill within 24 hours of placing concrete embedment or encasement.
- Fill voids behind timber ground support in close-timbered tunnels, drives and shafts by pressure grouting.
- Do not displace any valve or hydrant access cover assembly or supports.
- Correct any deficiencies caused by settlement.

Compaction of trench fill: Compact in layers to conform with WSA 03 Table 19.1 and clause 19.3.1.

Mechanical compaction: Do not commence mechanical compaction of fill material directly above the pipe until the total depth of cover above the pipe is adequate to prevent damage to the main.

Prevention of damage to pipes, coating and wrapping: Backfill and compact all materials without damaging the pipe or its external coating or wrapping or producing any movement of the pipe.

Embankment fill

Embankments: Submit proposal for construction of embankments in conformance with the drawings, including the method of placement and compaction, any limitations to placement/ compaction over the top of the pipeline. This is a **HOLD POINT**.

4.7 SWABBING AND DISINFECTION

Swabbing

Swab mains: Carry out swabbing to the mains to WSA 03 clause 18 and the following:

- Use new pre-packaged swabs, stored and handled hygienically.
- ≥ 2 swabs for each run.
- Swab size: To WSA 03 Table 18.1.
- Insert swabs during construction into the main at connection points of new mains to existing mains or into previously swabbed new mains or for DN 100 to DN 150 at hydrants.
- Swabbing procedure: To WSA 03 clause 18.3.

Disinfection

Disinfect mains: To WSA 03 clause 20, Appendix I and after satisfactory hydrostatic pressure test.

4.8 ACCEPTANCE TESTING

General

NATA: Provide NATA certified test results for all water mains and structures testing. This is a **WITNESS POINT**.

Unsatisfactory tests: Detect and rectify any faults that provide unsatisfactory tests until testing provides compliant test results. Rectify any visible leaks, blockage, malfunction or other defect even when results are conforming. This is a **HOLD POINT**.

Notice: Give notice for compaction testing, hydrostatic pressure testing, block testing and water quality testing. This is a **WITNESS POINT**.

Visual inspection

Requirement: Inspect all water mains and component markers to make sure in conformance with the documents. This is a **WITNESS POINT**.

Verify products and materials: Provide purchasing records for products and materials. This is a **WITNESS POINT**.

Compaction testing

Minimum compaction of embedment, trench fill and embankments: To WSA 03 Table 19.1 tested to AS 1289.5.6.1 for cohesionless materials and AS 1289.5.7.1 for cohesive materials.

Compaction testing requirements: Conform to the following:

- Drives and tunnel fill do not require testing.
- Trafficable areas test zone: 300 m² area with test at the centre, depth from the surface to the native ground or foundation level. Test each 300 mm of depth of fill and each test zone.
- Non-trafficable areas: 1200 m² area with test at the centre, depth from the surface to the native ground or foundation level. Test each 900 mm of depth of fill in each test zone.
- Retesting: Recompact and retest if any result does not conform with WSA 03 Table 19.1.

Hydrostatic pressure testing

Pressure test all drinking and non-drinking water mains: To AS/NZS 2566.2 clause 6.3, WSA 03 clause 19.4 and the following:

- Use calibrated gauges under quality control.
- Use mains water or other disinfected water.
- Trenchless mains: Carry out pressure testing before connection to the existing water main of the new section of water main being installed using open trench construction.
- Test length < 100 m.
- Pressure test each property service.
- Under pressure cut-in connections: Before cutting-in to the host pipe, pressure test the assembly by applying a pressure that is 400 kPa above the operating pressure of the pipeline. Do not exceed 1600 kPa for more than 3 minutes.

Sections: Test pipelines in sections as soon as practicable after each section has been laid, jointed and backfilled. Leave some or all of the pipe joints uncovered until the whole of the section has been successfully pressure tested. Commence testing 7 days after the last placement of concrete thrust or anchor block

Wet weather: Do not perform pressure testing during wet weather.

Field joints: During pressure testing, make sure all field joints, which have not been backfilled, are clean, dry and accessible for inspection.

Stop valves full test pressure: During the pressure testing of a pipeline, test each stop valve at least for the full test pressure on one side of the valve in closed position with no pressure on the other side for at least 15 minutes.

Filling with water: Before testing a pipeline section, clean it to the satisfaction of the Superintendent and fill it slowly with water, taking care that all air is expelled. Promote purging of air from rising mains by opening air valves.

Stable testing conditions: To allow for absorption, movement of the pipeline and escape of entrapped air, keep the section full of water for a period of not less than 24 hours prior to the commencement of the pressure testing.

Test pressure: Do not exceed the manufacturer's recommended test pressure for the lowest rated component taking into account the components location in the pipeline.

Duration of test: Maintain the specified test pressure for minimum 6 hours.

Compressed air test: Do not test the pipeline using compressed air.

Block testing dual water supply systems for connectivity

Connectivity inspection of dual water supply: To WSA 03 clause 19.5 and Appendix K.

Insulated joint resistance test

Test: Provide test results for insulated joint resistance test by application of a 500 V DC current to insulated joints to conform with WSA 03 clause 19.6.

Water quality testing

Water quality testing: Carry out a bacteriological test on all new mains following satisfactory swabbing/flushing and pressure testing of the main to conform with WSA 03 clause 19.7 and the following:

- Accept water main section where test results are within the acceptable ranges for the following:
  - Drinking water: To WSA 03 Table 19.2.
  - Non-drinking water: To WSA 03 Table 19.3.
- Failure of test: Swab, flush or disinfect the section of the water main and retest.

4.9 CONNECTIONS TO EXISTING WATER MAINS

General

Acceptance testing: Complete acceptance testing to the satisfaction of the Water Agency before connection to existing water mains. This is a **WITNESS POINT**.

Under pressure connections: To WSA 03 clause 22.2.

Inserted Tee connections: To WSA 03 clause 22.3.

Verify on site measurements: Check all relevant measurements on site and submit a proposal to adjust work to fit the connection to the existing as required. This is a **HOLD POINT**.

Connection and/or charging the new mains: Submit a request to charge the new mains to WSA 03 clause 22.4, including the time that will cause the least interference, isolation of the mains and notification of the affected dwelling occupants. This is a **HOLD POINT**.

Temporary private services: Reconnect all properties supplied by a temporary private service to WSA 03 clause 22.5.

4.10 RESTORATION OF SURFACES

General

Original condition requirement: Restore carriageway pavements, pathways, lawns and fencing and other improved areas in a continuous manner to a condition equivalent to that existing at the commencement of the works. Restore progressively and as soon as possible after the section of works is completed. This is a **HOLD POINT**.

Maintenance requirement: Maintain all restored surfaces in the restored condition until the expiry of the applicable Defects Liability Period, whether or not any deterioration of the restored surfaces is due to defects which become apparent or arise during the Defects Liability Period.

Restoration of surfaces: Conform to *1152 Road openings and restoration (Utilities)* and WSA 03 clause 23.

Property owner advice: Provide notice to affected property owners of any pending works.

Vertical tolerance: Structures and fittings on finished surface levels as follows:

- ± 5 mm in road reserves and trafficable areas.
- + 50 mm, - 20 mm in private property non-trafficable or occasional traffic areas.

Backfill

Requirement: In other than roadways, place the backfill sufficiently high to compensate for expected settlement and carry out further backfilling or trim the original backfill at the end of the Defects Liability Period so that the surface of the completed trench conforms to the adjacent surface.

Dry weather conditions: If dry weather conditions have persisted after the original backfilling, including during the Defects Liability Period, consolidate the trench before removing surplus materials from the site.

Disposal of surplus material: Submit for approval a proposal for spreading the surplus material neatly in the vicinity of the trench to avoid future erosion of the backfill and adjacent ground surfaces. This is a **WITNESS POINT**.

Tunnelling: If tunnelling under paving, kerb and gutter or other improved surfaces instead of trenching, backfill to restore full support to those surfaces.

Bushland

Environmental: Carry out bushland restoration works in conformance with the Environmental Regulator.

Promote rapid regrowth: As near as is practicable, restore the works area to the pre-existing condition and leave the site in a condition that will promote rapid re-growth of native bush plant species.

Topsoil: Return stockpiled topsoil to its pre-construction location and place to minimise erosion.

Pre-existing vegetation: Use pre-existing vegetation as a seed source and place branches and/or logs across the slope to intercept runoff.

4.11 COMMISSIONING

General

Procedure: Test and commission the water reticulation system in conformance with the commissioning procedure, schedules and record sheets in conformance with WSA 03 clause 6.2.3.

Supervision: Provide continuous supervision by personnel experienced in the operation of the equipment and have qualified personnel in attendance to carry out all necessary adjustments and/or remedial work during the commissioning tests.

4.12 CONSTRUCTION COMPLIANCE

Work-as-executed details

Operation and maintenance: Submit work-as-executed details and operation and maintenance information as follows:

- Work-as-executed drawings in the same format as the design drawings and certified by a Registered Surveyor.
- Showing the actual location and alignment of pipelines. Include the size, type, levels of pipelines, valve and hydrant chamber types and cover details and easement requirements for maintenance.
- Asset register data.

4.13 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	Limits/Tolerances	Worksection subclause
MATERIALS		
Valves and hydrants		
Double orifice air valves minimum size	DN 80	**Control valves**

Activity	**Limits/Tolerances**	**Worksection subclause**
Non-return valves lifting lugs	≥ DN 250.	
No flow switch minimum rating	10 amps, 240 V AC, 50 Hz	
Top of spring hydrants	between 100 mm and 200 mm below finished surface level	**Hydrants**
Access covers: - Single part round covers ≥ DN 375 - Multi-part covers	 0.3 ± 0.03 mm gap Max 4 mm gap	**Surface fittings**
EXECUTION		
Establishment		
Water mains horizontal lateral displacement from the design alignment	± 100 mm	**General**
Appurtenances and structures horizontal: - Lateral displacement from the design alignment - Lateral displacement along the water main axis	 ± 100 mm ± 200 mm	
Property services horizontal displacement along the water main axis.	± 100 mm	
Water meters horizontal displacement from design position.	± 100 mm	
Water mains, property connections and structures vertical cover.	± 50 mm minimum	
Hydrant risers, access chambers, shrouds and aqueduct verticality:	30 H (mm): 1000 V (mm).	
Structures higher than 5m verticality:	50 H (mm)	
Excavation for water supply systems		
Excavation across improved surfaces: - Saw cut neat straight lines	 ≥ 150 mm beyond the outer limits	**General**
Support	All trenches > 1.5 m in depth or in unstable ground strata	**Support of excavation**
Trench width	Not more than 500 mm over the minimum trench width	**Trench excavation**
Clearance for onsite works	Clear space ≥ 500 mm in all directions from the workface	
Stockpile: Distance between the edge of any excavation and the inner toe of stockpiles.	600 mm minimum	
Bedding for pipes		
Foundation: - Bearing capacity. - Minimum trench depth	 > 50 kPa + 0mm, - 50 mm	**Trench floor preparation**

Activity	**Limits/Tolerances**	**Worksection subclause**
Pipes other than PVC/PE: Non-cohesive granular bedding below the barrel and socket	75 mm minimum thickness	**Bedding and pipe support**
Pipe laying, jointing and connecting		
Cast-in situ concrete structures and slabs	± 0.5% or 5 mm which ever is greater	**Thrust and anchor blocks and restrained joints**
Concrete thrust, anchor blocks and bulkheads	+ 5%, - 2%.	
Field joints: overlap of sleeving	250 mm minimum	**Wrapping of ductile iron pipelines**
Chamber covers and frames: - Gradual irregularities - Exposed edges - Cover - Frame	 No more than 3 mm Minimum 4 mm radius. – 3 mm +0 mm – 3 mm +3 mm.	**Valve chambers for large diameter mains**
Concrete embedment and encasement		
- For trenches in other than rock:	150 mm minimum dimension under, on both sides and on top of the pipe barrel.	**Genera**l
- For trenches in rock:	75 mm minimum dimension under the pipe barrel, 150 mm on top of the pipe barrel and for the full width of trench excavated.	
Distance: Mark plate with legible numbers	80 mm high minimum	**Marking**
Acceptance testing		
Time period for specified test pressure	≥ 6 hours	**Hydrostatic pressure testing**
Restoration of surfaces		
Vertical tolerance for structures and fittings on finished surface levels: - In road reserves and trafficable areas. - In private property non-trafficable or occasional traffic areas	 ± 5 mm + 50 mm, - 20 mm	**General**

1342 WATER SUPPLY – PUMP STATIONS (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide water supply pump stations as documented, including booster pumps, non return valves, mechanical, connections to the network, pipe work, manifold, equipment, devices, pressure accumulator tank, power, telemetry, alarms and housing structures.

Precedence
Precedence: The technical requirements of, or any standard drawing provided by, the Water Authority, used in conjunction with and in conflict with this worksection, take precedence.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Traffic control.*
- *1341 Water supply – reticulation (Construction).*

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

Standards

AS 1111	ISO metric hexagon bolts and screws—Product grade C
AS 1111.1-2000	Bolts
AS 1112	ISO metric hexagon nuts
AS 1112.1-2000	Style 1 – Product grades A and B
AS 1112.2-2000	Style 2 – Product grades A and B
AS 1272-1974	Unsintered PTFE tape for thread sealing applications
AS 1349-1986	Bourdon tube pressure and vacuum gauges
AS/NZS 1359	Rotating electrical machines - General requirements
AS/NZS 1359.5:2004	Three-phase cage induction motors - High efficiency and minimum energy - performance standards requirements
AS 1627	Metal finishing—Preparation and pre-treatment of surfaces
AS 1627.4-2005	Abrasive blast cleaning of steel
AS 1657-1992	Fixed platforms, walkways, stairways and ladders—Design, construction and installation
AS/NZS 1680	Interior lighting
AS/NZS 1680.2.4:1997	Industrial tasks and processes
AS 2528-1982	Bolts, stud bolts and nuts for flanges and other high and low temperature applications
AS/NZS 3000:2007	Wiring rules
AS/NZS 3008	Electrical installations—selection of cables
AS/NZS 3008.1.1:2009	Cables for alternating voltages up to and including 0.6/1 kV—Typical Australian installation conditions
AS/NZS 3190:2011	Approval and test specification - Residual current devices (current-operated earth-leakage devices)
AS/NZS 4680:2006	Hot-dipped galvanized (zinc) coatings on fabricated ferrous articles

AS 60529-2004	Degrees of protection provided by enclosures (IP Code)
AS 60947	Low voltage switchgear and control gear
AS 60947.5.1-2004	Control circuit devices and switching elements - Electromechanical control circuit devices
ASTM A240/A240M:2012	Standard specification for chromium and chromium-nickel stainless steel plate, sheet and strip for pressure vessels and for general applications

Water Services Association of Australia (WSAA)

WSA 03-2011	Water Supply Code of Australia version 3.1
WSA 130-2011	Industry standard for ISO end suction centrifugal pumps
WSA 131-2011	Industry standard for ISO end suction centrifugal motor pumps

1.4 STANDARDS

General

Standard: To WSA 03 Part 2.

1.5 INTERPRETATIONS

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- ITP: Inspection and Test Plan.
- PLC: Programmable Logic Controller.
- PVC: Polyvinyl Chloride.
- RTU: Remote Telemetry Unit.
- SCA: Switchgear and Control gear Assembly.
- SCADA: Supervisory Control and Data Acquisition.

Definitions

General: For the purposes of this worksection the definitions given in WSA 03 and the following apply:

- Commissioning: Running the plant and equipment to make sure there is flow through the pumping system, carrying out any necessary testing and adjustments until it is ready and suitable for normal starting and running under service conditions.
- Electricity distributor: Any person or organisation that provides electricity from an electricity distribution system and includes distributor, supply authority, network operator, local network service provider, electricity retailer or electricity entity, as may be appropriate in the relevant jurisdiction.
- Nominal size (DN): Dimensionless whole number, which is indirectly related to the physical size, in mm of the bore or outside diameter of the end connections.
- Pre-commissioning: Preparation of plant or equipment so that it is in a safe and proper condition and ready for commissioning and operation. It includes all aspects of plant operation such as safety, electrical, mechanical and instrumentation.
- Water Agency: An authority, board, business, corporation, Council or local government body with the responsibility for planning or defining, design, construction and maintenance requirements for a water supply and/or sewerage systems.

1.6 SUBMISSIONS

Approvals

Submissions: To the Superintendent's approval. Submit the following for approval:

- Calculations: Survey set out of pump station and quantity calculations.
- Components: Pumps, pipes, fittings, valves and hydrants.
- Work-as-executed drawings: Include water supply pump station information sheets and works.
- Execution details: Refer to **HOLD POINTS**.
- Materials: Off-site certificates of components.
- Samples: For conformity testing to relevant standards.
- Technical data: Product information.

1.7 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/ Item	Requirement	Notice for inspection	Release by
MATERIALS			
General			
Authorised products and materials	Submit for approval alternative products and materials.	2 weeks before ordering	Superintendent
Electrical equipment	Submit all shop drawings for approval	2 weeks before ordering	Superintendent
EXECUTION			
Electrical requirements			
General - Electrical safety and earthing	Test for defects and submit a certificate of safety declaration.	1 week	Superintendent
Electrical installation - Marker tape	Submit for approval underground cabling requirements.	2 weeks	Superintendent
Practical completion			
General - Requirement	Test and commission and submit completed commissioning record sheet	3 working days	Water Agency and/or Superintendent
General - Requirement	Obtain approval of the Operating and Maintenance Manuals	1 week before operating	Water Agency and/or Superintendent

WITNESS POINTS table

Clause title/ Item	Requirement	Notice for inspection
MATERIALS		
General		
Compliance with manufacturers recommendations	Inspect material and products at time of delivery.	2 working days
EXECUTION		
Establishment		
General - Set out	Confirm the set out locations immediately prior to construction.	3 working days.
Electrical requirements		
General - Approval of electrical products and materials	Submit proposal for all equipment for approval	2 weeks
Pre-commissioning		
General	Test and prepare the pump station and submit pre-commissioning record.	3 working days
Commissioning		
General - Notification	Give notice of the intention to undertake commissioning	5 working days

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program so that it conforms with the approved products and materials.
- Authorities: Arrange approvals and conform to the local environmental requirements e.g. protection of the environment and heritage areas.
- Control of erosion and sedimentation: Prepare an erosion and sediment control plan before starting the works.

3 MATERIALS

3.1 GENERAL

Authorised products and materials

Products and materials: Provide only products and materials authorised by the Water Agency, the drawings and this specification. Submit for approval any alternative or non-authorised products and materials. This is a **HOLD POINT**.

Unauthorised material: Remove unauthorised or non-conforming materials from the site within 24 hours.

Conformance with manufacturer's recommendations

Requirement: Handle, transport and store materials in conformance with the manufacturer's recommendations and in a manner to prevent damage or deterioration or excessive distortion. Inspect all products and materials at the time of delivery and reject products and materials not in conformance with this specification and the manufacturers recommendations. This is a **WITNESS POINT**.

On site storage: Store in protective crating or packaging until immediately before use.

Damaged or defective materials: Do not use damaged or defective materials, including coatings and linings, outside the manufacturer's recommended limits.

Equipment

Manufacturer's warranty: Provide a written warranty from the manufacturer of the equipment covering liability for any defect in materials or workmanship which becomes apparent at any time within 2 years after the date of delivery of any piece of equipment.

Material: Minimum material requirement to the WSA 130 Table 2.2.

3.2 PUMP EQUIPMENT

General

Pumps: Provide pumps to WSA 130, WSA 131 and the **Pump equipment schedule**.

Independent witness testing: Test all pumps before delivery. Provide certificate for testing and the following data:

- Head (m)/quantity (L/s) curve.
- Pump input power curve (kW).
- Pump efficiency curve (%).
- NPSHR curve(s).

Motors: Test motors before delivery and submit certificate in conformance with AS/NZS 1359.5.

Pump equipment schedule

Requirements	Equip 1	Equip 2	Equip 3	Equip 4
Purchasing requirements				
Nominal size (DN x DN)				
Pump capacity				

Requirements	Equip 1	Equip 2	Equip 3	Equip 4
(L/s)				
Testing requirements				
Collection tank dimensions (mm)				
Tank and cover specification				
Class of tank access cover				

3.3 ELECTRICAL EQUIPMENT

General

Provide: Provide all switchboard(s), control panels, level control devices and level probe support brackets required for each pump station.

Shop drawings: Submit all shop drawings for approval before manufacture. This is a **HOLD POINT**.

Switchboards

Requirement: Provide complete switchboards with circuit breakers, contactors, fuses, soft starters, relays, timers, instruments and accessories.

Type: Outdoor, stationary, free standing, metal-enclosed, cubicle type series with a minimum degree of protection of IP56D in conformance with AS 60529 and the following:

- Securely mount all equipment on suitable mounting panels.
- Individual compartments.
- Provide a steel galvanized channel base.

Test: Test switchboards before delivery and provide certificate from the manufacturer.

Manufacturer: Conform to AS/NZS 3190 and submit certification including ITP and circuit diagrams.

Fault current: Show prospective fault currents for each installation on the respective power circuit diagrams. Confirm all fault levels with the electrical distributor.

3.4 STEEL AND CONCRETE

Structural steel and concrete

General: Conform to the NATSPEC *03 Structure* worksections relevant to the structure being constructed.

Ancillary steelwork

Ladders, brackets and covers: To AS 1657.

Abrasive blast cleaning: To AS 1627.4 Class 2.5.

Protection: Hot-dip galvanize to AS/NZS 4680.

Ancillary concrete works

Premixed, normal class concrete: To *0319 Minor concrete works*.

3.5 PIPES AND FITTINGS

General

Requirement: Provide pipes and fittings in conformance with the drawings, the schedules and *1341 Water supply – reticulation (Construction).*

3.6 VALVES AND HYDRANTS

General

Requirement: Provide valves and hydrants in conformance with the drawings, the schedules and 1341 *Water supply – reticulation (Construction).*

3.7 NUTS, BOLTS AND WASHERS

General
Standard: To AS 1111.1, AS 1112.1 and AS 1112.2, ISO metric series and fitted with washers beneath bolts heads and nuts as follows:

- Stainless steel to ASTM A240/A240M, minimum grade 316.
- Passivated.
- Rolled threads.
- Hexagonal heads.
- To AS 2528.
- Fit with lock washers/nuts as required for vibration.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General
Requirement: Conform to *1101 Control of traffic*.

4.2 ESTABLISHMENT

General
Set out: Confirm pump station and equipment location before construction. This is a **WITNESS POINT**.

Space allocations: Conform to any space allocation agreements, local agreements with land owners or other utility service provider.

Temporary drainage during construction
General: Conform to the requirements of *1341 Water supply – reticulation (Construction).*

4.3 EXCAVATION

General
Requirement: Conform to the requirements of *1341 Water supply – reticulation (Construction).*

4.4 BOOSTER PUMPS

Construction
General: Construct the water booster pumping station and associated works to the documented levels, grades, materials and methods. Implement and maintain environmental protection measures before disturbing the natural surface on site. Conform to *1152 Road openings and restorations* if work is carried out in roadways.

Installation
General: Install pumps, discharge equipment and other associated equipment in conformance with the drawings and manufacturer's recommendations. Undertake and complete all work, including fittings, before connecting to the water supply system.

Provision for maintenance
Maintenance: Provide dismantling joints and valves in the pipe work to facilitate removal of the pumps for maintenance and minimise the need for surge control devices. Make sure all pumps in the booster are identical and interchangeable with a pump operation of no more than 47.5 Hz and include temperature sensors.

4.5 PRESSURE GAUGES

General
Requirement: Install one diaphragm protected, glycerine oil filled, direct mounting, bottom connection pressure gauge complying with AS 1349 for centrifugal pump installation.

Inclusions: Provide each gauge with sized metric equivalent of 3 bronze fittings including gate valve, union, nipple and reducing nipple.

Protective case: Fabricate from stainless steel in conformance with ASTM A240/A240M or bronze. Provide a case which can be dismantled for cleaning without affecting the accuracy of the gauge.

Calibration: 100 mm diameter gauge face, calibrated in head (m) of water indicating the pump operating head and the pump no-flow head.

Installation

Requirement: Conform to the following:

- Pipework ≥ 150 mm: Screw gauges and fittings into the pipe wall of ductile iron pipes or pipe fittings. Install a ball valve to allow removal of the gauge where required.
- Pipework < 150 mm: Screw gauges and fittings into a tapping band.

Gauge range: For single or parallel pumps duty, 0 to 1.7 times the shut off head of the pumps.

4.6 BOLTS

General

Protrusion of bolts on flanges: No more than 10 mm past the nut when tightened.

Anti-galling, anti-seize: Apply to threads of all stainless steel fasteners either of the following:

- Polytetrafluroethylene (PTFE): Either tape to AS 1272, dipped or sprayed.
- Molybdenum disulphide.

Concrete anchor bolts, nuts, locking nuts and large series washers: Provide anchor bolts with a minimum diameter of 16 mm to the equipment manufacturer's details.

Concrete anchor bolts: Chemical masonry type set to full depth.

4.7 ELECTRICAL REQUIREMENTS

General

Standards: To AS/NZS 3000.

Proof of conformance: Provide proof of conformance with test certificate from an approved independent testing authority.

Electrical safety and earthing to water services: Test for defects in the electrical supply, provide a conductive bridge around the work area if required, notify occupants and electricity distributors of any change. Provide a certificate of safety declaration to proceed. This is a **HOLD POINT**.

Approval of electrical products and materials: Submit proposal for all equipment for approval. This is a **WITNESS POINT**.

Power system and supply: Provide for continuous monitoring of the availability of incoming power supply, power supply at the station and the control power supply.

Lighting: To AS/NZS 1680.2.4.

Lightning and surge protection: Provide to all incoming power supply and control power supply.

Electrical installation

Supply authority requirements and metering: Conform to the following:

- Submit an Application for supply to the electricity distributor.
- Make sure that permanent power is available before completion of the electrical installation.
- Submit an Application for service requirements and Notification of Electrical work to the electricity distributor.
- Pay all fees associated with the metering including inspection fees and capacity charges.
- Provide copies of all applications.
- Mount the metering equipment inside the switchboard or as shown on the drawings.

Point of supply: Obtain a service marking from the electricity distributor. Confirm the point of attachment.

Cabling: Provide all cabling including consumer mains, motor, control and flow meter cables, conduits and electrical pits.

Underground cabling: Submit for approval underground cabling requirements. This is a **HOLD POINT**.

Conduits: Install all wiring in HD-PVC underground conduits in conformance with the following:

- Laid to the electricity distributor's requirements.
- Tolerances:
  - Non-trafficable areas: Minimum 500 mm below the finished ground level.
  - Trafficable areas: 600 mm below the finished ground level.

- Clear the trench and backfill material of rocks and other foreign matter likely to damage the conduits.

Marker tape: Run electrical marker tape 150 mm below the finished ground level directly above the conduits for the entire length of the conduits. Conform to the following:

- Colour: Orange.
- Width: 150 mm.
- Warning text: Stamped with the words DANGER—ELECTRIC CABLES BELOW or similar.

Brass marking plates: Position brass marking plates on any concrete surround clearly showing the direction of the incoming consumer mains and including the following:

- Wording and markings: DANGER – ELECTRICAL CABLES BELOW.

Consumer mains: Generally run the consumer mains underground and commence at the Point of Supply/Attachment on a consumer's steel pole (if applicable), installed near the property boundary and run in conduit to the switchboard.

Minimum size: Size consumer mains to satisfy the following requirements:

- Current carrying capacity to suit the maximum demand with an excess current carrying capacity of 30% minimum.
- A voltage drop less than 1.5% to the maximum demand as calculated.
- Single core PVC/PVC cables. XLPE insulated cable may also be used.
- In conformance with the requirements of the electricity distributor.
- Pole termination method as shown on the drawings.
- To AS/NZS 3000 and AS/NZS 3008.1.1.

Earthing

Combined earthing system: Provide an MEN earthing system in conformance with AS/NZS 3000, the electricity distributor and the relevant state Service and Installation Rules.

Earthing conductor: Size and installation to the relevant state Service and Installation Rules and AS 3000. Run the main earthing conductor in conduit to the main earthing electrode.

Earthing connection: Contain the main earthing connection in an earthing electrode connection box,

Pipe work: Bond the pump station metallic pipe work to the main earth

Surge diverters: Provide a separate earthing conductor and electrode for the surge diverters, bond each electrode and label with engraved brass label.

Labelling: Label all major earth connection cables clearly at both ends.

Metering equipment

Requirement: Install metering facilities and panel within the switchboard as follows:

- To the approval of the electricity distributor.
- Suitable for the installation of the metering equipment required by the electricity distributor.
- Plug-in meter bases or all electricity meters (tariffs) supplied by the electricity distributor, as may be required by the electricity distributor.
- Service potential fuses.
- Current transformers metering equipment (if required).
- All necessary wiring and other accessories required by the electricity distributor.
- Key locking facilities for electricity distributor access.

Lock barrels: Liaise with the electricity distributor to supply a lock barrel for the metering equipment.

Switchboard

Standard: To AS 60947.5.1.

Switchboard manufacturer: Provide the switchboard and control gear designed and assembled by an approved manufacturer. Full AS/NZS 3190 certification including ITP and AS/NZS 3190 documentation for circuit diagrams.

Type: Outdoor, stationary, free standing, metal-enclosed, cubicle type series with a minimum degree of protection of IP56D in conformance with AS 60529. If the switchboards are installed within the pump station buildings the minimum degree of protection will be IP51. Switchboards to conform to the following:

- Securely mount all equipment on suitable mounting panels.

- Provide individual compartments for equipment as documented.
- Provide a steel galvanized channel base.

SCA electrical characteristics: Conform to the following:

- Main Circuit: 415/240 V, 50 Hz, 3-phase, 4-wire.
- Motor Control Circuit: 240 V, 50 Hz.
- Common Control Circuit: 240 and 24 V, A.C.
- Prospective short-circuit current: 14 kA for 1 second.
- Peak Factor: 2.2.
- Power Factor Correction (Determined in consultation with the Water Agency).
- Earthing (Multiple Earthed Neutral (MEN system).

Switchboard installation

Lifting and placement: Provide appropriate lifting facilities including lifting rods inserted through lifting loops in the switchboard support frame or lifting lugs.

Equipment mounting: Mount switchboards as shown on the drawings.

Thermal derating of equipment:

- Derate switchgear installed in switchboards to the manufacturer's recommended derating or to 88% of the equipments nominal current rating, whichever is the greater.
- Derate solid state power equipment installed in switchboards to the manufacturer's recommended derating or to 77% of its nominal 35°C current rating, whichever is the greater.

Switchgear data: Confirm Type 2 co-ordination between contactors, motor protection relays and corresponding circuit breakers.

Starter contactors: Confirm starter contactors have the appropriate rating for the proposed pumps to AC3 duty.

Lightning and surge protection: Confirm provision for all incoming power supply and control power supply as documented.

Operation: Make sure the AUTO mode can be overridden by turning the starter selector switch to the ON position.

- Manual operation: For use in the event of failure of the telemetry system or for function testing.
- Warning label: Provide a warning label (R/W/R) advising selector switches to be left in the AUTO mode to common control cover.

Pump control: Provide control equipment compatible with the existing equipment.

Lock barrel: Standard lock barrels for use on the switchboard are provided by the Superintendent.

Terminals: Provide the necessary terminals with terminal and cable numbers in conformance with the drawings. Connect the pump motor cables to the appropriate terminals. Do not joint cables.

Cable entry: Provide gland cables entering the outdoor switchboard compartment using non-ferrous metallic or plastic glands with neoprene compression seals.

Sealing: At the completion of commissioning tests, seal all conduits into the outdoor SCA with a non-setting sealing compound to prevent the ingress of vermin.

Completion of electrical works

Notification: Submit to the electricity distributor, the Notification of wiring completed by the switchboard manufacturer together with the Notification of wiring covering the installation work.

Switchboard metering panel: Attach a copy of the Notification of wiring for the switchboard to the switchboard metering panel.

Verification: Arrange inspection and testing for the electrical works in conformance with the electricity distributor.

Work-as-executed drawings: Provide electrical installation drawings showing changes that occurred during installation. Show prospective fault current for each installation on the respective power circuit diagrams.

4.8 CONTROL AND TELEMETRY

General

Requirement: Install telemetry hardware including radio, antenna, surge protection and associated cabling between the RTU in the switchboard and the antenna as documented. Submit proposal for equipment as required.

Communication service: Provide a communication service compatible with the existing system.

SCADA: Install SCADA to conform with manufacturers recommendations including upstream and downstream clearances. Connect pump station, reservoir, tank, control valves, flow meters and chambers to the SCADA for monitoring and control to conform with the drawings.

Alarms and controls: Provide an alarm and control system as documented and in conformance with the following:

- Do not use flashing lights.
- Wire digital input signals into a dedicated labelled terminal strip.
- Wire all signals from the dedicated terminal strip to an RTU cubicle marshalling terminal strip and then to the RTU.

Telemetry hardware

Requirement: Provide telemetry hardware in conformance with the following:

- Compatible with any existing systems.
- Allowing space in the switchboard for future installation of terminals.
- Analogue signals running to an interfacing strip with 2 terminals per signal and of the disconnect type.
- Standby power supply for an 8 hour power supply failure.
- Lightning and surge protection housing within the cubicle.

Telemetry software

Telemetry software: RTU/PLC programming and configuration in conformance with the logic drawings, process and instrumentation drawings, configuration list, I/O lists and including central monitoring and display system.

4.9 PRE-COMMISSIONING

General

Requirement: Test and prepare the pump station in conformance with the pre-commissioning procedure, schedules and record sheets in conformance with WSA 03 clause 6.2.3.2. Submit one signed copy of each completed pre-commissioning record sheet countersigned by the agreed independent witness when giving notice of the intention to start commissioning. This is a **WITNESS POINT**.

Specific requirements

Inclusions: Including but not limited to the following:

- Initial charges of lubricant in addition to any special lubricant requirements for initial flushing or treatment of the system or for running in.
- Physical checks and tests including:
  - . Completeness of assembly.
  - . Rotational tests (including checking that the rotation of electrical motors is in the correct direction).
  - . Alignment checks.
  - . Balancing and vibration checks.
  - . Temperature, pressure and flow measurements.
  - . Clearances.
  - . Belt alignment and tension.
- Electrical and instrument installation tests, including motor insulation tests and checking instruments against certified instruments and correcting as necessary.
- Tests for the correct functioning of automatic and manual control and protection equipment, including simulating danger conditions, mal-operations and failures. These tests also include adjusting instrument set points and alarm settings and proving correct operation of alarms.

- Equipment and system operating tests: Certify compliance of each item and submit a signed copy prior to commissioning.

4.10 COMMISSIONING

General

Notification: Give notice of the intention to undertake commissioning. This is a **WITNESS POINT**.

Procedure: Test and commission the pump station in conformance with the commissioning procedure, schedules and record sheets in conformance with WSA 03 clause 6.2.3.

Supervision: Provide continuous supervision by personnel experienced in the operation of the equipment and have qualified personnel in attendance to carry out all necessary adjustments and/or remedial work during the commissioning tests.

Final testing: Carry out final testing and commissioning (min. 1 day duration) of the electrical services in conjunction with the mechanical equipment (e.g. pump, etc) including setting and adjustment of equipment in conformance with state regulations.

4.11 PRACTICAL COMPLETION

General

Requirement: Conform to the following before the Date of Practical Completion:

- Submit a certificate of approval from the relevant statutory authorities.
- Submit one signed copy of each completed commissioning record sheet countersigned by the agreed independent witness. This is a **HOLD POINT**.
- Obtain Superintendent approval of the Operating and Maintenance Manuals. This is a **HOLD POINT**.
- Submit work-as-executed drawings of the pump station.

Work-as-executed details

Requirement: Submit work-as-executed details as follows:

- Work-as-executed drawings in the same format is the design drawings, certified by a Registered Surveyor.
- Showing the actual location of pump station and details including the size and type of pipes, valves, hydrants and pumps, switchboard equipment details.
- Asset register data.

Operation and maintenance manuals

Submit: Provide 3 copies of operation and maintenance manuals at the time of notification of commissioning. Include the following information in the manuals:

- Contractor's name, address and telephone number.
- Client's contract number, job name.
- Circuit diagrams.
- Electrical and mechanical layout.
- Workshop fabrication drawings.
- Commissioning manual.
- Pump station general arrangement drawing showing pumps, motors, valves, pipework, switchboard and electrical installation.
- Safe working procedures: For switching and isolating the supply and distribution system.
- Description of operation.
- Maintenance procedures: Recommended maintenance periods and procedures.
- Tools: Particulars of maintenance equipment and tools provided, with instructions for their use.
- Equipment: A technical description of the equipment supplied, with diagrams and illustrations where appropriate.
- Dismantling: Where necessary, procedures for dismantling and reassembling equipment;
- Spare parts: A list of the spare parts provided.
- Trouble shooting instructions for pumps, motors, valves and SCA.

- Assembly/disassembly procedures: Step-by-step procedures for dismantling and reassembly of pumps, motors and valves using any special tools.
- Replacement procedures: Step-by-step procedures for replacement of wearing parts such as bearing, seals, wear rings, etc.

Pump and motor curves: Include the following test curves in the manuals:

- Pump witnessed test curves.
- Motor test curves.
- Motor torque/speed/efficiency characteristic curves.

Pumps: Include the following information in the manuals for pumps:

- Manufacturer.
- Type and model number.
- Serial number.
- Dimensioned general arrangement drawing of pump and motor.
- Sectional arrangement drawing with parts and list.
- Dimensioned sectional arrangements detailing:
  . Maximum and minimum shaft/bearing clearance (radial).
  . Maximum and minimum impeller/bowl clearance (radial).
  . Maximum and minimum impeller/bowl clearance (axial).
  . Impeller/bowl wear rings.
  . Motor/pump coupling—type, make and model number.
  . Mechanical seals where applicable.

Motors: Include the following information in the manual for motors:

- Manufacturer.
- Type and model number.
- Serial number.
- Dimensioned general arrangement drawing.
- Sectional arrangement drawing for submersible motor power cabling where applicable.
- Gland sealing arrangement drawing for submersible motor power cabling where applicable.
- Cables where applicable.
- Terminal block arrangement drawing where applicable.

Valves: Include the following information in the manuals for valves:

- Dimensioned sectional arrangement drawing with parts and material list for all valves.

4.12 LIMITS AND TOLERANCES

Application

Summary: In addition to the limits and tolerances documented in *1341 Water supply – reticulation (Construction)* the following are applicable to this worksection, summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection subclause**
EXECUTION		
General		
Concrete anchor bolts, locking nuts and washers diameter	16 mm minimum	**Bolts and flanges**
Electrical requirements		
Cover to HD-PVC underground conduits		**Electrical installation**
- Non-trafficable areas	500 mm minimum below the finished ground level	
- Trafficable areas	600 mm below the finished ground level.	

1351 STORMWATER DRAINAGE (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Provide drainage works as a complete system for collecting and carrying stormwater from roadways, open spaces and built-up areas as documented. Include Water Sensitive Urban Design (WSUD) principles as follows:

- Preparation for stormwater drainage construction.
- Temporary drainage during construction.
- Detention or re-use of stormwater.
- Vegetation filtering or water efficient landscaping.
- All work associated with erosion control.

Performance

Precedence: Where any Council adopted document used in conjunction with this worksection includes technical requirements that conflict with this worksection, the requirements of the Council adopted document shall take precedence.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152 Schedule of rates – supply projects.*
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0257 Landscape – Roadways and street trees.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1102 Control of erosion and sedimentation (Construction).*
- *1112 Earthworks (Roadways).*
- *1121 Open drains, including kerb and channel (gutter).*
- *1352 Pipe drainage.*
- *1353 Precast box culverts.*
- *1354 Drainage structures.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection 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 1289.3.2.1-2009	Soil classification tests - Determination of the plastic limit of a soil - Standard method
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 4.4.1-1997	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 2566	Buried flexible pipelines
AS/NZS 2566.1:1998	Structural design - Commentary
AS/NZS 2566.2:2002	Installation
AS 3600-2009	Concrete structures
AS/NZS 3725:2007	Design for installation of buried concrete pipes
AS/NZS 3725 Supp 1:2007	Loads on buried concrete pipes - Commentary (Supplement to AS/NZS 3725:2007)
AS 3735-2001	Concrete structures retaining liquids

Other publications

Institute of Public Works Engineering Australia (IPWEA)

IPWEA (NSW)-2010	Specification for the supply of recycled materials for pavements, earthworks and drainage (Greenspec)

NSW Department of Environment and Conservation – 2006

Managing urban stormwater – Harvesting and Reuse.

1.4 INTERPRETATIONS

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- D: External diameter of the pipe.
- NATA: National Association of Testing Authority.
- WSUD: Water Sensitive Urban Design.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Materials: In conformance with relevant worksection.
- Inadequate foundation material: Material beneath or adjacent to the proposed drainage structures which the Superintendent deems to be of insufficient strength to support the structure and loads on the structure, or material whose characteristics the Superintendent deems would adversely affect the performance or construction of the drainage structure.
- Selected fill: Backfill material with known properties and grading placed and compacted in layers.
- Water Sensitive Urban Design (WSUD): Design principles aimed at improving the sustainable management of the urban water cycle. It integrates the planning and design of urban water cycle, water supply, waste water, stormwater and groundwater management, urban design and environmental protection.

1.5 SUBMISSIONS

Approval

Submissions: To the Superintendent's approval.

Documents

General: Submit the following for approval:

- Materials: Off-site certificates of components including certificate of the source of the materials used.
- Temporary drainage: Detailed proposals for diversion of existing flow paths.
- Calculations: Survey set out of stormwater works and quantity calculations.
- Work-as-executed drawings: Include stormwater system information sheets and works.
- Components: Pipes and fittings.
- Samples: For conformity testing to relevant standards.
- Technical data: Product information.
- Execution details: Refer to **HOLD POINTS**.
- Adverse ground conditions: NATA certificate for pH and electrical resistivity of soil tested to AS 1289.4.3.1 and AS 1289.4.4.1.

1.6 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Authority Approvals			
Temporary drainage	Submit details of procedures/devices for approval	2 weeks prior to site commencement	Superintendent
MATERIALS			
Bedding, support and backfill material			
Durability - Geotechnical NATA test	Submit tests for pH and resistivity	1 week prior to proceeding	Superintendent
Durability - Test for concentration of impurities	Test for chloride, sulphate and aggressive CO_2	1 week prior to proceeding	Superintendent
EXECUTION			
Establishment			
Siting of Culverts - Survey set-out	Submit survey set-out of culvert inlets and outlets for approval	1 week prior to proceeding	Superintendent
Siting of Culverts - Changes by Contractor	Submit proposed changes for approval	1 week prior to proceeding	Superintendent
Excavation near underground services - Public utilities	Obtain approval for adjacent excavation	1 week prior to proceeding	Superintendent
Excavation near underground services - Contact DIAL 1100 BEFORE YOU DIG	Contact DIAL BEFORE YOU DIG	1 week prior to proceeding	Superintendent
Excavation near underground services - Marking	Submit marking for approval	1 week prior to proceeding	Superintendent
Construction traffic - Protection measures	Submit certification and verification of protection measures	3 working days	Superintendent
Excavation for drainage systems			
General - Confirmation	Confirm soil type with design	3 working days	Superintendent
Bedding and backfilling			
Uncompacted bedding for steel pipes and pipe arches	Submit details for achieving dense bedding zone	1 week	Superintendent
Water sensitive urban design			
Landscape and vegetation - Plant species selection	Submit plant selection for a particular area	1 week	Superintendent

WITNESS POINTS table

Clause title/Item	Requirement	Notice for inspection

Clause title/Item	Requirement	Notice for inspection
EXECUTION		
Excavation for drainage systems		
Pipelines	Trench size to AS/NS 3735	3 working days
Drainage structures other than pipes	Clear widths between structure and wall of excavation	3 working days
Inadequate foundation material - Notice	Identify unsuitable material and provide remedial measures	3 working days
Inadequate foundation material - Rock foundation	Additional excavation and backfill required if rock is encountered at foundation level	1 week
Bedding and backfilling		
Backfilling – In situ concrete structures	Do not backfill against in situ concrete structures within 14 days of concrete placement	2 working days
Backfilling - Tolerance	Check shape of culvert during backfilling	1 working day
Compaction		
Compaction adjacent to culverts or drainage structures	Rectify any damage	2 working days before proceeding
Additional requirements for compaction of pipe drainage bedding	Provide if erosion of bedding material may occur	1 week
Water sensitive urban design		
Protection – Buffer strips, swales and bioretention systems	Provide temporary protection from construction traffic	3 working days
Protection – Permanent protection	Provide permanent protection from vehicular traffic	1 week

2 PRE-CONSTRUCTION PLANNING

2.1 AUTHORITY APPROVALS

Traffic control
Provision for traffic during construction: To *1101 Control of traffic.*

Temporary drainage
Documentation: Submit details of procedures/devices to maintain effective drainage of the works area during construction. This is a **HOLD POINT**.

Road opening permit
Application: Submit application to the relevant Council for approval to undertake works to road or footpath. This application includes but is not limited to the following information:

- Opening and compaction specifications: To *1152 Road openings and restoration (Utilities).*

2.2 ESTABLISHMENT

Documentation
Survey control: Required for the following:

- Mapping and pegging the drainage system.
- Locating components.

2.3 SCHEDULING

Program of works
General: Program the works as follows:

- Materials: Arrange the program for compliance and handling of components and materials.
- Authorities: Conform with approvals and the local environmental requirements.
- Constraints: Incorporate **HOLD POINTS** and **WITNESS POINTS**.

3 MATERIALS

3.1 GENERAL

Certificate of conformity

Verification: Provide certificates of conformance to the specification for all pipes, culverts, precast concrete units, access covers, road grates or frames and all materials and components.

Certificate: Identify the item and record the inspection and test records that verify conformity.

Materials and components

Pipes: To *1352 Pipe drainage*.

Precast: To *1353 Precast box culverts*.

Structures: To *1354 Drainage structures*.

3.2 BEDDING, SUPPORT AND BACKFILL MATERIAL

General

Recycled material: To *Specification for supply of recycled material for pavements, earthworks and drainage*. Submit for approval any recycled material proposed.

Durability

Geotechnical NATA test: Determine the pH and resistivity of water and soil in conformance with AS 1289.4.3.1 and AS 1289.4.4.1. This is a **HOLD POINT**.

Test for concentration of impurities: Carry out groundwater or soil extract testing for chloride, sulfate and aggressive CO_2. Testing to conform to AS 1289.4.2.1. This is a **HOLD POINT**.

Materials and protective treatment for durability: Conform to *1352 Pipe drainage*, *1353 Precast box culverts*, *1354 Drainage structures*.

Bed and haunch zones

Material for bed and haunch zones: Select fill to conform with the following:

- Particle size distribution: Within the limits set out in AS 3725 Table 6 and tested to AS 1141.11.1.
- Plasticity index: To AS 1289.3.2.1 and AS 1289.3.3.1 with a maximum of 6.

Side and overlay zones

Fill material: Select fill material for side and overlay zones of pipes, box culverts and adjacent to other drainage structures to conform with the following:

- Maximum dimension: 50 mm.
- Plasticity index: Between 2 and12 to AS 1289.3.2.1 and AS 1289.3.3.1.

Material adjacent to weepholes

Requirement: Conform to the following:

- Clean, graded, hard and durable stone or river gravel.
- Nominal particle sizes between 10 and 50 mm.
- Maximum particle dimension < 50 mm.
- Minimum particle dimension < 5% by mass passing the 9.5 mm AS sieve.

Flexible pipes

Embankment material: If using flexible pipes and the embankment method, provide embankment material to AS/NZS 2566.1 clause 3.3 or AS/NZS 2566.2 Appendix G.

4 EXECUTION

4.1 ESTABLISHMENT

Temporary drainage during construction

General: For each part of the drainage system, complete the erosion and sedimentation control measures before commencing the drainage works (except those parts of the drainage system forming part of the control measures).

Control of erosion and sedimentation: Conform to *1102 Control of erosion and sedimentation*. Make adequate provision for runoff flows at drainage works under construction or at surrounding areas/structure.

Dams and diversions: Do not dam up or divert existing watercourses (either temporarily or permanently). Submit for approval if required.

Material and equipment: Locate material and equipment clear of watercourses or secure to prevent danger or damage in the event of large runoff flows.

Swales and buffer strips: Protect during construction or make use of the swale as a temporary measure. Provide geotextile with a shallow 50 mm topsoil and instant turf laid perpendicular to the flow path.

Stabilisation of topsoil areas: Immediately following earthworks where required, stabilise the topsoil with hydroseed to *0257 Landscape – roadways and street trees,* **Hydroseeding**.

Siting of culverts

Requirement: Set out the stormwater drainage systems and identify the following:

- The location, lengths and levels at outlets and inlets of pipes and box culvert structures.
- The locations and levels of gully pits, junction boxes, energy dissipators, and inlet and outlet structures.
- The location and levels of the ends of wingwalls and headwalls.
- The location and levels of open drains.

This is a **HOLD POINT**.

Site conditions: If required to suit site conditions, amend the inlet and outlet locations, designed levels or the culvert length as part of the work covered by the schedule of rates.

Changes by contractor: Submit for approval any proposed change to the culvert location, length, designed levels, culvert strength, conditions of installation or cover to suit construction procedures, and provide proposed culvert set-out in addition to the designed set-out. This is a **HOLD POINT**.

Excavation near underground services

Public utilities within the excavation for drainage systems: Obtain approval of the relevant authority for the method of excavation before commencing excavation. This is a **HOLD POINT**.

Contact: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, collecting enquiries and passing them on to affiliated utilities to assist in locating underground pipe and cables (initial response possible within two working days with responses from utilities some time later). See www.1100.com.au.This is a **HOLD POINT**.

Locations: Obtain locations of water, sewer, stormwater, gas, electricity and telephone services.

Marking: Before commencing earthworks, locate and mark existing underground services in the areas which will be affected by the earthworks operations including clearing, excavating and trenching. This is a **HOLD POINT**.

Construction traffic

Protection measures: If proposing to move heavy construction plant or vehicles over pipe or box culverts structures, provide verification and certification of protective measures. This is a **HOLD POINT**.

Existing structures

Existing redundant drainage structures: Demolish and remove existing redundant pipe culverts, head walls and pits as shown on the drawings.

4.2 OPEN DRAINS

General

Detail: Provide open drains, associated embankments and protective linings in conformance with *1121 Open drains, including kerb and channel (gutter).*

4.3 EXCAVATION FOR DRAINAGE SYSTEMS

General

Topsoil: Remove topsoil in conformance with *1112 Earthworks (Roadways)* before undertaking stormwater drainage excavation.

Trench support stabilising: Provide any shoring, sheet piling or other stabilisation of the sides of trench excavations necessary to conform to statutory requirements.

Excavation level: Excavate trench or foundation for stormwater drainage works to the designed level of the bottom of the bedding or foundation. Remove all loose material.

Excavation: Level beds of swales, batter slopes and bioretention trenches shown on the drawings.

Confirmation: Confirm surrounding soil type with design. Give notice if not consistent with the design. This is a **HOLD POINT**.

Pipelines

Trench size for pipelines: Excavate the trench to AS/NZS 3725. This is a **WITNESS POINT**.

Installation condition: [complete/delete]

Side zones of pipe trenches: Density and stiffness requirements to AS/NZS 3725 clause 9.2.3.1 for Type HS3 support.

Embankment installation condition: Prior to placement of bedding and laying pipes, place and compact embankment fill to a height above the top of the bed zone of at least 0.7 times the external diameter of the pipe and for a minimum lateral distance outside each trench wall of 2.5 times the external diameter of the pipe. Place earthworks to *1112 Earthworks (Roadways)*.

Trench installation condition: Complete the embankment to the underside of the selected material zone prior to the commencement of the excavation.

Drainage structures other than pipes

Excavation: Provide clear width between the structure wall and the face of the excavation as the greater of the following:

- 300 mm.
- 1/3 of the excavation face height. This is a **WITNESS POINT**.

Inadequate foundation material

Notice: Give notice of any area of the foundation including the sides of the trenches that may contain material that is inadequate to support the proposed drainage structure. This is a **WITNESS POINT**.

Confirmation of inadequate foundation material: Remove and dispose of inadequate foundation material to *1112 Earthworks (Roadways)*and replace the material to **Bedding, support and backfill material**.

Rock foundation: If rock is encountered at the foundation level, excavate for an additional depth. Backfill and compact the additional excavation with material conforming to the requirements for HS3 pipe support. This is a **WITNESS POINT**.

4.4 BEDDING AND BACKFILLING

Pipe Bedding

Type: Provide bedding depths and compaction for concrete pipes to **Pipe installation dimensions table.**

Pipe installation dimensions table

		Pipe support type						
		U	**H1**	**H2**	**H3**	**HS1**	**HS2**	**HS3**
Dimension (minimum)	x	75 on rock and Nil on soil	100 for D ≤ 1500150 for D > 1500		0.25 D but >100	100 for D ≤ 1500150 for D > 1500		
	y	—	0.1D	0.3D	0.3D	0.1D	0.3D	0.3D
	z	—	—	—	—	≥ 0.7D		

	Pipe support type						
	U	**H1**	**H2**	**H3**	**HS1**	**HS2**	**HS3**
D = External diameter of pipe							

Flexible pipework minimum cover and embedment geometry: To AS/NZS 2566.1 Table 3.1 and Figure 3.1.

Uncompacted bedding for steel pipes and pipe arches

Tolerance: Provide minimum 75 mm thick uncompacted bedding material between the foundation and the outer surface of corrugations.

Firm support: Submit details for achieving a dense bedding zone for uniform firm support of the corrugated structure by ramming or other methods. This is a **HOLD POINT**.

Backfilling

In situ concrete structures: Do not backfill against in situ concrete drainage structures within 14 days of concrete placement. This is a **WITNESS POINT**.

Trench backfill material: Backfill the remainder of the trench to the underside of the subgrade, or selected material zone in conformance with *1112 Earthworks (Roadways).*

Sequence: Commence backfilling and compaction at the pipe or wall to confine future backfill material.

Dimension: Place backfill around the steel pipe or structure, equally balanced on both sides, to the minimum dimension shown on the drawings or as directed.

Tolerance: Check the shape of the culvert during backfilling to ensure that on completion of backfilling, the vertical and horizontal centreline dimensions of the pipe or structure do not vary from the manufacturer's specified dimensions by more than ± 2% for pipes and pipe arches. This is a **WITNESS POINT**.

4.5 COMPACTION

Foundations, bedding and backfilling

Foundations, bedding (other than for pipe drainage) and backfilling: To 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 -within 1.5 m of finished surface	95% 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 required relative compaction before the next layer is commenced.

Moisture content range: At the time of compaction, adjust the moisture content of the material to permit attainment of the required compaction (within the range 60% to 95% of the optimum moisture content), as determined by AS 1289.5.7.1 (standard compaction).

Compacting 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.

Damage: Give notice and rectify any damage caused. This is a **WITNESS POINT**.

Additional requirements for compaction of pipe drainage bedding

Protection of the pipe from construction damage: If required, adjust the layer thickness to avoid damaging the pipe e.g. for the first placed layer above the pipe crown in the overlay zone.

Bed and haunch zones compaction: Select fill material compaction to the appropriate pipe support requirements for concrete pipes in **Bedding material compaction requirements table.**

Bedding material compaction requirements table

Bedding material			**Pipe support type**						
Criteria	**Location**		**U**	**H1**	**H2**	**H3**	**HS1**	**HS2**	**HS3**
Minimum Relative Compaction %	Bed and haunch zones		—	50	60	Concrete	50	60	70
AS1289.5.4.1 (Standard Compaction)	Side and overlay zones:	Cohesionless	—	—	—	—	50	60	70
		Cohesive	—	—	—	—	85	90	95

Material directly under the pipe support: Place and shape the top 0.1D mm of the bedding and haunch material directly under the pipe.

H3 pipe support including concrete bedding: Provide concrete grade N20 to AS 3600. Make sure pipe is suitably reinforced in conformance with AS 3725 as standard elliptically reinforced pipe may not be adequate for H3 pipe support.

Cementitious stabilisation in the bedding and haunch zones: Provide cementitious stabilisation, if the impermeability of the natural ground and the slope of the drainage line is such that erosion of bedding material may occur. This is a **WITNESS POINT**.

4.6 CONCRETE WORK

General

Requirement: Supply and place normal class concrete, sprayed concrete, steel reinforcement, formwork and provide tolerances, construction joints, curing and protection to *0319 Minor concrete works* and as shown on the drawings.

4.7 WATER SENSITIVE URBAN DESIGN

Protection

Buffer strips, swales and bioretention systems: Do not allow any construction traffic access to areas of WSUD or infiltration tools to ensure that the soil compaction remains unaffected and as designed. Provide fences where required to *1195 Boundary fences for road reserves*. This is a **WITNESS POINT**.

Permanent protection: Install bollards, signposting or other street furniture to protect the constructed vegetated areas from damage such as parking of cars. Conform to *1192 Signposting* and *1193 Guide posts*. This is a **WITNESS POINT**.

Vegetated swales and buffer strips

Details: Conform to the drawings and to the following requirements where appropriate.

Preventing ponding: Provide a perforated pipe beneath the swale drain.

Geometry: Trapezoidal or parabolic shapes, side slopes no steeper than 3H:1V.

Longitudinal slope: Conform to the following if longitudinal slope is not within 1 to 4 %:

- Install check dams for slopes greater than 4%.
- Install under drains for slopes less than 1%.

Maximum swale width: 2.5 m.

Bioretention systems

Depth of filter media: Between 0.3 mm and 0.7mm, as shown on drawings.

Saturated hydraulic conductivity: Between 200 mm/hr and 500 mm/hr.

Perforated pipe capacity: Ensure perforated pipe capacity is greater than the infiltration capacity of the filter media.

Depth of drainage layer: 150 mm to 200 mm.

Drainage layer 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.

Liner type: [complete/delete]

Transition layer: Minimum 100 mm thick layer of sand or geotextile fabric.

Gross Pollution Treatment (GPTs) as part of a treatment system

General: Provide GPTs as shown on the drawings.

Treatment objectives: To capture gross pollutants litter and vegetation larger than 5 mm and sediment particles larger than 0.125 mm.

Landscape and vegetation

Landscape and vegetation: Conform to this worksection and *0257 Landscape – Roadways and street trees*.

Minimum depths of topsoil: Conform to the following:

- 150 mm for turf species.
- 300 mm for ground covers and small shrubs.
- 450 mm for large shrubs.
- 600 mm for trees.

Plant species selection: If required, conform to the species as shown on the drawings and submit plant selection for a particular area for approval. Give attention to the plant selection requirements for constructed wetlands, sedimentation basins, ponds and lakes. This is a **HOLD POINT**.

Stormwater re-use

Requirement: Provide stormwater re-use collection, storage, treatment and distribution in conformance with the drawings and this worksection.

4.8 COMPLETION

Inspection

Closed circuit television (CCTV) inspections: Submit a report including video evidence for all drainage structures as follows:

- On completion of all drainage structures and prior to 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 prior to completion to verify tolerances and ensure that there is no obstruction to the flow of water.

Testing

Quality: Test and submit reports for all characteristics in conformance with *0161 Quality (Construction).*

Flushing

General: On completion of the entire system, flush all pipes clean from end to end and leave in proper working order.

5 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of Limits and Tolerances

Activity	Limits/Tolerances	Worksection clause reference
Fill for bed and haunch zones		**Bedding, support and backfill material**
- Maximum size of particles	50 mm	
- Plasticity index	2-12	
Fill adjacent to weepholes		
- Particle size	10 – 50 mm	
Excavation for drainage structures other than pipes		**Excavation and drainage systems**
- Clear width between wall of structure and face of excavation	The greater of 300 mm and 1/3 the face of excavation height	

Activity	Limits/Tolerances	Worksection clause reference
Uncompacted bedding and backfill	Minimum 75 mm thick	**Bedding and backfilling**
Maximum permitted distortion of pipes and pipe arches	± 2% from manufacturers specified dimensions	
Minimum thickness of compacted layer	150 mm	**Compaction**
Maximum width of vegetated swales and buffer strips	2.5 m	**Water sensitive urban design**
Bioretention systems		
- Depth of filter media	0.3 – 0.7 mm	
- Saturated conductivity	200 – 500 mm/hr	
- Depth of drainage layer	100 – 200 mm	
- Transition layer of sand or geotextile fabric	100 mm	
Landscape and vegetation		
- Minimum topsoil depths	- 150 mm for turf species - 300 mm for ground covers and small shrubs - 450 mm for large shrubs - 600 mm for trees	

6 MEASUREMENT AND PAYMENT

6.1 MEASUREMENT

General

Payments made to the Schedule of Rates: To *0152 Schedule of rates – supply projects*, this worksection, the drawings and **Pay items 1351.1, 1351.2 and 1351.3**.

Lump Sum prices: Not acceptable.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology

The following methodology will be applied for measurement and payment:

Erosion and sedimentation control: To *1102 Control of erosion and sedimentation*.

Topsoil removal: To *1112 Earthworks (Roadways)*.

Concrete work: To *1352 Pipe drainage, 1353 Precast box culverts or 1354 Drainage structures.*

Sprayed concrete work: To *0319 Minor concrete works*.

Rock filled wire mattresses and gabions: To *1121 Open drains, including kerb and channel (gutter).*

Excavation and stone pitching of open drains: To *1121 Open drains, including kerb and channel (gutter).*

Miscellaneous minor concrete work: To *0319 Minor concrete works*.

1352 PIPE DRAINAGE

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Provide the pipework for the drainage system as documented.

Selections: As documented.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152 Schedule of rates – supply projects.*
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1112 Earthworks (Roadways).*
- *1171 Subsurface drainage.*
- *1351 Stormwater drainage (Construction).*
- *1354 Drainage structures.*
- *1392 Trenchless conduit installations.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

AS/NZS 1260:2009	PVC-U pipes and fittings for drain, waste and vent application
AS/NZS 1477:2006	PVC pipes and fittings for pressure applications
AS 1646-2007	Elastomeric seals for waterworks purposes
AS/NZS 2041	Buried corrugated metal structures
AS/NZS 2041.1:2011	Design methods
AS/NZS 2041.4:2010	Helically formed sinusoidal pipes
AS/NZS 2041.6:2011	Bolted plate structures
AS/NZS 2566	Buried flexible pipelines
AS/NZS 2566.1:1998	Structural design
AS/NZS 2566.2:2002	Installation
AS 2758	Aggregates and rock for engineering purposes
AS 2758.1-1998	Concrete aggregates
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
AS/NZS ISO 9001:2008	Quality management systems – Requirements
AASHTO M190-2008	Standard specification for bituminous coated corrugated metal culvert pipe and pipe arches
AASHTO M196-2004	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M197-2006	Standard Specification for Aluminum Alloy Sheet for Corrugated Aluminum Pipe

Other publications

Concrete Pipe Association of Australasia

CPAA	Concrete pipe website and pipeclass software

Plastics Industry Pipe Association of Australia PIPA

POP001-2011	Electrofusion jointing of PE pipe and fittings for pressure applications
POP003-2011	Butt fusion jointing of PE pipes and fittings – recommended parameters
POP102-2009	Solvent cement jointing of PVC pipe

1.4 INTERPRETATIONS

Abbreviations

General: For the purposes of this worksection the abbreviations given below apply.

- FRC: Fibre-reinforced concrete.
- SRCP: Steel reinforced concrete pipes.

Definitions

General: For the purposes of this worksection the definitions given below apply.

- Effective pipe length: The centre-line length dimension specified by the manufacturer and subject to permissible tolerances.

1.5 SUBMISSIONS

Approval

Submissions: To the Superintendent's approval.

Documents

Submit the following for approval:

- Materials: Batch certification to AS/NZS ISO 9001 and AS/NZS 4058 or AS 4139 as appropriate.
- Manufacturers data and installation recommendations.
- Components: Pipes and fittings.
- Samples: Pretreat the samples if necessary so as to represent the condition and grading when compacted and in service.
- Execution details: Refer to **HOLD POINTS**.

1.6 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
MATERIALS			
General			
Certification	Submit manufacturers certification	2 weeks prior to dispatch	Superintendent
Corrugated aluminium pipes			
General - Durability	Submit for approval the protective treatment to achieve the expected design life	1 week before application	Superintendent
Plastic Flexible pipes			
General - Proprietary product	Submit for approval prior to construction	2 weeks	Superintendent
EXECUTION			
Installation			
General - Progressive inspections	Give notice for completed installation and jointed pipes for inspection	Progressive before backfilling	Superintendent

WITNESS POINTS table

Clause title/Item	Requirement	Notice for inspection
EXECUTION		
Establishment		
Drainage - Handling and storage damage	Repair or replace damaged units	1 week
Installation		
Joints for concrete pipes	Submit joint test results	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program for compliance and usage of components and materials.
- Authorities: Arrange approvals and confirm environmental requirements.
- Ground conditions: Identify and report on adverse ground conditions affecting selection of pipe materials.

3 MATERIALS

3.1 GENERAL

Certification

Quality: Prior to dispatch of each batch to site, submit manufacturer's certification to the relevant pipe standard code. This is a **HOLD POINT**.

Ground conditions

Ground condition: If the chemical composition for the soil is unknown or not tested use the default condition 'Aggressive' to AS/NZS 2041.1, AS/NZS 4058 or AS 4139.

3.2 CONCRETE PIPES

Precast reinforced concrete pipes

Requirement: Provide precast reinforced non-pressure concrete pipes to AS/NZS 4058 and in conformance with the following:

- Pipe class and size as shown on the drawings.
- Tolerance: ± 15 mm from manufacturer's nominated effective pipe length.
- Jointing type: Provide flexible rubber ring, spigot and socket joints to AS 1646 (use flush or butt joints only for the first pipe when extending existing pipes).
- Load classes: As shown on the drawings.
- Clear cover to reinforcement: Based on normal environments to AS/NZS 4058 Table 3.3.
- Maximum limit of water absorption: 6.0%.
- Tests required: Routine tests for cover and dimensional accuracy.

Marking: To AS/NZS 4058.

Durability: Protective treatments to AS/NZS 4058 Appendix E and the manufacturer's recommendations.

Fibre reinforced concrete pipes

Requirement: Provide fibre reinforced concrete pipes to AS 4139 and in conformance with the following:

- Pipe sizes: As shown on the drawings.
- Load classes and installation conditions: As shown on the drawings.
- Jointing: Provide flexible, elastomeric, double V-ring joints to AS 1646. Use flush or butt joints only for the first pipe when extending existing pipes.
- Tests required: Dimensions and tolerance test to verify conformance with AS 4139 clause 10.

Test frequency: One pipe per 50 pipes.

Aggregates: To AS 2758.1 and the following:

Manufacturer's statement: Submit manufacturer's statement of information to AS 4139 Appendix A2.

Marking: To AS 4139 clause 12.

Durability.

Durability: Protective treatments to AS 4139 Appendix B and the manufacturer's recommendations.

3.3 CORRUGATED ALUMINIUM PIPES

General

Requirement: Provide corrugated aluminium pipes to AASHTO M197-06 and AASHTO M196-08, AS/NZS 2041.4 and in conformance with the following:

- Type:
  - Staked, double offset lock seam joint.
- Thickness:
  - 2.0 mm for 450 mm diameter and under.
  - 2.5 mm for 600 mm to 1500 mm diameter.
  - 3.0 mm for 1650 mm to 2400 mm diameter.
- Corrugations:
  - 68 x 13 mm for 1500 mm diameter and under.
  - 125 x 25 mm for 1650 mm to 2400 mm diameter.

Dissimilar metals: Prevent dissimilar metals from direct contact.

Durability: Submit for approval the protective treatment required to achieve the required design life to the manufacturer's recommendations. This is a **HOLD POINT**.

3.4 PLASTIC FLEXIBLE PIPES

General

Requirement: Provide flexible pipes including fitting to AS/NZS 2566.1 with pipe class and size as shown on the drawings.

Pressure polyethyelene (PE): To AS/NZS 4130.

Polyethelene (PE) and Polypropylene (PP): To AS/NZS 5065.

PVC pipes: To AS/NZS 1260.

Pressure PVC: To AS/NZS 1477.

Proprietary product: Submit proprietary product for approval prior to construction. This is a **HOLD POINT**.

Store rubber rings for pipe joints: To AS 1646.

Electrofusion jointing for PE pressure pipe: Conform to POP001.

Butt fusion jointing for PE pipe: Conform to POP003.

Solvent cement jointing for PVC pipe: Conform to POP102.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Control of traffic: Conform to the following:

- Worksection *1101 Control of traffic*: **Traffic Guidance Scheme**.

4.2 ESTABLISHMENT

General

Excavation drainage: Dewater the excavation to permit the compaction of the foundation, the bedding and any backfilling as documented.

Tolerances dimensions: Provide culverts within 10 mm of the grade line and within 10 mm of the horizontal alignment as shown on the drawings.

Re-install: Relay any culvert which is not within tolerance.

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.

- Position: In the trench 100 mm above the invert level of the Pipe.
- Discharge: Through the wall of the pit or headwall.

Detail: Seal the subsurface drainage pipe at the upstream end and enclose in a seamless tubular filter fabric in conformance with *1171 Subsurface drainage*.

Construction plant movement

Loads: If the movement of construction plant in excess of 5 t gross mass over pipes is proposed, submit details including design protective measures for the crossings.

Damage

Handling and storage: Repair damaged units in conformance with manufacture's requirements. Replace units if unable to repair satisfactorily. This is a **WITNESS POINT**.

Inspection of pipeline components: Inspect all pipe line components for damage and flaws immediately before installation.

4.3 INSTALLATION

General

Stiffening of culverts: If required by the manufacturer, provide temporary stiffening struts to the interior prior to filling.

Lifting holes: Prior to backfilling seal lifting holes in all pipes with approved plastic preformed plugs or a 3:1 sand cement mortar.

Bulkhead locations: Construct bulkheads in conformance with *1354 Drainage structures* on all lines where the pipe gradient exceeds 5%.

Bulkheads for flexible pipes: If required, provide bulkheads or trenchstops if required to AS/NZS 2566.2 Table 5.7 or as shown on the drawings.

Progressive inspections: For each section of the work, give notice for inspection of the completed installation and jointed pipes before commencement of trench backfilling. This is a **HOLD POINT**.

Plastic culvert 'float' precautions: To ensure plastic pipe culverts do not 'float' during the backfilling and vibration process, take appropriate precautions such as holding down straps.

Positioning of pipes

Lay pipes: Install pipes with the socket end upstream.

Top designation: Install pipes which have marks indicating the crown or invert strictly in conformance with the markings.

Length: Provide pipe with minimum length of 1.2 m.

Laying and jointing for flexible pipes: Install pipes to AS/NZS 2566.2 Section 5 and to the manufacturer's recommendations.

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 exceeding 20% and as shown on the drawings. Place in situ concrete directly against all faces of the keys in the sides and base of the trench.

Joints for concrete pipes

Rubber ring joints in reinforced concrete pipes: Complete rubber ring joints to the manufacturer's recommendations.

Joint testing: Submit joint test results. This is a **WITNESS POINT**.

Fibre reinforced concrete pipes: Test joints to AS 4139 Appendix L.

Precast concrete pipes: Test joints to AS/NZS 4058 Appendix H.

Skid rings: To the manufacturer's recommendations, including the use of lubricants if wedge shaped 'skid' rubber rings are required.

Jointing: Provide flush or butt joints only if required to extend existing culverts.

Sealing: Seal the joints with proprietary rubber sleeves in conformance with the manufacturer's recommendations.

Joints in fibre-reinforced cement pipes: Provide flexible type joints using rubber rings to seal joints in both rebated and spigot and socket jointed pipes or use a jointing compound comprising plasticised butyl rubber and inert fillers all in conformance with the manufacturer's recommendations.

Other joints: Make direct side connections to other pipes as shown on the drawings.

4.4 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances

Activity	Limits/Tolerances	Worksection clause Reference
		MATERIALS
Variation from nominated effective pipe length	± 15 mm	**Concrete pipes**
Maximum limit of water absorption	6.0%	
Fibre reinforced concrete pipes:		
Test frequency:	One pipe per 50 pipes.	
		EXECUTION
Culverts:		**Establishment**
- Grade line	± 10 mm	
- Horizontal alignment	± 10 mm	
Subsurface drain:		
- Length	3 m	
- Diameter	100 mm	
- Location	100 mm above the invert level	
Lifting plugs seal	3:1 sand cement mortar	**Installation**
Bulkhead locations	> 5% gradient in pipeline	
Minimum length	1.2 m	**Positioning of pipes**
Anchor blocks:		
- Maximum spacing	3 m	
- Location	> 20% gradient in pipeline	
Annular corrugations	68 mm pitch	**Joints for steel pipes**
Geotextile cover material:		
- Width	250 mm	
- Minimum mass	270 grams/m^2	
Invert protection sprayed concrete		**Invert protection for steel pipes**

Activity	Limits/Tolerances	Worksection clause Reference
- Over crest of corrugations over bottom third of pipe circumference	> 100 mm	
Sprayed concrete reinforcement:		
- Reinforcement	Steel wire 4 mm diameter with 200 mm square mesh	
- Laps in fabric	300 mm	
- Cover	50 mm	

1353 PRECAST BOX CULVERTS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide precast box culvert units including construction of base slabs as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- *0136 General requirements (Construction)*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1112 Earthworks (Roadways).*
- *1121 Open drains, including kerb and channel (gutter).*
- *1141 Flexible pavement base and subbase.*
- *1171 Subsurface drainage.*
- *1172 Subsoil and foundation drains.*
- *1351 Stormwater drainage (Construction).*
- *1352 Pipe drainage.*
- *1354 Drainage structures.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1012	Methods of testing concrete
AS 1012.9-1999	Determination of the compressive strength of concrete specimens
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 1554.3:2008	Welding of reinforcing steel
AS 1597	Precast reinforced concrete box culverts
AS 1597.1-2010	Small culverts (not exceeding 1200 mm span and 1200 mm height)
AS 1597.2-1996	Large culverts (from 1500 mm span and up to and including 4200 mm span and 4200 mm height)
AS 2758	Aggregates and rock for engineering purposes
AS 2758.1-1998	Concrete aggregates
AS 3600-2009	Concrete structures
AS 3610	Formwork for concrete
AS 3972-2010	General purpose and blended cements
AS/NZS 4671:2001	Steel reinforcing materials
AS/NZS ISO 9001:2008	Quality management systems – Requirements

Other publications
AUSTROADS

AGPT04G/09	Guide to Pavement Technology Part4G – Geotextiles and Geogrids

National Precast Concrete Association Australia

NP:PCH 2009 Precast Concrete Handbook

1.4 STANDARDS

General

Small culverts: To AS 1597.1.

Large culverts: To AS 1597.2.

Precast culverts: To the recommendations in NP:PCH *Precast concrete handbook*.

1.5 INTERPRETATION

Definitions

General: For the purposes of this worksection the definitions given in AS 1597.1, AS 1597.2, as appropriate and below apply:

- Large culvert unit: Culvert unit with a span from 1500 mm up to 4200 mm and a height up to 4200 mm.
- Precast box culvert: Includes link slabs and precast reinforced concrete crown sections.
- Small culvert unit: Culvert unit with a span up to 1200 mm and a height up to 1200 mm.

1.6 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
MATERIALS			
Precast concrete			
General - Certificate	Submit certificate of conformance	3 working days prior to dispatch	Superintendent
Testing - Prototype load testing	Submit certificate and test results	3 working days prior to dispatch	Superintendent
EXECUTION			
Coffer dams			
Construction of coffer dams	Submit construction details for approval	1 week prior to construction	Superintendent
Handling, delivery and storage			
General - Inspection	Inspect box culvert units for conformance	1 week prior to installation	Superintendent
Establishment			
Pegging of culverts	Present set out of centreline and inverts	3 working days	Superintendent
Foundations			
Bedding	Select from bedding alternatives	1 week before placing material	Superintendent
Installation			
Placement of units - Inspection of seals	Present joints and seals for before backfilling	1 working day	Superintendent
Completion			
Construction loading on culvert - Constraint	Do not load base slab until strength has reached 32 MPa	28 days	Superintendent
Construction loading on culvert –	Submit procedure for prevention of early	1 week prior to loading	Superintendent

Clause title/Item	Requirement	Notice for inspection	Release by
Construction vehicles or plant	loading		

WITNESS POINTS table

Clause title/Item	Requirement	Notice for inspection
MATERIALS		
Precast concrete		
Sampling and testing	Provide test results	3 working days
EXECUTION		
Coffer dams		
Timber or bracing removal	Inspect removal of bracing materials	1 working day
Establishment		
Diversion and disposal of water	Submit water management plan for approval	1 week
Installation		
Cast in situ base slabs	Attainment of concrete minimum compressive strength	1 working day
Backfill		
General - Wingwalls	Wait 21 days after concrete placement to commence backfill	21 days
General – Balancing backfill	Control balanced backfill procedure	1 working day

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program for compliance and usage of component and materials.
- Authorities: Arrange approvals and confirm with the local environmental requirements.
- Constraints: Incorporate constraints of **HOLD POINTS** and **WITNESS POINTS**.

3 MATERIALS

3.1 CONSTITUENT MATERIALS

Cement

Standard: To AS 3972.

Type: Do not use high alumina cement.

Aggregates

Standard: To AS 2758.1.

Aggregate properties: Conform to the **Aggregate property schedule**.

Aggregate property schedule

Aggregate property	Tests	Limits
Particle density		
Water absorption		

Aggregate property	Tests	Limits
Particle size		
Durability		

Water

Standard: To AS 1379.

Quality: Provide clean water, free from oil, acid, alkali, organic or vegetable matter and having not more than 300mg/L of chloride ions.

Other

Chemical admixtures: To AS 1478.1.

Durability: Do not use admixtures containing nitrates, calcium chloride, significant chlorides or other strongly ionized salts.

Reinforcement

Standard: To AS/NZS 4671.

General: Clean and free from harmful matter. e.g. loose mill scale, loose rust, oil, grease and retarders. Ensure there is no pitting.

Corrosion protection: To AS 3600 clause 17.2.

Structural welding: To AS/NZS 1554.3.

Reinforcement: Provide starter bars in the factory for end units for headwall and wingwall construction.

Cast-in items

Cast in inserts: Provide structural steel cast in lifting items as shown on the drawings.

3.2 FORMWORK

Formed concrete surface

Requirement: Conform to the following:

- Smooth, dense and dust free concrete finish.
- Unobtrusive form joint marks.
- No blowholes deeper than 5 mm.
- Class 3 formwork to AS 3610.
- Surface irregularities: Maximum 3 mm over the width of the surface.

Unformed concrete surface

Requirement: Conform to the following:

- Wood float to a uniform surface without pitting or cavities.
- Surface irregularities: Maximum 5 mm over the width of the surface.

3.3 PRECAST CONCRETE

General

Concrete: To AS 1379.

Casting: Do not remove precast units from casting mould until the concrete compressive strength > 15 MPa.

Concrete production, placement and curing: Conform to AS 1597.1 clause 2.6 or AS 1597.2 clause 2.6 and 2.7 as appropriate.

Type of joint: Butt joint.

Certificate: Provide precast box culvert unit certificate of conformance with the following:

- Small culvert units: To AS 1597.1.
- Large culvert units: To AS 1597.2.

This is a **HOLD POINT**.

Marking: Mark each unit at time of manufacture with the following, using 75 mm high letters in an easily visible location which is hidden once the unit is installed:

- Type and size.
- Casting date.

- Manufacturer's name.
- Inspection pass date.
- Batch number.

Durability

Exposure classification: Conform to the following:

- For small culvert units to AS 1597.1
- For large culvert units to AS 1597.2

Concrete cover: Conform to the following:

- Small culvert unit: To AS 1597.1 Table 2.3.
- Large culvert unit: To AS 1597.2 Table 2.4.

Strength

Minimum compressive strength: Conform to the following:

- For small culvert units to AS 1597.1:
- For large culvert units to AS 1597.2:

Dimensions and tolerances

Dimensions and tolerances: Conform to the following:

- Small culvert unit: To AS 1597.1 clause 2.8, 2.9 and Table 2.7.
- Large culvert unit: To AS 1597.2 clause 2.9, 2.11 and 2.12.

Sampling and testing

Routine sampling and testing: Supply and test precast box culvert units to conform with the following:

- Small culvert unit: To AS 1597.1 clause 3.4.
- Large culvert unit: To AS 1597.2 clause 5.
- Manufacturer's quality system: To AS/NZS ISO 9001.

This is a **WITNESS POINT**.

Prototype load testing certificate: Provide certificate and test results for prototype proof load testing to the following:

- Small culvert unit: To AS 1597.1 Appendix G.
- Large culvert unit: To AS 1597.2 Appendix J.

This is a **HOLD POINT**.

3.4 IN SITU CONCRETE

General

In situ concrete: Conform to 0319 *Minor concrete works* for the concrete and reinforcement for cast-in situ base slabs.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Control of traffic: Conform to the following:

- Worksection *1101 Control of traffic*: **Traffic Guidance Scheme**.

4.2 COFFER DAMS

General

Requirement: Construct a coffer dam as necessary for site specific conditions to allow dewatering of the construction area.

Costs: Allow for all costs associated with the construction of coffer dams and diversion and dewatering.

Construction of coffer dams

General: Provide coffer dams in conformance with the following:

- Sufficiently watertight to prevent damage, by percolation or seepage through the sides, of the concrete used in culverts.
- Founded sufficiently below the level of the culvert footings to prevent loosening of the foundation materials by water rising through the bottom of the excavation.

Bracing: Construct and brace coffer dams to prevent weakness or damage to the structure on their removal.

Forms: A coffer dam constructed to the size of the reinforced concrete invert slab can be used as side forms for the concrete.

Approval: Submit for approval the details of the coffer dam, formwork required, and proposed clearances. This is a **HOLD POINT**.

Specified clearances

Adjustment: Right or enlarge coffer dams which have tilted or moved laterally during sinking to provide the documented clearances.

Timber or bracing removal

Removal: Remove timber or bracing from the concrete and the backfill of the finished structure.

Completion: Remove coffer dams, including temporary piles, at least to the level of the culvert invert after completion of the structure. Ensure that no material associated with the coffer dam or dewatering can enter the culvert. This is a **WITNESS POINT**.

4.3 HANDLING, DELIVERY AND STORAGE

General

Handling: Provide for delivery and unloading.

Lifting: Provide lifting holes, galvanised lifting points or steel lifting eyes in the culvert units, link and base slabs.

Proprietary systems: Provide in conformance with manufacturer's specifications and recommendations.

Handling and loading: Handle and load precast box culvert units to prevent any damage to the units.

Delivery and storage: Do not transfer completed precast box culvert units from the place of manufacture until the following is achieved:

- 70% of the minimum concrete strength.
- Small culvert units: Cured to AS 1597.1 clause 2.6.3.
- Large culvert units: Cured to AS 1597.2 clause 2.7.

Inspection: Inspect batches of precast box culvert units for dimensional accuracy and defects following delivery to installation location. Conform to the following:

- Small culvert unit: To AS 1597.1.
- Large culvert unit: To AS 1597.2.

This is a **HOLD POINT.**

4.4 ESTABLISHMENT

Pegging of culverts

Set out: Peg the centreline of the culvert at the inlet and outlet inverts and peg the extent of the clearing required. This is a **HOLD POINT**.

Diversion and disposal of water

Control any water: Divert and/or dispose of water from the works as required without causing damage to any portion of the works or surrounding properties due to this operation. Submit plan for managing any water for approval. This is a **WITNESS POINT**.

Excavation

Excavation: Conform to *1351 Stormwater drainage (Construction)* and *1112 Earthworks (Roadways)*.

Trench width: If not shown otherwise on the drawings, the width of the base slab plus 150 mm minimum each side.

Bedding, support and backfill material: Unless otherwise documented, to *1351 Stormwater drainage (Construction)*.

Uniform 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.

Line and level: Finish earth foundations to line and level to the underside of bedding shown on the drawings. Do not disturb material below this level.

Batter slopes: Evenly transitioned over 10 m length from the edge of the wingwall to match culvert wingwall slopes.

Excavate existing stream bed

Joining: Excavate inlet and outlet channels as shown on the drawings and extend to the existing stream bed to *1121 Open drains, including kerb and channel (gutter)*.

4.5 FOUNDATIONS

Rock foundations

Level: Excavate foundations in rock neatly to the underside of the bedding as shown on the drawings.

Prepare: Thoroughly clean out all minor fissures and refill with concrete, mortar or grout. Remove all loose material.

Rock: If rock is encountered over part of the foundation, excavate the whole of the foundation to a depth of 300 mm below the level of the bottom of the base concrete slab.

Backfill: Replace and compact this additional excavation with backfill material to provide uniform bearing conditions. Conform to the following:

Small culverts: AS 1597.1 clause 4.3.

Large culverts: AS 1597.2 clause 6.3.

Bedding

General: Select bedding from the following alternatives: This is a **HOLD POINT**.

- Mass concrete bedding for cast in situ base slabs:

Or

- CRB20-2 bedding for cast in situ base slabs:
  - CRB20-2 material: To *1141 Flexible pavement base and subbase*.
  - Lightly bound and compacted: To *1351 Stormwater drainage (Construction).*
  - Dimensions: As shown on the drawings.
  - Place to the line and level of the underside of the base slab: ± 10 mm in level and ± 5 mm in line.
  - Finish: Smooth surface finish by screeding.

Or

- Foundation support for precast base slabs:
  - Small culverts: Select backfill to AS 1597.1.
  - Large culverts: Select backfill to AS 1597.2.
  - Compacted depth: > 150 mm.

4.6 INSTALLATION

General

Inlet and outlet invert levels: As shown on the drawings ± 10 mm and smooth, uniform gradient throughout each culvert length.

Installation: Conform to the following:

- Small culvert units: To AS 1597.1 clause 4, the drawings and this worksection.
- Large culvert units: To AS 1597.2 clause 6, the drawings and this worksection.

Cast in situ base slabs

Requirement: Construct cast in situ base slabs to the dimensions shown on the drawings and in conformance with this worksection.

Traffic: Prevent construction or public traffic over the base slab within 7 days of placement.

Tolerance: Conform to the following:

- Invert levels: - 10 mm, + 10 mm.
- Grade: 5 mm in 2.5 m (1 in 500).

- Plan position: ± 50 mm.
- Surface irregularities: < 5 mm abrupt and 8 mm over a 3 m straight edge.

Recesses: Form recesses to accommodate the walls of the precast crown units in the base slab to the dimensions shown on the drawings.

Minimum strength requirement: Install precast units after the base slab has attained a minimum compressive strength of 20 MPa. This is a **WITNESS POINT**.

Placement of units

Temporary plug: If required, seal the ends of the culvert with a temporary plug to exclude water, sand or other deleterious materials.

Cement mortar: 0.4:1:3 water:cement:sand ratio by mass.

Mortar bed in recess: Install precast crown units on a bed of cement mortar in the recesses in the base slab. Pack any gaps between the side walls and the sides of the recesses with cement mortar.

Voids: Seal lifting holes and butt joints between the ends of units with cement mortar or grout of a consistency that ensures filling of the void.

Mortar bed on supports: Clean thoroughly the bearing areas of the supports before placement of top slabs on U-shaped units or link slabs on adjacent crown units and cover with a bed of mortar.

Thickness of mortar bed: > 5 mm after placement of precast units.

Lifting hooks: Cut lifting hooks and coat the exposed steel to prevent corrosion.

Multi-cell: In the case of multi-cell culverts, provide a gap between adjacent cells as shown on the drawings or typically 15 mm. Fill this gap with cement mortar or grout.

Curing of joints: Protect all mortar joints from the sun and cure in an approved manner > 48 hours prior to placing backfill.

Joint covering: Cover all external surfaces of joints between precast crown units, both laterally and longitudinally for the full length, and minimum 250 mm width, with strips of non-woven geotextile of minimum mass 270 grams/m^2 in conformance with AGPT04G/09.

Check inspection: Prior to backfill placing inspect and make good all seals, joints and levels. This is a **HOLD POINT**.

4.7 BACKFILL

General

Removal of formwork: Remove all bracing and formwork prior to backfilling.

Zones: Place selected backfill in the side zones of the box culverts and wingwalls, and to a depth of 300 mm in the overlay zone of the culverts.

Compaction: Compact in layers > 150 mm compacted thickness in conformance with the following:

- Small culverts: To AS 1597.1 clause 4.6.
- Large culverts: To AS 1597.2 clauses 6.5 and 6.6.

Ordinary backfill: Backfill the remainder of the excavation with ordinary embankment fill in conformance with *1112 Earthworks (Roadways)* and the following:

- Small culverts: To AS 1597.1 clause 4.6.
- Large culverts: To AS 1597.2 clause 6.3.

Wingwalls: Place backfill against wingwalls no less than 21 days after casting unless otherwise directed. This is a **WITNESS POINT**.

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 shown on the drawings and in conformance with *1172 Subsoil and foundation drains*.

Balancing backfill: Place backfill layers simultaneously on both sides of the culvert with a maximum 600 mm level difference to avoid differential loading. Commence backfilling and compaction at the wall and proceed away from it. This is a **WITNESS POINT**.

Horizontal terraces: If the slopes bounding the excavation are steeper than 4H:1V, cut benches in the form of successive horizontal terraces at least 1 m in width before the backfill is placed.

4.8 COMPLETION

General

Requirement: Remove and replace a precast box culvert if required for any of the following reasons:

- Any culvert is not within tolerances true to line.
- The level or grade shows settlement of the culvert after installation.
- Damage occurs during backfilling, compaction or subsequent operations.

Flushing: Flush clean all culverts from end to end and maintain in proper working order until the completion of works.

Construction loading on culverts

Constraint: Prevent the passage of construction vehicles and plant over the culvert until 28 days after the casting of the base slab or until the compressive strength of the base slab concrete has reached 32 MPa. This is a **HOLD POINT**.

Construction vehicles or plant: Where construction vehicles or plant with axle loads > 50 t submit proposed procedures and method for approval. This is a **HOLD POINT**.

Loading restrictions: Provide construction vehicle loads on culverts for various design fill heights to conform with the following:

- Small culverts: To AS 1597.1 clause 4.7.
- Large culverts: To AS 1597.2 clause 6.7.

5 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	Limits/Tolerances	Worksection clause reference
Large culvert unit		**Interpretations**
- Span	1500 mm to 4200 mm	
- Height	≤ 4200 mm	
Small culvert unit:		
- Span	≤ 1200 mm	
- Height	≤ 1200 mm	
Water chloride ions	≤ 500 mg/L	**Constituent materials**
Surface irregularities maximum	3 mm over the width of the surface	**Formed concrete surface**
Surface irregularities maximum	5 mm over the width of the surface	**Unformed concrete surface**
Width of the base slab plus	Width of base slab plus 150 mm minimum each side	**Excavation**
Batter slope transition from edge of wingwall	10	**Excavation**
Rock excavation	Depth of 300 mm below the level of the bottom of the base concrete slab	**Rock Foundations**
Bedding alternatives:		**Bedding for precast base slabs**
- To line of underside of the base slab	± 5 mm	
- To level of underside of the base slab	± 10 mm	
- Compacted depth	> 150 mm.	
Cast in situ base slabs:		**Cast in situ base slabs**

Activity	Limits/Tolerances	Worksection clause reference
- Invert levels	± 10 mm	
- Grade	5 mm in 2.5 m (1 in 500).	
- Plan position	± 50 mm	
- Surface irregularities:	< 5 mm abrupt and 8 mm over a 3 m straight edge	
- Minimum strength requirement before installation of precast unit	20 MPa	
Cement mortar:		**Placement of units**
- Water:cement:sand ratio by mass	0.4:1:3	
- Thickness of mortar bed	> 5 mm	
Gap between adjacent multi-cell culverts	15 mm	**Placement of units**
Protection of mortar joints	> 48 hours before backfill	**Placement of units**
Depth of backfill in side zones	300 mm	**Backfill**
Compaction layers	> 150 mm compacted thickness	**Backfill**
Backfill against wingwalls	≥ 21 days after casting.	**Backfill**
Backfill maximum level difference to avoid differential loading	600 mm	**Backfill**
Horizontal terraces requiring cut benches at least 1 m width before the backfill is placed.	> 4H:1V	**Backfill**
Construction loading:		**Completion**
- Restriction on construction traffic after the casting of the base slab	28 days	
- Compressive strength of the base slab concrete	32 MPa minimum	

1354 DRAINAGE STRUCTURES

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide drainage structures as documented including the following: headwalls, wingwalls, pits, gully pits, inspection pits, junction boxes/pits, drop structures, inlet and outlet structures, energy dissipators, batter drains and other supplementary structures as shown on the drawings.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1102 Control of erosion and sedimentation.*
- *1112 Earthworks (Roadways).*
- *1121 Open drains, including kerb and channel (gutter).*
- *1351 Stormwater drainage (Construction).*
- *1352 Pipe drainage.*
- *1353 Precast box culverts.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1012-Various	Methods of testing concrete
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 1554.3:2008	Welding of reinforcing steel
AS 1657-1992	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS 1726-1993	Geotechnical site investigations
AS 2758	Aggregates and rock for engineering purposes
AS 2758.1-1998	Concrete aggregates
AS 3600-2009	Concrete structures
AS 3610	Formwork for concrete
AS 3610.1-2010	Documentation and surface finish
AS 3735-2001	Concrete structures retaining liquids
AS 3972-2010	General purpose and blended cements
AS 3996-2006	Access covers and grates
AS/NZS 4671:2001	Steel reinforcing materials
AS 5100-Various	Bridge design
NP:PCH-2009	Precast concrete handbook

Other publications
Austroads

AGPT04G:2009	Guide to geotextiles – Geotextiles and geogrids

1.4 INTERPRETATION

Definitions

General: For the purposes of this worksection 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.
- Selected backfill: The material obtained from excavation of the pipe trench or elsewhere with a particle size not greater than 75 mm, and which conforms with the soil classes defined in AS 1726.

1.5 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
EXECUTION			
Precast units			
General – Product drawings	Submit details of precast or proprietary items for approval	1 working day	Superintendent
General – Quality	Submit quality test results.	3 working days before delivery	Superintendent
Installation			
Excavation	Excavation and compaction of foundation as documented	1 working day	Superintendent
Headwalls and wingwalls			
General – Rock foundations	Submit details of cut-off walls in rock	1 working day	Superintendent
Backfill			
General - Commencement	Obtain approval for commencement	1 workday day	Superintendent

WITNESS POINTS table

Clause title/Item	Requirement	Notice for inspection
EXECUTION		
Pits and junction boxes		
Precast units	Give notice of installation of precast pits and junction boxes	1 week
Construction	Submit for approval part omission of concrete lining	3 working days

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program for compliance and usage of component and materials.
- Authorities: Arrange approvals and confirm environmental requirements from local authorities.
- Constraints: Incorporate **HOLD POINTS** and **WITNESS POINTS**.

3 MATERIALS

3.1 CONSTITUENT MATERIALS

Cement

Standard: To AS 3972.

Type: Do not use high alumina cement.

Aggregates

Standard: To AS 2758.1.

Aggregate properties: Conform to the **Aggregate property schedule**.

Aggregate property schedule

Aggregate property	Tests	Limits
Particle density		
Water absorption		
Particle size		
Durability		

Water

Standard: To AS 1379.

Quality: Provide clean water, free from oil, acid, alkali, organic or vegetable matter with not more than 500 mg/l of chloride ions.

Other

Chemical admixtures: To AS 1478.1.

Reinforcement

Standard: To AS/NZS 4671.

General: Clean and free from harmful matter e.g. loose mill scale, loose rust, oil, grease and retarders. Ensure there is no pitting.

Corrosion protection: To AS 3600 clause 17.2.

Structural welding: To AS/NZS 1554.3.

Cast-in items

Cast in inserts: Provide structural steel cast in lifting items in conformance with the drawings.

Protective coating: [complete/delete]

3.2 FORMWORK

Formed concrete surface

Requirement: Conform to the following:

- Smooth, dense and dust free concrete finish.
- Unobtrusive form joint marks.
- No blowholes deeper than 5 mm.
- Class 3 formwork to AS 3610.1.
- Surface irregularities: Maximum 3 mm over the width of the surface.

Unformed surface

Requirement: Conform to the following:

- Wood float to a uniform surface without pitting or cavities.
- Surface irregularities: Maximum 5 mm over the width of the surface.

3.3 IN SITU CONCRETE

General

In situ concrete: Conform with *0319 Minor concrete works* for the concrete and reinforcement for cast-in situ structures.

3.4 PRECAST CONCRETE

General

Concrete: To AS 3600 and AS 1379.

Testing: To AS 1012.

Casting: Do not remove precast units from casting mould until the concrete compressive strength > 15 MPa.

Concrete cover: To AS 3600.

3.5 ACCESS COVERS AND FRAMES

Specification

Access covers and frames: To AS 3996 and the **Access covers and frames schedule**.

Ductile iron cover size:

- Width: Parallel to the lifting ends and undercut.
- Length: Parallel to the direction of cover removal.

Infill material: Bond tile or paver to the concrete bed with an epoxy mortar.

Proprietary products: To the manufacturer's recommendations.

Access covers and frames schedule

Requirements	A1	A2	A3	A4
Cover number				
Load class				
Size				
Aesthetics				
Decorative edging				
Cover type				
Security				
Seals				
Cover orientation				
Handling				

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Control of traffic: To *1101 Control of traffic*.

4.2 PRECAST UNITS

General

Product drawings: For any precast item, including proprietary items, not detailed in the drawings, submit the following:

- Product drawings.
- Method of manufacture, testing and installation including clearance to pit shaft ends, pipe to pipe jointing and step iron positioning

This is a **HOLD POINT**.

Substituting precast units for cast in situ units: Submit detailed drawings and complete details of installation procedures for approval.

Quality: Submit test results for all units prior to delivery to the works. This is a **HOLD POINT**.

Handling, delivery and storage

Handling and installation: Handle and install precast units, including kerb inlet lintels, to conform with the manufacturer's instructions.

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.

4.3 INSTALLATION

General

Members subject to traffic and earth loads: To AS 5100.

Water retaining structures with a capacity > 25000 L: To AS 3735.

Water retaining structures with a capacity ≤ 25000 L: To AS 3600.

Other concrete components: Conform to AS 3600.

Program: Install drainage structures as soon as possible and not later than 14 days after the installation of associated pipes, box culverts or open drains.

Location: As shown on the drawings.

Horizontal tolerance: ± 25 mm.

Inlet and outlet invert levels: As shown on the drawings ± 10 mm.

Excavation

Bedding: Excavate and compact the foundation to conform with *1351 Stormwater drainage (construction)*. This is a **HOLD POINT**.

Foundation

Preparation: Dewater and wash clean of contaminants in preparation for concreting.

Mass concrete bedding: Dampen the surface of the foundation and place a layer of concrete > 50 mm thick over the excavated surface and finish to a smooth, even surface.

Joints and seals

Location: Provide an isolation joint where a drainage structure abuts a structure or concrete pavement.

Isolation joint: 10 mm wide approved preformed jointing filler.

Sealing: Effectively seal joints and connection points against the ingress of water and other kinds of material with cement mortar 1: 3 general purpose cement: sand ratio.

Locating drainage structures

Arrangement: Unless otherwise shown on the drawings, construct headwalls and pits parallel to the road centreline and wingwalls at 135° to the headwall.

Skewness: If the culvert is laid skew to the road, 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 as shown on the drawings.

Trash racks: If shown on the drawings, construct trash racks with access for machine removal of accumulated debris.

Rung ladders and step irons

Drop structures > 600 mm deep: Install an individual rung ladder or step iron on one internal wall for the full depth of the structure to conform to AS 1657.

Tolerance: Conform to the following:

- 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.

Fixing: Conform to the following:

- Fix step irons firmly 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.
- Install at a later date by drilling the pit wall.
- Drill holes using a rotary masonry bit or similar. Do not use percussion tools to form the hole for the step iron.
- Use epoxy resin in conformance with the step iron and epoxy resin manufacturer's recommendations.
- Ensure that no movement of the step irons occurs until the epoxy resin has reached the specified strength.

4.4 HEADWALLS AND WINGWALLS

General

In situ concrete: To *0319 Minor concrete works* and the drawings.

Batter retention: Construct the wingwalls to retain the batters as shown on the drawings.

Rock foundations: If rock is encountered at the bottom of excavations for wingwalls and headwalls, submit for approval, a proposal to reduce the depth of cut-off walls in uniform rock over the full width of the foundations. This is a **HOLD POINT**.

- Depth: > 150 mm into sound rock.

Weepholes

Detail: Provide weepholes as shown on the drawings.

Requirement: Place broken stone or river gravel to *1351 Stormwater drainage (construction)* 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.

Geotextile: Enclose the broken stone or river gravel with geotextile filter fabric in conformance with AGPT04G.

Alternative to geotextile: Cover the facial area of the structure with an equivalent area of geocomposite.

4.5 PITS AND JUNCTION BOXES

Precast units

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.

Notice: Give notice before installation of precast pits and junction boxes. This is a **WITNESS POINT**.

Construction

Details: Construct all new pits to accept access covers, gully grates and frames to AS 3996 and to the details shown on the drawings.

Concrete: Unless otherwise shown on the drawings, conform to the following:

- Strength: > 32 MPa.
- Aggregate size: > 12 mm.

Access cover and pit: Locate so that removal of the cover is not obstructed by a wall, kerb or other fixed item.

Existing pits: Modify existing pits only if shown on the drawings.

Finished level: Flush with the finished level of the surrounding area ± 3 mm.

Full depth rock excavation: If the full depth of the excavation is in sound rock, submit for approval to omit part of the concrete lining of gully pits and sumps and to construct a neatly formed pit of the required dimensions. Construct in concrete the wall of the pit adjacent to and parallel to the road. This is a **WITNESS POINT**.

Inlet and outlet pipes: Cast ends of inlet and outlet pipes into the pit walls.

Subsoil drain: Provide subsoil drains for the pits or headwalls to *1172 Subsoil and foundation drains*.

Access covers and frames

Fit and seals may be compromised: Covers and frames are matched items. Do not switch.

Tight fit: Make sure there is no excavated or other material between cover and frame to compromise seals and service life.

Proprietary access covers: Conform with the manufacturer's recommendations, including any infill requirements for the covers.

Bulkheads

Location: If the pipe gradient of the line > 5%, construct concrete bulkheads on stormwater drainage pipe lines. Spacings and details as shown on the drawings.

4.6 BACKFILL

General

Commencement: Do not backfill against cast in situ concrete drainage structures within 14 days of placing the concrete or until compressive strength > 15 MPa unless otherwise approved. This is a **HOLD POINT**.

Selected backfill: Place selected backfill 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 shown on the drawings.

Loading: Prevent excessive surcharge loading against vertical surfaces during the backfilling.

Horizontal terraces: If the sides of the excavation are steeper than 4H:1V, cut benches in the form of successive horizontal terraces at least 600 mm in width, before the backfill is placed.

Balance: Backfill on both sides of the structure alternately in layers to avoid unbalanced forces on the structure.

Compaction: To *1351 Stormwater drainage (Construction)*. Commence backfilling and compaction at the wall.

4.7 COMPLETION

General

Requirement: Remove and replace any drainage structure if required for any of the following reasons:

- Not true to line or level.
- Shows settlement after laying.
- Damaged during backfilling, compaction or subsequent operations.

5 LIMITS AND TOLERANCES

Summary of limits and tolerances

Activity	Limits/tolerances	Clause Worksection reference
Formed concrete surface:		**Formwork**
- No blowholes	< 5 mm	
- Surface irregularities	< 3 mm over the width of the surface	
Unformed surface:		
- Surface irregularities	< 5 mm over the width of the surface	
Precast units compressive strength of concrete	> 15 MPa	**Precast concrete**
Identification marking lettering	75 mm high	
Horizontal tolerance	± 25 mm	**Installation**
Inlet and outlet invert levels	± 10 mm	
Foundation:		
- Mass concrete bedding depth	> 50 mm	
Joints and seals:		
- Thickness	10 mm	
- Cement mortar	1:3 general purpose cement:sand	

Activity	Limits/tolerances	Clause Worksection reference
Wingwalls location	135° to the headwall	
Step irons:		
- Distance from top of the uppermost rung to top of pit	< 600 mm	
- Distance of top of the bottom rung above the invert of the pit	≥ 300 mm and ≤ 500 mm	
- Rung spacings	300 mm ± 50 mm	
Headwalls and wingwalls – cut off walls depth into sound rock	> 150 mm	**Headwalls and wingwalls**
Weepholes:		
- Height of gravel above the bottom of the weephole	> 450 mm	
- Plan area of gravel centrally about the weephole	> 600 mm along the wall and 300 mm out from the wall located	
Concrete construction:		**Pits and junction boxes**
- Strength	> 32 Mpa	
- Aggregate size	> 12 mm.	
- Finished level	± 3 mm. level of the surrounding area	
- Compressive strength	> 15 MPa	**Backfill**
Headwalls and wingwalls – cut off walls		
– Depth into sound rock	> 150 mm	**Headwalls and wingwalls**
Foundation for concrete bases		
– Mass concrete bedding depth	> 50 mm	**Foundation for concrete basis**

1361 SEWERAGE SYSTEMS – RETICULATION (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide sewerage reticulation as documented.

Precedence
Precedence: The technical requirements of any standard drawing provided by the Water Authority, used in conjunction with and in conflict with this worksection, take precedence.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):

- *0136 General requirements (Construction).*
- *0152 Schedule of rates – supply projects*.
- *0161 Quality (Construction).*
- *0257 Landscape road reserve and street trees.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1102 Control of erosion and sedimentation (Construction).*
- *1112 Earthworks (Roadways).*
- *1152 Road openings and restoration (Utilities).*
- *1392 Trenchless conduit installations.*
- *1859 CCTV inspection of drainage conduits*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

Australian standards

AS 1141	Methods for sampling and testing aggregates
AS 1141.22-2008	Wet/dry strength variation
AS 1141.32-2008	Weak particles (including clay lumps, soft and friable particles) in coarse aggregates
AS 1210-2010	Pressure vessels
AS 1214-1983	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS/NZS 1260:2009	PVC-U pipes and fittings for drain, waste and vent application
AS 1281-2001	Cement mortar lining of steel pipes and fittings
AS 1289	Methods for testing soils for engineering purposes
AS 1289.4.3.1-1997	Soil chemical tests - Determination of the pH value of a soil - Electrometric method
AS 1289.4.4.1-1997	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 1289.5.6.1-1998	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
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 1477:2006	PVC pipes and fittings for pressure applications
AS/NZS 1554	Structural steel welding

AS/NZS 1554.1:2011	Welding of steel structures
AS 1579-2001	Arc-welded steel pipes and fittings for water and waste-water
AS 1627	Metal finishing - Preparation and pretreatment of surfaces
AS 1627.4-2005	Abrasive blast cleaning of steel
AS 1646-2007	Elastomeric seals for waterworks purposes
AS 1657-1992	Fixed platforms, walkways, stairways and ladders—Design, construction and installation
AS 1741-1991	Vitrified clay pipes and fittings with flexible joints—Sewer quality
AS/NZS 2032:2006	Installation of PVC pipe systems
AS/NZS 2033:2008	Installation of polyethylene pipe systems
AS 2129-2000	Flanges for pipes, valves and fittings
AS 2187-Various	Explosives - Storage, transport and use
AS/NZS 2280:2012	Ductile iron pipes and fittings
AS/NZS 2566	Buried flexible pipelines
AS/NZS 2566.1:1998	Structural Design
AS/NZS 2566.2:2002	Installation
AS 2638	Sluice valves for water works purposes
AS 2638.1-2011	Metal seated
AS 2638.2-2011	Resilient seated
AS/NZS 2648	Underground marking tapes
AS/NZS 2648.1:1995	Non-detectable tape
AS 2832	Cathodic protection of metals
AS 2832.1-2004	Pipes and cables
AS 2832.2-2003	Compact buried structures
AS/NZS 3500	Plumbing and drainage
AS/NAS 3500.2:2003	Sanitary plumbing and drainage
AS/NZS 3518:2013	Acrylonitrile butadiene styrene (ABS) compounds, pipes and fittings for pressure applications
AS 3571	Plastics piping systems - Glass reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin
AS 3571.1-2009	Pressure and non-pressure drainage and sewerage (ISO 10467:2004, MOD)
AS 3572.2-2002	Determination of chemical resistance of glass filament reinforced plastics
AS 3600-2009	Concrete structures
AS 3681-2008	Application of polyethylene sleeving for ductile iron piping
AS/NZS 3690-2009	Installation of ABS pipe systems
AS 3705-2012	Geotextiles - Identification, marking, and general data
AS 3735-2001	Concrete structures retaining liquids
AS/NZS 3750	Paints for steel structures
AS/NZS 3750.4:1994	Bitumen paint
AS/ZNS 3750.19:2008	Metal primer - General purpose
AS/NZS 3862:2002	External fusion-bonded epoxy coating for steel pipes
AS/NZS 3879:2011	Solvent cements and priming fluids for use with unplasticized PVC (PVC-U and PVC-M), ABS and ASA pipes and fittings
AS 3894	Site testing of protective coatings
AS 3894.1-2002	Non-conductive coatings - Continuity testing - High voltage ('brush') method
AS 3996-2006	Access covers and grates
AS/NZS 4020:2005	Testing of products for use in contact with drinking water
AS/NZS 4058:2007	Precast concrete pipes (pressure and non-pressure)
AS 4060-1992	Loads on buried vitrified clay pipes
AS/NZS 4087:2011	Metallic flanges for waterworks purposes
AS/NZS 4129:2008	Fittings for polyethylene (PE) pipes for pressure applications
AS/NZS 4130:2009	Polyethylene (PE) pipes for pressure applications
AS/NZS 4158:2003	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS 4198-1994	Precast concrete access chambers for sewerage applications
AS 4310-2004	DN80 piston type vacuum interface valves for municipal sewer systems
AS 4321-2001	Fusion-bonded medium density polyethylene coating and lining for pipes and fittings
AS/NZS 4331	Metallic flanges

AS/NZS 4331.1:1995	Steel flanges
AS/NZS 4441:2008	Oriented PVC (PVC-O) pipes for pressure applications
AS/NZS 4680:2006	Hot-dip bed galvanised (zinc) coatings on fabricated ferrous articles
AS/NZS 4765:2007	Modified PVC (PVC-M) pipes for pressure applications
AS 4794-2001	Non return valves - Swing check and tilting disc
AS 4795	Butterfly valves for waterworks purposes
AS 4795.1-2011	Wafer and lugged
AS 4795.2-2011	Double flanged
AS 4796-2001	Water supply - Metal bodied and plastic bodied ball valves for property service connection
AS 4883-2008	Air valves for sewerage
AS 5065-2005	Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
AS 6401-2003	Knife gate valves for waterworks purposes

Water Services Association of Australia (WSAA)

WSA 01-2004	Polyethylene Pipeline Code 2004 3rd edition Version 3.1
WSA 02-2002	Sewerage Code of Australia Second Edition Version 2.3 Standard Drawings
WSA 03-2011	Water Supply Code of Australia Version 2.3. Parts 1-4. Includes Planning & Design, Products & Materials, Construction and Standard Drawings. CD
WSA 06-2008	Vacuum Sewerage Code of Australia Version 1.1 Parts 0-4 and WSA 06 Standard drawings CD
WSA 07-2007	Pressure Sewerage Code of Australia Version 1.1 Parts 0-4 and WSA 07 Standard drawings (CD)
WSA 113-2002	Industry standard for reinforced concrete pipes with flexible thermoplastic linings

Other standards

ASTM A240/A240M-2013	Standard specification for chromium and chromium-nickel stainless steel plate, sheet and strip for pressure vessels and for general applications
ASTM A276-2013	Standard Specification for Stainless Steel Bars and Shapes
ASTM C1244-2011	Standard test method for concrete sewer manholes by the negative air pressure (vacuum) test prior to backfill (Metric)
BS 3416-1991	Specification for bitumen-based coatings for cold application, suitable for use in contact with potable water
BS EN 295-1-2013	Vitrified clay pipe systems for drains and sewers – Requirements for pipes, fittings and joints
BS EN 681-1-1996	Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications - Vulcanized rubber

Other publications

Plastic Industry Pipe Association of Australia Limited (PIPA)

POP102-2009	Solvent cement jointing of PVC-U pipe
POP007-2006	Metal Backing Flanges For Use With Polyethylene (PE) Pipe Flange Adaptors

1.4 STANDARDS

General

Sewerage construction: To WSA 02 Part 2 and Part 3.

Buried flexible pipes design and installation: AS/NZS 2566.1 and AS/NZS 2566.2.

PVC-U installation: To AS/NZS 2032.

PE installation: To AS/NZS 2033.

ABS installation: To AS 3690.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- ABS: Acrylonitrile butadiene styrene.
- DAV: Double air valve.
- DI: Ductile iron.

- DICL: Ductile iron cement lined pipe.
- DN: Dimensionless whole Number.
- GRP: Glass reinforced plastic.
- IS: Inspection shaft.
- MH: Maintenance holes.
- MS: Maintenance shaft.
- PE: Polyethylene.
- PIPA: Plastic Industry Pipe Association of Australia Limited.
- PN: Pressure classification.
- PVC-U: Polyvinyl chloride.
- PVC(M): Modified polyvinyl chloride.
- PVC(O): Oriented polyvinyl chloride.
- RC: Reinforced concrete.
- SDR: Standard dimension ratio.
- SRM: Sewer rising main.
- TMS: Terminal maintenance shaft.
- VC: Vitrified clay.

Definitions

General: For the purposes of this worksection the definitions given in WSA 02 and the following apply:

- Commissioning: Running of the plant and equipment to make sure there is flow through the pumping system, carrying out any necessary testing and making adjustments until it is ready and suitable for normal starting and running under service conditions.
- Inadequate foundation material: Material beneath or adjacent to the proposed drainage structures which the Superintendent deems to be of insufficient strength to support the structure and loads on the structure, or material whose characteristics the Superintendent deems would adversely affect the performance or construction of the drainage structure.
- Nominal size (DN): Dimensionless whole number, which is indirectly related to the physical size, in mm, of the bore or outside diameter of the end connections.
- Pre-commissioning: Preparation of plant or equipment for commissioning and operation. It includes all aspects of plant operation such as safety, electrical, mechanical and instrumentation.
- Section: A length of pipeline which can be effectively isolated for testing, e.g. by means of main stop valves.
- Selected material zone: The top part of the upper zone of formation in which material of a specified higher quality is required.
- Water Agency: An Authority, board, business, corporation, Council or local government body with the responsibility for planning or defining, design, construction and maintenance requirements for a water supply and/or sewerage systems. This includes Local Water Utilities (LWU).

1.6 SUBMISSIONS

Approvals

Submissions: To the Superintendent's approval. Submit the following for approval:

- Materials: Off-site certificates of components.
- Calculations: Survey set out of sewerage works and quantity calculations.
- Work-as-executed drawings: Include sewerage system information sheets and works.
- Components: Pipes and fittings.
- Samples: For conformity testing to relevant referenced documents.
- Technical data: Product information.
- Execution details: Refer to **HOLD POINTS**.

1.7 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that inspections and submissions may be made to the **HOLD POINT table** and **WINTNESS POINT table:**

HOLD POINT table

Clause title/Item	Requirement	Notice for inspection	Release by
MATERIALS			
General			
Authorised products and materials	Submit for approval alternative products and materials	2 weeks before ordering	Superintendent
EXECUTION			
Establishment			
Excavation near underground services – Public utilities within the excavation for sewerage system	Approval from relevant Authority for the method of excavation	1 week	Superintendent
Excavation near underground services – Marking	Locate and mark existing underground services affected.	3 working days	Superintendent
Excavation near underground services – Protection of other services	Submit for approval Give notice of any interference to the works caused by an existing service and submit a proposed work method statement	1 week	Superintendent
Excavation for sewerage systems			
General – Soil type	Confirm surrounding soil type, give notice if different to design	1 week	Superintendent
General - Excavation across improved surfaces	Approval from the land owner before excavating across improved surfaces	1 week	Superintendent
Support of excavation - Trench instability	Submit for approval the proposal to provide adequate permanent stability of the ground affected by trenching	1 week before relevant action	Superintendent
Bedding for pipes			
Trench floor preparation- Foundation	Where bearing capacity < 50 kPa	3 working days	Superintendent
Pipe laying, jointing and connecting			
Wrapping of ductile iron pipelines – Damage to sleeving	Rectify any damage to sleeving before backfilling trench	2 working days	Superintendent
Maintenance holes, shafts and inspection openings			
Precast concrete MH/MS/IS systems	Submit proposed proprietary items, if not sealed	2 weeks before ordering	Superintendent
Embedment and backfill			

Clause title/Item	Requirement	Notice for inspection	Release by
Pipe embedment support – Notification of pipeline laid and jointed.	Present the laid and jointed pipes for approval before the trench backfilling	2 working days	Superintendent
Embankment fill - Embankment	Submit proposal for construction of embankments	1 week	Superintendent
Acceptance testing			
General - Unsatisfactory test results	Rectify any defects even when results are in conformance	1 week	Superintendent
Connections to existing sewers			
General - Notice	Submit request to connect to the existing sewer and give notice of works including any affected occupants	2 weeks before connection	Water Agency - Superintendent
Restoration of surfaces			
General – Original condition requirement	Restore progressively and as soon as possible after the section of works is completed	2 working days	Superintendent

WITNESS POINT table

Clause title/Item	Requirement	Notice for inspection
MATERIALS		
General		
Conformance with manufacturer's recommendations - Requirement	Inspect material and products at time of delivery	2 working days
Pipes and fittings		
General - Certification	Provide product or material certification before delivery to the works	3 working days
Valves, holes/shafts and access covers		
Valves - Certification	Provide product or material certification before delivery to the works	1 week
EXECUTION		
Establishment		
General – Set out	Confirm the set out locations immediately before construction	3 working days
General – Crossings Authority approvals	Approval from relevant Authority and payment of fees	2 weeks
Temporary drainage during construction- Discharge	Approval from appropriate Authority for any discharge to sewers, stormwater drains or watercourses	2 weeks
Excavation for sewerage systems		
Inadequate foundation material - Notice	Give notice of any area of the foundation that may contain	1 week

Clause title/Item	Requirement	Notice for inspection
	inadequate foundation material	
Inadequate foundation material - Rock foundation	Excavate for an additional depth as directed. Backfill and compact the additional excavation	1 week
Trench excavation – Trench size for pipelines	Conformance with documentation	1 week
Trench excavation – Trench widths	Present trench width within permitted over-excavation	1 week
Pipe laying, jointing and connecting		
Thrust and anchor blocks and restrained joints - Notice	Give notice if the allowable bearing pressure of the ground and the design pressure of the pipeline differ from actual pressures on site	1 week
Welding for steel pipelines – Field welding of flanges	Submit proposal for approval	1 week
Maintenance holes, shafts and inspection shafts		
Maintenance holes (MH) – MH location	Submit any proposal to change positions of maintenance holes before commencing the works	2 weeks
Covers and frames - Delivery	Submit conformance certification of the covers and/or frames before delivery to the works	3 working days
Embedment and backfill		
Embankment fill - Embankment	Geotechnical assessment and supervision of work, if required.	Progressive
Trench stops and concrete bulkheads – Concrete bedding and encasement to pipe	Concrete bulkhead in conformance with documentation	2 working days
Acceptance testing		
General – NATA	Provide NATA certified test results for all testing	2 working days progressive
General – Notice	Give notice for compaction testing, hydrostatic pressure testing, block testing and water quality testing	3 working days progressive
Visual inspection - Requirement	Inspect system component markers for conformance with the documents	2 working days
Visual inspection - Verify	Submit purchasing records for products and materials	2 working days
Air pressure and vacuum testing of sewers- Testing of concrete MH	Test concrete MH	2 working days
Infiltration testing – Infiltration testing requirement	Submit method of infiltration testing	1 week
Deflection (ovality) testing of flexible sewers – Deflection testing	Submit proposal for deflection testing	1 week
CCTV inspection - Verification	Carry out a CCTV verification inspection	2 working days
Pressure testing of inverted syphons - Requirement	Submit proposed method of pressure testing	2 weeks

Clause title/Item	Requirement	Notice for inspection
Connections to existing sewers		
General - Connecting to existing sewers	Submit proposal for connection to existing sewers including work method, timing, equipment	2 weeks
Restoration of surfaces		
Backfill - Disposal of surplus material	Submit for approval proposal for spreading surplus material.	2 working days progressive

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program so that it conforms to the approved products and materials.
- Authorities: Arrange approvals and conform to the local environmental requirements e.g. protection of the environment and heritage areas.
- Control of erosion and sedimentation: Prepare an erosion and sediment control plan before starting the works.

3 MATERIALS

3.1 GENERAL

Authorised products and materials

Products and materials: Provide only products and materials authorised by the Water Agency, the drawings and this specification. Submit for approval any alternative or not authorised products and materials. This is a **HOLD POIN**T.

Unauthorised material: Remove unauthorised or non-conforming materials from the site within 24 hours.

Conformance with manufacturer's recommendations

Requirement: Conform to the requirements of the manufacturer's recommendations for handling, transport and storage of materials and in a manner to prevent damage or deterioration or excessive distortion. Inspect all products and materials at the time of delivery and reject products and materials not in conformance with this specification and the manufacturer's recommendations. This is a **WITNESS POINT**.

On site storage: Store pipe fittings, valves, seals and other components as follows:

- Maintain protective crating or packaging until immediately before use.
- Stack piping to avoid ovalisation.
- Support all fittings and pipes off the ground.

Damaged or defective materials: Do not use damaged or defective materials, including coatings and linings, outside the manufacturer's recommended limits and the following:

- Faded/discoloured plastics, plastic coated pipes, fittings and appurtenances.
- PVC-U pipes and fittings scored deeper than 10% of wall thickness to a maximum of 1 mm.
- PE pipes and fittings scored deeper than 10% of wall thickness.
- GRP pipes and fittings scored deeper than 1 mm or with impact damage.
- DI and steel pipes and fittings with damage to linings in excess of 20% of the lining thickness.
- Plastics coated pipes, fittings and appurtenances with damage to coating in excess of 20% of the coating thickness.

3.2 PIPES AND FITTINGS

General

Requirement: Provide pipes and fittings in conformance with the drawings, the schedules and the specification.

Certification: Submit product or material certification before delivery to the works. This is a **WITNESS POINT**.

Products and materials: Conform to the **Material properties schedule**.

Material properties schedule

Material properties	**Mat 1**	**Mat 2**	**Mat 3**
Material type			
Nominal size (DN)			
Pipe series			
Pressure classification (PN)			
Material classification number (as necessary)			
Joint type			
Length and form of pipes			
Type, materials and classes of fittings			
Internal and external corrosion protection: - Fittings - Pipes			
Proof stress tests: - Fittings - Pipes			
Classification of flanges			
Means of tapping			
Identification of drinking and non-drinking pipe systems			
Gasket types and tightening sequence			

Ductile iron (DI)

Standard pipe: Provide DI pipe cement mortar lined to AS/NZS 2280.

Epoxy coating: To AS/NZS 3862 (or thermal-bonded polyethylene to AS/NZS 4158).

Elastomeric seals: To AS 1646.

Flanges: To AS/NZS 4087 and AS 2129.

Bolts and nuts for flanged joints: To AS 2129, galvanized to AS 1214 or stainless steel to ASTM A276.

Corrosion protection of fittings: Conform to the following or as shown on the drawings:

- Thermal-bonded coated: To AS/NZS 4158.
- Sleeved: To AS 3681. Do not allow exposure to sunlight > 7 days.
- Wrap all unprotected joints in the trench with an approved petrolatum tape system or an approved alternative.

Fitting without flanges: Pressure class ≤ Class 35.

Steel pipeline systems

Standard pipe: To AS 1579, WSA 02 Table 10.1 and the following:

- Steel pipe rated pressure: Hydrostatically tested.
- Fittings rated pressure: May be non-hydrostatically tested.
- Size, minimum wall thickness, lining and coating to **Material properties schedule**.

Pipe and fittings: Cement mortar lined to AS 1281.

Buried steel pipe and fittings: External coat with fusion bonded polyethylene (medium density): To AS 4321.

Pipe jointing: Conform to the following or as shown on the drawings:

- Elastomeric seal: To AS 1646, or
- Butt welded, welded spigot and socket, or welded using a welding collar and with the application of a polyethylene heat shrunk sleeve over the weld, or wrapped, or
- Flanges: To AS/NZS 4087.

Bolts and nuts for flanged joints: To AS/NZS 4087 clause 3.2.

Corrosion protection: Wrap all unprotected joints in the trench with an approved petrolatum tape system or an approved alternative.

PVC-U non-pressure

Standard: To AS/NZS 1260 and WSA 02 Table 10.1.

PVC-U pressure/vacuum

Standard: Conform to WSA 02 Table 10.3 and the following:

- PVC-U: To AS/NZS 1477 clause 2.4.2.
- PVC-M: To AS/NZS 4765.
- PVC-O: To AS/NZS 4441, Appendix ZZ clause 9.3.2.
- Vacuum pipes and fittings: To WSA 06 clause 9.5.2.

Elastomeric seals: To AS 1646.

Handling and storage: To AS/NZS 2032. Record time in storage and type of shelter protection from UV damage.

PVC-U pipe sockets: Do not use spigots of ductile iron fittings.

Jointing: Solvent cement jointing of PVC-U mains to AS/NZS 3879 and PIPA POP102 available from www.pipa.com.au/images/pdf/POP102.pdf .

DI fittings: If used in conjunction with ductile iron fittings:

- Series 1 PVC-U pipe: To AS/NZS 1477.
- Series 1 PVC-M pipe: To AS/NZS 4765.

Polyethylene (PE)

Standard pipe: To AS/NZS 4130, WSA 01 and WSA 02 Table 10.1.

Fittings: To AS/NZS 4129.

Mechanical couplings: Self-restraining.

Stub flanges and backing rings: To POP007.

Flanges: To AS 2129, AS/NZS 4331.1 and AS/NZS 4087.

Property service pipe: PE 100, PN 16, series 1.

Jointing: Provide butt thermal fusion or electrofusion couplings or mechanical fittings.

Bending: To AS 2033.

Vacuum pipes and fittings: Conform to WSA 06 clause 9.5.3.

Internal diameter and wall thickness: Provide pipe and fittings with minimum wall thickness and minimum internal diameter to **Material properties schedule**.

Polypropylene (PP) non-pressure

Standard: To AS/NZS 5065 Type B ID series and to WSA 02 Table 10.2.

Pipe stiffness class: SN 10.

Elastomeric joint seals: To AS 1646.

Glass reinforced plastic (GRP)

Standard pipe: To AS 3571.1 and WSA 02 Table 10.1.

Surge cycles: Refer to the manufacturer if the temperatures are likely to exceed 35°C.

GRP fittings: To AS 3572.2.

Handling and storage: Provide protection from ultra violet light and damage if storing for longer than 7 days.

Vitrified clay pipe and fittings (VC)
Standard: To AS 1741, BS EN 295-1 and WSA 02 Table 10.1.

Class of pipe: To the loading requirements of AS 4060.

Elastomeric joints: To BS EN 681-1.

Acrylonitrile butadiene styrene (ABS)
Standard: To AS/NZS 3518 and WSA 02 Table 10.1.

Joints: Conform to manufacturer's recommendations using solvent cement to AS/NZS 3879.

Pipe class: Provide for cyclic loading.

Reinforced concrete (PVC-U lined)
Standard: To AS/NZS 4058 and WSA 113.

Testing: To AS 4058 Appendix A including crack load, ultimate load, hydrostatic pressure, dimensional accuracy, cover, joint assembly.

3.3 VALVES, HOLES/SHAFTS AND ACCESS COVERS

Valves
Requirement: Provide valves, hydrants, holes/shafts, surface fittings and access covers as documented.

Certification: Submit product or material certification before delivery to the works. This is a **WITNESS POINT**.

Extended spindle: To AS/NZS 2638.1 Test J and AS/NZS 2638.2 Test M and the following:

- Welding: To AS/NZS 1554.1 Category GP. Do not weld cast iron (including grey and ductile iron) components.
- Coating: Provide the following:
  - Bitumen coat: To AS/NZS 3750.4, or
  - Synthetic resin base coat: To AS/NZS 3750.19, or
  - Thermal bonded polymeric coatings: To AS/NZS 4158.

Valves: Conform to the **Valves schedule**.

Valves schedule

Valves and hydrants properties	Val 1	Val 2	Val 3
Location			
Spacing			
Type			
Class			
Sizing			
End connections			
Gearing			
Valve chamber			
Installation requirements			
Identification, colour and marking			
Operation (e.g. electric etc)			
Supports required			

Flanges: To AS 2129 and AS/NZS 4087.

Socket joint configurations: Elastomeric joint seal to AS 1646.

Vacuum interface valves: To AS 4310 and the following:

- [complete/delete]

Stop valves
Resilient seated ball valves for property services: To AS 4796.

Metal seated valves: To AS/NZS 2638.1.

Scour valves: Connect to pipelines with a flanged joint.

Gaskets: 3 mm thick insertion rubber.

Gate valves: Conform to the following:

- Anti-clockwise rotation of the input spindle for closure.
- Provide spindle cap.

Knife gate valves: To AS 6401 and the following:

Butterfly valves: To AS 4795.1, AS 4795.2 and the following:

- Do not use in reticulation mains.
- Direction for closing: Anti-clockwise.
- Do not use if throttle of flow is required.
- Installed with trunnions horizontal and gearing operated from the surface.
- Provide chamber where gearbox is not sealed.

Control valves

Air valves for DN 50 to DN 200 sewerage: To AS 4883.

Non-return valves: To AS 4794 and the following:

- Pressure class: PN 16.
- Provide lifting lugs: ≥ DN 250.
- Swing check type of ductile cast iron or steel body, cover and disc or bronze body and disc seat rings.
- Clear swinging leaf to provide an unobstructed waterway.
- Do not use wafer style non-return valves.
- Maintenance: Provide body cover of sufficient size and in a location that allows removal of the valve flap and the seat for inspection without removal of the valve body.
- No flow switch: Extended spindle of minimum grade 316 stainless steel to ASTM A240/A240M and fitted with an adjustable counterweight together with a proximity switch to indicate a no-flow condition and with the following features:
  - Eccentric cam operated limit switch type.
  - Minimum rating of 10 amps, 240 V AC, 50 Hz.
  - Oil tight and dust proof to IP 65.
  - Suitable for 25 mm conduit entry.
  - Mounted on rigid adjustable brackets of stainless steel in conformance with ASTM A240/A240M and free of sharp edges and exposed corners.

Surface fittings

Access covers: To AS 3996 and the following:

- Coating to AS/NZS 3750.4 or BS 3416 for all cast iron solid-top covers and frames other than recessed parts. Do not apply to sealing and threaded surfaces. Make sure coating is dry to touch when handled.
- Single part round covers ≥ DN 375: 0.3 ± 0.03 mm gap between the edge of the cover and the inside edge of the frame.
- Multi-part covers: Each part snugly against the frame with no gap greater than 4 mm between either part and the frame.

Access covers and frames schedule

Requirements	**A1**	**A2**	**A3**	**A4**
Cover number				
Load class				
Size				
Aesthetics				
Security				
Seals				
Cover orientation				
Handling				

Jointing components

Jointing lubricant: To AS/NZS 4020.

Joint seals: To AS 1646.

Maintenance holes and shafts

Maintenance holes (MH): Conform to the following:

- ABS: To AS 3518.
- Concrete: To AS 4198.
- GRP: To AS 3571.1.
- PE: To AS/NZS 2033.
- PVC-U: AS/NZS 1477, AS/NZS 4441 or AS/NZS 4765.

Maintenance shafts (MS), inspection shafts (IS) and terminal maintenance shafts (TMS) including cover: Conform to the following:

- ABS: To AS 3518.
- Concrete: AS 4198.
- GRP: AS 3571.1.
- PE: To AS/NZS 4130.
- PVC-U: To AS/NZS 1477, AS/NZS 4441 or AS/NZS 4765.

Maintenance hole covers, frames and installation: To AS 3996.

Concrete covers and frames: To AS 4198 and AS 3996.

Covers capable of being bolted down: For areas below the 1 in 100 flood level.

3.4 STEEL AND CONCRETE

Steelwork

Ancillary steelwork, including ladders, brackets, and covers: To AS 1657.

Abrasive blast cleaning: To AS 1627.4 Class 2.5.

Protection: Hot-dip galvanize to AS/NZS 4680.

Step irons: Provide step irons as shown on the drawings or encapsulated in plastic.

Concrete

Premixed, normal class concrete: To *0319 Minor concrete works*.

3.5 PROTECTION AGAINST DEGRADATION

General

Detail: Protect pipeline system items (e.g. pipes, fittings, appurtenances, elastomeric seals) including the following:

- Eliminate contact between dissimilar metals to prevent galvanic corrosion.
- Fully seal conduits for plastic pipes and fittings in contaminated ground.
- Fully seal conduits for all elastomeric seal jointed pipes and fittings in contaminated ground.
- Control trench fill and pipe embedment materials.
- Mitigate stray current or telluric effects on buried steel pipelines in conformance with WSA 03 clause 4.8.6.
- Cathodic protection for buried steel pipelines to AS 2832.1 and AS 2832.2 and in conformance with WSA 03 clause 4.8.5.

3.6 BEDDING, EMBEDMENT AND FILL MATERIAL

General

Bedding and embedment material: To AS/NZS 2566.2, WSA 02 clause 20.2 and the following:

- Free of noxious weeds and dangerous chemicals.

Bedding, embedment and fill material schedule

Material	Mat1	Mat2	Mat3
Grading			

Material	Mat1	Mat2	Mat3
Resistivity (AS 1289.4.4.1)			
pH (AS 1289.4.3.1)			
Wet strength (AS 1141.22)			
Wet strength/dry strength variation (AS 1141.22) Weak particles (AS 1141.32)			
Aggregate type			
Nominal size of aggregate (mm)			
Mix proportions			
Size for stabilisation (mm)			
28 day compressive strength (MPa)			
Maximum moisture content at delivery			
Trafficable or non trafficable areas			

Recycled material: Submit for approval any recycled material proposed. This is a **HOLD POINT.**

Geotextile

Properties: Non-woven fabric, unaffected by bacteria and fungi, marked to AS 3705.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic*.

4.2 ESTABLISHMENT

General

Requirement: If using trenchless technology conform to *1392 Trenchless conduit installations.*

Set out: Confirm the locations immediately before construction. This is a **WITNESS POINT**.

Space allocations: Conform to any space allocation agreements, local agreements with road owners or other utility service provider.

Sewer mains in easements: Conform to WSA 02 clause 4.2.5, WSA 02 drawing SEW-1105 and the documented requirements.

Supply of water for the works: To WSA 02 clause 14.6.

Protection: Provide protection from external factors such as external loading, third party intrusion as documented including:

- Precast reinforced concrete removable slabs.
- Concrete encasement to WSA 02 clause 14.5.
- Service duct.
- Security fencing.
- Protection barriers.

Overhead power lines and transmission towers: Provide protection as documented and as follows:

- If welded steel pipelines simultaneously run parallel (for more than 1 km) and within 500 m of powerlines > 50 kV
- Where metal pipelines are located within 5 m of a transmission tower
- Where metal pipeline access is within 50 m of a transmission tower.

Above ground water mains: Provide above ground water main components as documented including pipeline items, supports, restraints, loading protection, maintenance and access requirements, protection from exposure conditions.

Document: Record contact details with all affected customers. Resolve enquiries and complaints promptly.

Road opening permits: Obtain a road opening permit before starting of any works within a road or road reserve.

Crossings Authority approvals: If a pipeline crosses a main or state road, creek or involves features shown on the drawings under the control of any Authority, carry out the work in conformance with the requirements of that Authority including obtaining any approvals and paying any fees as appropriate. This is a **WITNESS POINT**.

Tolerances

Sewer horizontal: ± 100 mm lateral displacement from the design alignment.

Structures horizontal: ± 100 mm lateral displacement from the design alignment and ± 200 mm along the water main axis.

Junctions horizontal: ± 100 mm displacement along the sewer axis.

Property connection sewers: ± 100 mm displacement along the sewer axis.

Property connection risers, inspection openings and surface fittings: ± 100 mm displacement along the sewer axis and ± 100 mm displacement along the property connection sewer axis.

Sewers, property connection sewers and structures invert level: + 10 mm, – 50 mm, no reverse grades.

Property connection risers and inspection openings inverts: + 10 mm, – 150 mm.

Sewer grade tolerance: To WSA 02 Table 23.1.

Property connection sewer grade tolerance: To WSA 02 Table 23.2.

Verticality of MH, MS, TM, inspection shafts, vertical risers and vents: 10 mm/m rise in any direction.

Structures higher than 5 m verticality: 50 mm cumulative deviation in any one particular direction.

Cast in situ concrete structures internal dimensions (diameter, length, width, depth etc): + 5%, - 2%.

Cast in situ concrete slabs external dimensions: + 5%, - 2%.

Cast in situ concrete thickness: + 50 mm, – 0 mm.

Temporary drainage during construction

General: For each part of the system, complete the erosion and sedimentation control measures before commencing the works.

Control of erosion and sedimentation: Conform to *1102 Control of erosion and sedimentation*. Make adequate provision for runoff flows at drainage works under construction or surrounding areas/structure. Submit plan to WSA 02 clause 13.5.6.4.

Dams and diversions: Do not dam up or divert existing watercourses (either temporarily or permanently). Submit for approval if required.

Dewatering: Keep all excavations free of water. Provide dewatering including any equipment required. Make sure no damage is caused to adjacent structures and services.

Discharge: Obtain approval by the appropriate Authority for any discharge to sewers, stormwater drains or watercourses. This is a **WITNESS POINT**.

Material and equipment: Locate material and equipment clear of watercourses or secure to prevent danger or damage in the event of large runoff flows.

Stabilisation of topsoil areas: Immediately following earthworks where required or as directed, stabilise the topsoil with hydroseed to *0257 Landscape – road reserve and street trees,* **Hydroseeding**.

Excavation near underground services

Public utilities within the excavation for sewerage systems: Obtain approval of the relevant Authority to the method of excavation before commencing excavation. This is a **HOLD POINT**.

Location: Obtain locations of water, sewer, stormwater, gas, electricity and telephone services from DIAL BEFORE YOU DIG and the **Contacts schedule** in *0136 General Requirements (Construction)* to verify the location of services.

Marking: Before commencing earthworks, locate and mark existing underground services in the areas which will be affected by the earthworks operations including clearing, excavating and trenching. This is a **HOLD POINT**.

Protection of property and environment: To WSA 02 clause 13.5.2 and the following:

- Protection of other services: Give notice of any interference to the works caused by an existing service and submit a proposed work method statement. This is a **HOLD POINT**.
- Disused or redundant sewer mains: Carry out works as documented and to WSA 02 clause 13.5.3.

4.3 EXCAVATION FOR SEWERAGE SYSTEMS

General

Topsoil: Remove topsoil in conformance with *1112 Earthworks (Roadways)* before undertaking sewerage system excavation.

Excavation level: Excavate trench or foundation for sewerage works to the designed level of the bottom of the bedding or foundation. Remove all loose material.

Soil type: Confirm surrounding soil type with design. Give notice if not consistent with the design. This is a **HOLD POINT**.

Location: Carry out all excavations for structures and pipelines to the lines, grades and forms shown on the drawings.

Authority requirements: Conform to the requirements of the appropriate Authority including drainage, dewatering, silt control, noise abatement, proximity to existing buildings and generally for the amenity of adjacent owners.

Safety fencing: At the completion of work each day, provide safety fencing along the edges of open excavations to statutory requirements. Plug any open pipelines to prevent ingress of soil or other material and backfill to prevent flotation of any laid pipelines.

Access to properties: Provide fenced walkways and vehicular crossings across trenches to maintain access at all times from the carriageway to individual properties or within individual properties and give prior notice to all affected occupiers.

Existing services: Locate, protect and repair, as necessary, all services within the extent of the works.

Protection of trees: Conform to the following:

- Obtain approval from the tree owner and Council for tree removal or working within allowed distances.
- Do not store materials or products against trees, under tree canopies or root zones.
- Fence off trees to keep machinery away as required or use boring or hand excavation.
- Protect roots:
  - Cleanly cut tree roots ≤ 60 mm diameter. Obtain approval before for cutting larger roots
  - Damaged roots: Treat as documented in the environmental management plan or as directed.

No blasting: Submit blasting plan to AS 2187 for approval for any blasting if required.

Excavation across improved surfaces: To *1152 Road openings and restoration (Utilities)* and the following:

- Obtain approval from the land owner before commencing any excavation across improved surfaces. This is a **HOLD POINT**.
- Saw cut neat straight lines ≥ 150 mm beyond the outer limits.

Cover over pipelines

Minimum cover: Provide mains pipelines with the minimum depth of cover as documented and in conformance with WSA 02 Table 4.8, measured vertically from the finished ground level to the top of any socket.

Less than minimum cover: Provide lesser cover where special protection of the pipelines is documented.

Greater than minimum cover: Provide greater cover where special situations occur, where there is conflict with other services or to meet grading requirements.

Inadequate foundation material

Notice: Give notice of any area of the foundation including the sides of the trenches that may contain material that is inadequate to support the proposed drainage structure. This is a **WITNESS POINT**.

Confirmation of inadequate foundation material: If directed, remove and dispose of inadequate foundation material to *1112 Earthworks (Roadways)* and replace the material to **Bedding, embedment and fill material**.

Rock foundation: If rock is encountered at the foundation level, excavate for an additional depth as directed. Backfill and compact the additional excavation with material conforming to the **Bedding, embedment and fill material**. This is a **WITNESS POINT**.

Support of excavation

Trench support stabilising: Provide any shoring, sheet piling or other stabilisation of the sides of trench excavations necessary to conform to statutory requirements.

Support: All trenches of depth > 1.5 m or in unstable ground strata.

Trench support system: Do not disturb adjacent structures and services.

Compaction of pipe embedment and trench fill material: Below any trench support and against native ground.

Permanent trench support system: Cut off the support system below ground surface.

Precaution against slips or falls: Support all excavations as the works proceed.

Trench instability: Submit, for approval, the proposal to provide adequate permanent stability of the ground affected by trenching. This is a **HOLD POINT**.

Excavation for under pressure cut-in connection to pressure pipes ≥ DN 80

Requirements: Excavate below and behind the host pipe ≥ 100 mm.

Host pipe: Support during excavation and drilling.

Excavation sides: Keep sides of excavation vertical ≥ 150 mm above the pipe.

Minimum cover: Satisfy minimum cover requirements at all times.

Trench excavation

Requirements: Conform to the following requirements for trench excavation:

- Minimum cover requirements as documented.
- Maintain trench excavation in a stable condition.
- Minimise the length of the open trench at any one time.
- Align the trench centreline with the design pipeline centreline.

Trench size for pipelines: Excavate the trench to WSA 02 clause 8.9 and the following:

- Buried flexible pipelines or embankment method in general: To AS/NZS 2566.2.
- PVC-U: AS/NZS 2032.
- PE: AS/NZS 2033.
- ABS: AS/NZS 3690.

This is a **WITNESS POINT.**

Minimum trench width: 300mm

Embankment installation condition: To AS 2566.2. Before placement of bedding and laying pipes, place and compact embankment fill to a height above the top of the bed zone of at least 0.7 times the external diameter of the pipe and for a minimum lateral distance outside each trench wall of 2.5 times the external diameter of the pipe. Place earthworks to *1112 Earthworks (Roadways)*.

Trench installation condition: Complete the embankment to the underside of the selected material zone before starting the excavation.

Trench width: Do not excavate > 500 mm over the minimum trench width. This is a **WITNESS POINT**.

Bitumen and concrete surfaces: Carefully cut, by sawcutting or other means approved by the Superintendent, to provide a neat straight line free from broken ragged edges.

Widen for fittings: Widen the trench where necessary for the installation of valves and fittings and protective coating systems.

Maximum trench depth: Excavate no more than 50 mm below the invert of the pipe.

Rock foundations: Excavate trenches to 75 mm below the underside of the pipe barrel and socket or coupling, or as otherwise shown on the drawings.

Pipe support: Provide solid and uniform support for each pipe over the whole length of the barrel with chases provided for joints and wrapping.

Minimum clearance requirements: Clearances between sewers and other underground services to WSA 02 Table 4.2.

Easement: Do not excavate outside the easement.

Clearance for on-site works: Provide over 500 mm clear space in all directions from the workface where works such as welding or corrosion protection are required.

Stockpile: Provide stockpiles as follows:

- Do not stockpile excavated materials against the walls of any building or fence.
- 600 mm minimum between the edge of any excavation and the inner toe of stockpiles.
- Stockpile excavated topsoil separately and use for surface restoration after backfilling.
- Remove any surplus excavated material not required for re-use for topsoil or backfill.

Trenchless technology

General: If using trenchless technology conform to *1392 Trenchless conduit installation.* Submit proposal for trenchless installation. Include documentation for the following:

- Geological conditions and plan for inspection of actual geological conditions as the excavation progresses.
- General description of method and sequence of operation.
- Size, depth and position of temporary pits required.
- Use of specialist subcontractors.
- Use of specialist equipment.
- Grout type and method of injection.

Existing road crossings: If shown on the drawings, use trenchless methods for the installation of the mains.

Encasement pipe: As shown on the drawings. Extend the encasement pipe 1.0 m behind the back of the kerb on either side of the carriageway.

Support cradles: Position the carrier pipe on support cradles centrally located within the encasement pipe.

Ductile iron cement lined (DICL) carrier pipe: Polyethylene sleeving is not required for any length of ductile iron cement lined carrier enclosed within the encasement pipe.

Grouting: After installation and pressure testing of the carrier pipe, fill the annular space between the carrier pipe and the encasement pipe with suitable grout or cementitious grout filler.

4.4 BEDDING FOR PIPES

Trench floor preparation

Foundation: Before placing embedment, test the proposed foundation in conformance with WSA 02 clause 15.8 and the following:

Bearing capacity: > 50 kPa at the minimum trench depth – 50 mm. If not achieved give notice for directions. This is a **HOLD POINT**.

Compaction: Compact all fill and disturbed areas to the density of the natural ground. Refill areas of excessive excavation.

Preparation: Remove all debris and water before placing bedding.

Bedding and pipe support

Pipes other than PVC/PE: Provide non-cohesive granular bedding with minimum thickness of 75 mm below the barrel and socket of the pipe.

PVC-U pipes: To AS/NZS 2032 Figure 5.1.

PE pipes: To AS/NZS 2033 Figure 5.1.

Concrete support: Do not place bedding material until concrete has obtained its initial set.

Compaction of beddings: Provide compaction of bedding conforming to the following:

- Flexible pipes: To WSA 02 Table 22.1.
- Rigid pipes: To WSA 02 Table 22.2.
- Pressure pipes: To WSA 07 Table 21.1.

Protect: Do not walk on the centreline of the compacted bedding.

Bedding for maintenance holes: To WSA 02 clause 16.6.

4.5 PIPE LAYING, JOINTING AND CONNECTING

Installation of pipes

Pipeline: Maintain the cleanliness and dryness of all items during construction by using exclusion caps, plugs or blank flanges. Remove any dirt and foreign matter if pipes flood at any time.

Examine: Clean and examine all pipeline system items before installation. Inspect each joint seal for fit and flaws. Do not use damaged, dirty or incorrect seals.

Cut pipes: Chamfer where required and provide witness marks on the unmarked length of any cut pipes. Do not score pipes when providing the witness mark. Treat cut pipes in conformance with the manufacturer's recommendations.

For field cuts of ductile iron or steel: Make sure that working fire fighting equipment is on the site before making the field cuts.

Petrol engine pipe cutter: If using a petrol engine pipe cutter in an excavation, maintain a safe atmosphere in the excavation at all times.

Witness mark on cut pipes: Except for PE pipes to be butt welded, if pipes are cut in the field, make a clearly identifiable witness mark on the pipe at the length specified by the manufacturer from the end of the pipe.

Witness marks on PVC/PE pipes: Do not use PVC/PE pipes with scored witness marks.

Witness marking depth: If the same manufacturer does not make spigots and sockets, refer to the socket manufacturer for the correct marking depth.

Laying: To WSA 02 clause 17.1.4.

Laying method: Start laying pipes from the downstream end with sockets at the upstream end and barrels firm and evenly embedded on the bedding material.

Laying sequence: Lay pipes on continuously rising grades from scour valve to air release valve, despite any minor irregularities in the ground surface.

Lift and re-lay construction: Supply affected properties with a temporary water service including a ball valve.

Horizontal and vertical separation of crossing pipelines: Maintain minimum horizontal and vertical separation of crossing pipelines as documented. Fill with embedment material and compact.

Maintenance: Install valves and other appurtenances for easy access for maintenance and repair.

Prevent flotation: Conform to WSA 02 clause 17.4.

Existing asbestos cement pipe cutting and disposal: Submit method statement for approval.

Aqueducts: Install in conformance with the drawings including protection grills and corrosion protection.

Horizontal and vertical deflections of pipes

Limits of deflection: To the pipe manufacturer's recommendations.

Remove temporary pegs and stakes: Do not point load pipes.

Curving of pipe: If documented, cold bend pipes with a uniform radius along the length of the pipe in conformance with the manufacturer's recommendations. Join pipes directly before making the curve. Do not use temporary pegs or stakes to restrain the pipe during curving.

Methods of deflection for horizontal and vertical curves: To WSA 02 clause 17.2 and Table 17.1 or WSA 06 clause 34.2 and Table 34.1.

Thrust and anchor blocks

Requirement: Provide thrust or anchor blocks in conformance with the drawings and the following:

- Position thrust and anchor blocks to bear against undisturbed material in the direction of the thrust and over the specified bearing area. Do not encase any part of adjacent joints.
- Provide a membrane between the fitting and the concrete to prevent damage to the coating of the fitting.
- To WSA 02 clause 5.10 and Table 5.1, as shown on the drawings.
- Make sure that thrust and anchor blocks are central to the fitting and do not interfere with any other services.

Notice: Give notice if the allowable bearing pressure of the ground and the design pressure of the pipeline are different to the actual pressures on site. This is a **WITNESS POINT.**

Concrete: 20 MPa.

Cast in situ concrete structures and slabs: Tolerance ± 0.5% or 5 mm, which ever is greater.

Concrete thrust, anchor blocks and bulkheads: Tolerance + 5%, - 2%.

Restrained joints

Requirement: For DI pipes, follow manufacturer's recommendations.

Pressure and vacuum sewer: To WSA 07 clause 18.7 and WSA 06 clause 34.7.

Marking

Non-detectable marking tape: Lay on top of the pipe embedment material before trench filling and to AS/NZS 2648.1.

Detectable marking tape: Lay tape on top of the pipe embedment to form a continuous connection between valves. Connect bare wires to a nut or bolt of a valve or hydrant.

Requirement: Lay detectable identification tape along the line of the rising main within 150 mm of the finished surface or as otherwise directed by the Superintendent.

Tracer wire: Provide 2 mm diameter 316 stainless steel in trenchless installations.

Appurtenance location marking: Provide location marker posts, plates or other as shown on the drawings.

Time: Fix marking as soon as practicable after each valve or hydrant is installed.

Temporary cover: Temporarily cover marking plates for hydrants using masking tape or other approved cover and remove on satisfactory completion of the pressure testing of the pipeline.

Distance: Permanently mark the plate with the distance to the valve or hydrant in metres, to an accuracy of 0.1 m, with legible numbers a minimum 80 mm high.

Wooden posts: If there is evidence, by rotting or termite activity, that the integrity of the posts will be affected, do not use.

Post length: Sufficient length to be set firmly in place under saturated ground conditions.

Post projection: When installed, in conformance with the following:

- Generally: 1000 mm above the ground.
- If tall grass or crops are likely to obscure the post: 1500 mm above the ground.

Finish: Paint posts with 2 coats of white enamel for exterior use.

Pavement markers: Two-way reflective raised pavement markers to the road pavement and kerb.

Bored pipes under roads, driveways etc.

Plastic slippers: Place plastic slippers between the sewer and the bored hole in conformance with the manufacturer's recommendations.

Buffer rings: Place buffer rings between vertical clay (VC) and reinforced concrete pipes pushed into bores.

Joints: Provide a continuous pipe under the road carriageway or limit to a single joint.

Grouting: Provide gravity or pressure grouting commencing from the downhill end of the bore. Achieve full penetration and complete filling of the void.

Insulators: Insert plastic slippers between the sewer and the bored hole in conformance with the manufacturer's recommendations.

Unsupported bore: Complete all pipework and grouting within 24 hours.

Plastics-lined reinforced concrete (RC) pipe

Protection: Protect protruding plastic lining flaps of precast pipes from sharp changes in flap direction.

Plastic–lined < 360° of internal pipe: Provide unlined pipe inverts aligned continuously along the invert of the installed sewer.

Field jointing: Following installation of precast plastics-lined concrete products, join the plastics flap at the spigot end to the plastic lining of the previously laid pipe by welding.

Plastics lining ancillary work: Conform to the following:

- Vertically align plastics-lining keys.
- Provide vertical seepage channels between plastics-lining and precast or in situ concrete components.

- Jointing accessories and adhesives in conformance with manufacturer's recommendations.

Flanged joints

Support: Fully support matching pipe and valve/fitting during installation.

Sequence: Tighten bolts in the specified sequence using a torque wrench.

PE pipe: Provide a butt welded PE stub flange adaptor with a stainless steel backing ring in conformance with POP007.

Welding of steel pipelines

Welding: To AS/NZS 1554.1 Category SP and WSA 02 clause 17.16.

Reinstate cement mortar linings for pipes as documented: Use an approved primer and mortar mix of sand and cement 2:1. Apply in conformance with WSA 03 Figures 15.1, 15.2, 15.3, 15.4.

Field welding of flanges: Do not field weld MS flanges. Submit proposal for approval in conformance with WSA 02 clause 17.16.2. This is a **WITNESS POINT**.

Wrapping of ductile iron pipelines

Polyethylene sleeving: Enclose a pipeline or a section of pipeline, in layflat polyethylene sleeving and plastic tape adhesive in locations as shown on the drawings and in conformance with manufacturer's recommendations.

Material: High impact resistance polyethylene sleeving in conformance with the following

- To AS 3681.
- 50 mm wide plastic adhesive tape.
- The width of the sleeving when flat: To the manufacturer's recommendations for the size and type of the pipeline being encased.
- Do not exceed 48 hours exposure to direct sunlight.

Protection: Protect the sleeve from damage during application and the backfilling of the trench.

Field joints: Provide 250 mm minimum overlap of sleeving at each field joint.

Sleeving ends: Hold in position with at least three circumferential turns of adhesive tape.

Excess material: Neatly draw up loose, excess polyethylene sleeving material around the pipe barrel, fold into an overlap on top of the pipe and hold in place with strips of plastic tape at approximately one-metre intervals.

Bends, tapers and similar fittings: Cover with polyethylene sleeving as specified for the pipes.

Valves and irregular shaped fittings and joints: Hand wrap using flat polyethylene sheets secured with plastic adhesive tape, or other suitable material, to provide an adequate seal.

Damage to sleeving: Rectify any damage done to the polyethylene sleeving before proceeding to backfill of the trench. This is a **HOLD POINT**.

Steel bolts and nuts corrosion protection

General: Wrap all galvanized steel bolts and nuts, used for below ground installation of flanges, bolted gland joints, mechanical joints and tapping bands in conformance with the manufacturer's recommendations.

Requirement: Dry, clean and free from rust, immediately before wrapping.

Tape: Synthetic fibre open weave cloth impregnated with saturated hydrocarbons approved by the Superintendent.

Joints

General: Except where solvent cement joints are needed to make up or install fittings, conform to the following:

- Location: As shown on the drawings.
- Elastomeric seal joints:
  - Either roll-on or skid type.
  - Apply only lubricant to manufacturer's recommendation in making the joint.
- Mechanical joints: Fixed flange, bolted gland type, or a PE pipe system specific joint type.

Roll-on rubber ring joints: Make sure spigots and sockets are clean and dry.

Skid rubber ring joints: Use lubricant recommended by the manufacturer. Make the joint so that the witness mark is no more than 3 mm from the end of the socket.

Weld PE pipe: To WSA 01.

PE weld pre-qualification: Submit pre-qualification for PE electrofusion and butt fusion for approval in conformance with WSA 07 clause 18.3.

Electrofusion: PE pipes ≤ 90 DN and for pipes of different SDRs.

Butt welding: PE pipes > 90 DN with the same SDR.

Solvent cement joints: To AS/NZS 3879 and manufacturer's recommendations.

Jointing pipes of different materials

Gravity sewer: If jointing PVC/PE pipes to DI pipes, make joints by inserting a PVC/PE spigot into a DI socket. Do not insert DI spigots into PVC/PE sockets.

Compatibility: Confirm the compatibility of the PVC/PE pipe, joint seal and DI socket.

PVC-U pipes: If jointing pipes to pipes of another material, make the joints as follows:

- PVC/PE spigot or PVC/PE socket to VC socket: Provide a PVC/PE adaptor. Make joints using a ring conforming to AS 1646.
- PVC-U to DI: Provide a rubber ring (elastomeric) joint with an adaptor coupling.
- PE to DI: Provide a restrained joint (flange or coupler).

Alternative: Multi-fit mechanical couplings or flanged adaptor couplings, but not stainless steel leak/repair clamps, may be used to join pipes of different materials. If jointing PE with mechanical couplings, provide joint restraint.

Appurtenances

Compatibility with pipework: Provide proper sealing between the pipe flanges and the valve.

Concrete lining in pipework: Do not chip away or reduce to provide clearance from the working parts of valves.

Installation: Make sure that valves are installed to facilitate maintenance.

Rising main fittings

Location: Install rising mains, air release valves and inspection pipes as shown on the drawings.

Identification tape: Top all rising mains with an appropriate identification tape.

Marking plates: At changes of direction and, at such chainages that the location of the main is marked, at least once each 100 m. Provide marking plates bearing letters as follows:

- For double air valves: DAV.
- For scour pipes: SCOUR.
- For sewage rising main: SRM.

Urban areas: Paint the kerb adjacent to each fitting with two (2) coats of non-slip paint coloured black.

Distance: Mark the distance to the fitting in m, to an accuracy of 0.1 m, permanently on the plate with legible numbers a minimum 80 mm high.

Wooden posts: If there is evidence, by rotting or termite activity, that the integrity of the posts will be affected, do not use.

Post length: Sufficient length to be set firmly in place under saturated ground conditions.

Post projection: When installed in conformance with the following:

- Generally: 1000 mm above the ground.
- If tall grass or crops are likely to obscure the post: 1500 mm above the ground.

Post finish: Paint posts with 2 coats of white enamel for exterior use.

4.6 JUNCTIONS AND PROPERTY CONNECTION SEWERS

Location

Property connection sewers: Provide to WSA 02 clause 17.7 and the following:

- Where concrete surround or encasement is required, allow more than 16 hours for the concrete to set before connecting sewer.
- Locate vertical drops or risers to prevent sewer damage and provide support to maintain their position during encasement or backfilling.
- Mark property connection locations.
- Provide junctions for dead ends and property connection sewers or risers to properties to serve existing and future dwellings.

- Depth of service connection: < 2.5 m, provided the property still has service to the sewer.
- Existing dwellings: Inside the property boundary to facilitate the connection with existing sewage outlets.
- Dual occupancies: Provide separate connections.
- Vacant blocks: Inside the property boundary to facilitate the connection with topography and future likely positioning of sewage outlets.
- Long property connection sewers: Extend property connections so that sewer lines < 75 m from premises.

Squeeze-off on PE pipework: Use specially designed squeeze-off tools, avoid over compression and minimise damage. On release of the squeeze inspect and re-round the pipe as necessary, cut-out and renew the pipe if there is any indication of damage or weld an electrofusion repair saddle. Do not squeeze-off PE pipe within 5 pipe diameters from a previous point of squeeze-off isolation.

Valves, valve chambers, scours and surface fittings: Install in conformance with the drawings and WSA 07 WAT-1307.

Tolerance for valves, fittings and junctions:

- Horizontal: ± 100 mm displacement from the design position along the sewer axis.

Tolerance for valve chambers:

- Horizontal: ± 100 mm displacement from the design sewer alignment and ± 200 mm displacement from the design position along the sewer axis.
- Vertical: ± 250 mm provided design covers, grades, finished surface levels are within tolerance.

Concrete or backfill requirements

Concrete encasement for junctions: Encase junctions for risers in 20 MPa concrete to conform to WSA 02 clause 17.7 and clause 20.6.

Backfill: Compact backfill around risers to the top of the socket or coupling on the highest branch off the riser, for the full width of trench and for a minimum distance of 500 mm upstream and downstream of the riser.

Marking

Location: Clearly mark the position of each riser, junction or end of a property connection sewer on completion of backfilling.

Adjacent to fence or boundary structure: Stencil the letter ‘J’ 50 mm high on the fence or structure. Finish marking tape flush with the existing ground surface as close to the boundary fence or structure as possible.

Peg: Drive a 75 mm × 50 mm × 600 mm long peg into the ground and leave flush with the surface of the surrounding ground. Connect the peg to an underground identification tape.

Tape position: Tie the identification tape to the junction or end of the property connection sewer and hold the tape in a vertical position during backfilling. Spike the top end of the tape by the junction peg immediately upon completion of backfilling.

Identification tape type: 75 mm red coloured polyethylene.

Inscription: ‘CAUTION – BURIED SEWER LINE’, printed in heavy black letters every 200 mm.

On-property items

Collection/pump units: Install the collection/pump units in conformance with the drawings and the manufacturer’s recommended instructions. Slope finished surface level away from the units gradually.

Tolerance on collection tanks:

- Horizontal: ± 100 mm lateral displacement from the design boundary offsets and ± 200 mm displacement from any other design position.
- Vertical: ± 250 mm provided design covers, grades, finished surface levels are within tolerance.

Customer sanitary drains: Install new sanitary drains to AS/NZS 3500.2 and PSS-1101.

Property discharge lines: Conform to WSA 07 clause 18.9.3.

4.7 MAINTENANCE HOLES, SHAFTS AND INSPECTION SHAFTS

General

Installation: Provide MH, MS, TM, IO in conformance with the drawings and the manufacturer’s recommendations.

Maintenance shafts and inspection openings: To WSA 02 clause 19.

Step irons: Provide step irons in conformance with SEW-1307.

Maintenance holes (MH)

MH base: Construct the MH base to WSA 02 clause 18.2 and the following:

- Set out and support the MH base pipe connections to suit the diameter and offset centreline.
- In situ concrete base: Provide secure formwork and place concrete directly onto firm foundation.
- Precast base: Form the channels after the base has been placed.

MH location: Position a maintenance hole to conform to occupational health and safety requirements for access by maintenance staff, providing a proper working area around the top and access into the hole. Submit any proposal to change positions of MH before commencing the works. This is a **WITNESS POINT**.

Trench drainage around MH: Provide trench stops and drainage as shown on the drawings and to WSA 02 SEW-1207.

Connections to MHs: Provide a hydrophilic seal around the fitting in at least 2 positions for polyethylene, polypropylene or similar materials used in connections.

Core drill holes: Use a diamond hole saw.

Connections: Connect pipelines to maintenance holes, structures or embedded concrete with 600 mm long pipes. Provide 2 flexible joints, first joint < 150 mm of the face of the structure.

Flexible joints: If flexible joints cannot be made with cut pipes, select pipes from the various lengths provided to make the second joint within 300 mm of the position shown on the drawings (WSA 02 Part 3, Section 18.10, and drawings SEW-1302, 1303, 1313).

Precast concrete MH/MS/IS systems

Standard: To WSA 02 clause 18.4, SEW-1300, SEW-1301 to SEW-1306 and AS 4198 and the following:

- Submit proposed proprietary items if not selected. This is a **HOLD POINT**.
- Provide certification of quality before delivery to the works.
- Watertight components: Provide components that make a watertight system and satisfactory surface finish.
- Shaft sections: Section lengths to minimise the number of joints required.
- Maintenance holes: Conform to the following:
  - Make-up rings: Provide between cone sections and frames to make up height differentials.
  - Minimum wall thickness of any reinforced component below the frame: 84 mm
  - Vertical distance: 600 mm to 900 mm range from the top of the surround and the first step.

Installation: Install all preformed components in conformance with the manufacturers' recommended procedures and requirements.

Backfill: Place backfill for preformed maintenance holes and maintenance shafts and compact evenly to a level 300 mm above the top of the highest incoming pipe and for the full width of the excavation.

Import material: If necessary, import and compact non-cohesive granular material.

Cast in situ MH/MS/IS

Concrete cast in situ MH: To WSA 02 clause 18.5, 18.7, 18.8, SEW-1301 and *0319 Minor concrete works*.

Benching and channels: Thoroughly roughen and clean each base, brush coat of wet dry epoxy or sulphate resistant cement slurry. Render and shape benches and channels using 2:1 sand: sulphate resistant cement mix > 15 mm thick. Maintain in a damp condition for 72 hours after finishing.

Foam formwork: Construct benching and channels with off form finish.

Step irons: Fix step irons in formwork before placing concrete, ensuring step hold, alignment and spacing is positioned for safe access.

Covers and frames

On-site filling of recessed covers: To AS 3996, WSA 02 clause 18.9, SEW-1300, SEW-1301, SEW-1308 and any manufacturer's instructions.

Covers and frames: Warped or twisted covers and frames are not permitted.

Unformed surfaces: Provide a surface that is dense, uniform and free from blemishes.

Exposed edges: 4 mm radius minimum to WSA 02 Part 3, Section 18.9.

Delivery: Submit conformance certification of the covers and/or frames before delivery to the works. This is a **WITNESS POINT**.

Tolerances: Conform to the following tolerances:

- Cover: – 3 mm + 0 mm.
- Frame: ± 3 mm.
- Irregularities in finish: No abrupt irregularities and gradual irregularities not exceeding 3 mm.

Cover seating: Seat maintenance hole covers on a layer of bitumen impregnated fibre board with a cross-section of 25 x 25 mm or as otherwise approved.

Cover levels: Finish flush with the surface in roadways, footpaths and paved surfaces of any type.

Cover levels other than roadways, footpaths and paved surfaces: Finish 25 mm above the surface of the ground.

Tripping hazard: Make sure that the access chamber cover is not a tripping hazard.

Cast iron cover and frame location: Install a cast iron cover and frame instead of the standard concrete maintenance hole cover.

Bolt down frames: Install bolt down frames and covers in areas subjected to 1 in 100 year flooding.

4.8 EMBEDMENT AND BACKFILL

Pipe embedment and support

Notification of pipeline laid and jointed: Present the laid and jointed pipes for approval before starting trench backfilling. This is a **HOLD POINT**.

Material for embedment: Conform to **Bedding, embedment and fill material**.

Uniform placement: Place embedment material uniformly along and around the whole length of the pipe barrel, couplings and other appurtenances with no distortion, dislodgement or damage to the water main. Maintain more than 50% of the specified bedding depth under all projections.

Compaction: Compact in layers no more than150 mm for minimum compaction of embedment conform to AS 2566.2 and WSA 02 clause 20.3, Table 22.3.

Compaction techniques: Do not use equipment or methods that would produce horizontal or vertical earth pressures that would cause damage or distortion of the water main.

Flooding compaction: Do not use unless otherwise approved in conformance with WSA 02 clause 20.3.1 and AS 2566.2.

Removal of trench supports: Lift temporary trench support systems progressively above each layer of embedment. Compact layers against undisturbed native soil.

Concrete embedment and encasement

Requirement: Embed and encase pipes in concrete as shown on the drawings.

Encasement: Set pipes to line and level on bags of natural fibre filled with sand and cement mix or on concrete blocks or saddles. Make sure pipes do not move or deform while placing concrete.

Contraction joint: Provide at the junction of encased pipeline and the concrete encased section.

Concrete: 20 MPa.

Cast in situ concrete structures and slabs: Tolerance ± 0.5% or 5 mm which ever is greater.

Concrete thrust, anchor blocks and bulkheads: Tolerance + 5%, - 2%.

Reinforced concrete: Tolerances to AS 3600.

Drainage: Provide a 75 mm diameter drain hole in concrete bulkhead above the top of the encasement bedding or foundation. Place crushed gravel or rock in the upstream end of the drain hole as follows:

- 10 to 20 mm size within 150 mm in all directions upstream.
- Above the invert of the drain hole.
- 2 to 10 mm size for a further 150 mm surround.

Grouting: After installation and pressure testing of the carrier pipe, fill the annular space between the gravity carrier pipe and the encasement pipe with suitable grout or cementitious grout filler.

Ductile iron cement lined (DICL) carrier pipe: Polyethylene sleeving is not required for any length of ductile iron cement lined carrier enclosed within the encasement pipe.

Mechanical protection of pressure pipeline: Conform to WSA 07 clause 18.11, PSS-1001, PSS-1002, PSS-1003 and AS/NZS 2566.2 Figure 5.6.

Trench fill

Material: To **Bedding, embedment and fill material**.

Fill: Place and compact trench fill material. Avoid subsidence over or near the trench and damage to adjacent pavements and structures.

Non-trafficable areas: Provide excavated material as trench fill as follows:

- Excavated material: Free of organic material, containing no rock or hard clay > 75 mm and compatible in conformance with WSA 02 Table 22.3.
- Cohesionless soil excavated material: Do not use in cohesive soil locations.

Placement: Conform to the following:

- Damage: Make good any damage caused by subsidence.
- Do not impact load water main.
- Do not place fill within 24 hours of placing concrete embedment or encasement.
- Fill voids behind timber ground support in close-timbered tunnels, drives and shafts by pressure grouting.
- Do not displace any valve or hydrant access cover assembly or supports.
- Correct any deficiencies caused by settlement.

Compaction of trench fill: Compact in layers to conform to WSA 02 Table 22.3.

Mechanical compaction: Do not start mechanical compaction of fill material directly above the pipe until the total depth of cover above the pipe is adequate to prevent damage to the main.

Prevention of damage to pipes, coating and wrapping: Backfill and compact all materials without damaging the pipe or its external coating or wrapping or producing any movement of the pipe.

Embankment fill

Embankments: Submit proposal for construction of embankments in conformance with the drawings, including the method of placement and compaction and any limitations to the placement/ compaction over the top of the pipeline. This is a **HOLD POINT**.

If geotechnical assessment is required. This is a **WITNESS POINT**.

Trench stops and concrete bulkheads

Location and spacing: Provide trench stops and concrete bulkheads in conformance with WSA 02 clause 8.10, Table 8.1, SEW-1206, SEW-1207 and as shown on the drawings.

Concrete strength: 20 MPa.

Bedding: Conform to the following:

- Concrete bedding or encasement to pipe: Cast the 150 mm thick bulkhead integral with the concrete bedding or encasement across the width of trench and key into both sidewalls for a minimum of 150 mm. Extend the bulkhead 150 mm below finished surface level or as directed by the Superintendent. This is a **WITNESS POINT**.
- Other bedding or no bedding: Key the bulkhead into the bottom of the trench 150 mm for the full width of trench.

Drain hole: Provide a 75 mm nominal diameter drain hole in the concrete bulkhead immediately above the top of the encasement bedding or foundation. Place crushed rock or gravel in and at the upstream end of the drain hole to act as a filter as follows:

- 10 to 20 mm in size within 150 mm in all directions upstream and above the invert of the drain hole.
- 2 to 10 mm in size for another 150 mm surround.

Work on live maintenance holes

General: Unless shown otherwise on the drawings, complete all necessary works on live maintenance holes (that is, access ways to sewer system that is currently in service).

Work by others on live maintenance holes: Co-ordinate the works with any simultaneous and/or adjacent work by others and liaise with these Contractors and Authorities to avoid disruption, delays and possible conflict.

4.9 ACCEPTANCE TESTING

General

NATA: Provide NATA certified test results for all testing. This is a **WITNESS POINT**.

Unsatisfactory tests: Detect and rectify any faults that provide unsatisfactory tests until testing provide compliant test results. Rectify any visible leaks, blockage, malfunction or other defect even when results conform. This is a **HOLD POINT**.

Notice: Give notice for compaction testing, hydrostatic pressure testing, block testing and water quality testing. This is a **WITNESS POINT**.

Acceptance test: Carry out before the issue of the Certificate of Practical Completion and not earlier than one month after completion of construction of all sewers and maintenance holes in a section.

Visual inspection

Requirement: Inspect all system component markers for conformance with the documents. This is a **WITNESS POINT**.

Verify: Submit purchasing records for products and materials. This is a **WITNESS POINT**.

Compaction testing

Minimum compaction of embedment, trench fill and embankments: To WSA 02 Table 22.1, Table 22.2 and Table 22.3 tested to AS 1289.5.6.1 for cohesionless materials and AS 1289.5.7.1 or AS 1289.5.4.1 for cohesive materials.

- Pressure pipes: To WSA 07 Table 21.1.

Compaction testing requirements: Conform to the following:

- Drives and tunnel fill do not require testing.
- Trafficable areas test zone: 300 m² area with test at the centre, depth from the surface to the native ground or foundation level. Test each 300 mm of depth of fill and each test zone.
- Non-trafficable areas: 1200 m² area with test at the centre, depth from the surface to the native ground or foundation level. Test each 900 mm of depth of fill and each test zone.
- Retesting: Recompact and retest for any result that does not conform to WSA 02 Table 22.1, Table 22.2 and Table 22.3.

Embedment compaction testing for sewers > DN 300: In conformance with WSA 02 clause 22.3.3, test at the spring line ± 100 mm for each 50 m of pipeline.

Embedment compaction testing for sewers ≤ DN 300: In conformance with SEW-1200 allowable bearing pressure of the ground ≥ 50 kPa and the pre qualification method in conformance with WSA 02 clause 20.3.2.

Trench fill compaction testing: In conformance with WSA 02 clause 22.3.4, test as follows:

- Trenches in trafficable zone: 1 test in each 300 mm layer of fill for each 50 m of pipeline.
- Trenches in non-trafficable zone: 1 test in each 900 mm of fill for each 100 m of pipeline.
- MS, MH: 1 test within each 1 m depth at each location within 300 mm of each MS, MH riser.

Air pressure and vacuum testing of sewers

Pressure pipe: Do not use compressed air testing for pressure pipe.

Requirement: Pressure test all sewers ≤ DN 1500 including external MH drops, property connection sewers, vertical risers, MS and inspection shafts and fittings.

Sewers ≥ DN 750: Test during construction before MH construction.

Calibration certificates: Submit calibration certificates for testing equipment.

Low pressure air testing: Submit proposed method for testing in conformance with WSA 02 clause 22.4.2.

Vacuum testing: Submit proposed method for testing in conformance with WSA 02 clause 22.4.2.

Joints: Test every joint of sewers > DN 1500. Include proposed method with the testing submission.

Testing of concrete MH: Test after placement and compaction of embedment surround in conformance with WSA 02 clause 22.4.4, Table 22.5, Table 22.6 and ASTM C1244. Note precast and cast in situ concrete are viewed separately in WSA 02 Table 22.5. This is a **WITNESS POINT**.

Hydrostatic pressure testing

Pressure test the sewer system: Submit proposed method for testing to AS/NZS 2566.2 clause 6.3 and the following:

- Use calibrated gauges under quality control.
- Trenchless mains carry out pressure testing before connection to the existing water main or the new section of water m ain installed using open trench construction.
- Test length < 100 m.
- Pressure test each property service.
- Pressure pipework: Pressure testing to WSA 07 clause 21.4 and 21.6.
- Pressure PE pipework: Pressure testing to WSA 07 clause 21.5.
- Do not use hydrostatic testing on vacuum sewers.

Sections: Test pipelines in sections as soon as practicable after each section has been laid, jointed and backfilled. Leave some or all pipe joints uncovered until the whole of the section has been successfully pressure tested. Start testing 7 days after the last placement of concrete thrust or anchor block

Wet weather: Do not perform pressure testing during wet weather.

Field joints: During pressure testing, make sure all field joints, which have not been backfilled, are clean, dry and accessible for inspection.

Stable testing conditions: To allow for absorption, movement of the pipeline and escape of entrapped air, keep the section full of water for a period of minimum 24 hours before starting the pressure testing.

Test pressure: Do not exceed the manufacturer's recommended test pressure for the lowest rated component taking into account the components location in the pipeline.

Duration of test: Maintain the specified test pressure as directed for a minimum 6 hours.

Infiltration testing

Infiltration testing requirement: Carry out infiltration testing where a free standing water table exists at a level 1.5 m or more above a sewer or 150 mm or more above any side connections along the sewer. Submit method of infiltration testing. This is a **WITNESS POINT**.

Acceptable infiltration: < 5 L/mm diameter/km/day over a 24 hour period.

Deflection (ovality) testing of flexible sewers

Deflection testing: Carry out deflection testing in conformance with WSA 02 clause 22.6 at least 14 days after completion of placement and compaction of trench and embankment fill. Submit proposal for deflection testing. This is a **WITNESS POINT**.

Ovality proving tools: Conform to WSA 02 clause 22.6.2.

Maximum allowable short term pipe deflections: In conformance with WSA 02 Table 22.7.

CCTV inspection

Verification: Carry out a CCTV inspection of the sewer system and maintenance structures to *1859 CCTV inspection of drainage conduits*. This is a **WITNESS POINT**.

Inspection and testing of plastic lined concrete sewers and MHs

Visual inspection: Visually inspect all plastics lined concrete sewers and MHs for cuts, tears or cracks and open or incompletely fused thermoplastic lining welds.

Spark testing: Carry out spark testing to AS 3894.1 and WSA 02 clause 22.8.

Locking key pull-out tests: Carry out locking key pull-out test for each 5 m² of plastics lined work in conformance with WSA 02 clause 22.8.3.

Pressure testing of inverted syphons

Requirement: Pressure test all inverted syphons at least 7 days after completion but before grouting in conformance with WSA 02 clause 22.9. Submit proposed method of pressure testing. This is a **WITNESS POINT**.

Testing of vacuum sewers and service connections

Acceptance vacuum testing: Carry out vacuum testings both daily and complete to conform to WSA 06 clause 41.4. Provide all certificates and test results.

Vacuum and moisture removal vessels: Conform to WSA 06 clause 24.8.

Vacuum vessels: Test vacuum vessels and submit certificate in conformance with AS 1210 and WSA 06 clause 24.10.5.

Moisture removal vessels: Test moisture removal vessels and submit certificate in conformance with WSA 06 clause 24.10.6.

Collection chamber and vacuum vessel: Install level sensors to conform to the manufacturer's recommendations and WSA 06 clause 25.10.

4.10 CONNECTIONS TO EXISTING SEWERS

General

Connecting to existing sewers: Submit proposal for connection to existing sewers including work method, timing, equipment. This is a **WITNESS POINT**.

Notice: Submit request to connect to the existing sewer and give notice of works including any affected occupants. This is a **HOLD POINT**.

Completed works: Do not start any connections to existing sewers until all works are completed.

Spillage: Give notice to the environmental regulator and the Water Agency immediately following any spillage.

4.11 COMMISSIONING

General

Procedure: Test and commission the sewerage reticulation system in conformance with the commissioning procedure, schedules and record sheets in conformance with WSA 02 clause 13.2.

Supervision: Provide continuous supervision by personnel experienced in the operation of the equipment and have qualified personnel in attendance to carry out all necessary adjustments and/or remedial work during the commissioning tests.

4.12 RESTORATION OF SURFACES

General

Original condition requirement: Restore carriageway pavements, pathways, lawns, fencing and other improved areas in a continuous manner to a condition equivalent to that existing at the commencement of the works. Restore progressively and as soon as possible after the section of works is completed. This is a **HOLD POINT**.

Maintenance requirement: Maintain all restored surfaces in the restored condition until the expiry of the applicable Defects Liability Period, whether or not any deterioration of the restored surfaces is due to defects which become apparent or arise during the Defects Liability Period.

Restoration of surfaces: Conform to *1152 Road openings and restoration (Utilities)* and WSA 02 clause 25.

Property owner advice: Provide notice to affected property owners of any pending works.

Vertical tolerance: Structures and fittings on finished surface levels as follows:

- ± 5 mm in road reserves and trafficable areas.
- + 50 mm, – 20 mm in private property non-trafficable or occasional traffic areas.

Backfill

Requirement: In other than roadways, place the backfill sufficiently high to compensate for expected settlement and carry out further backfilling or trim the original backfill at the end of the Defects Liability Period so that the surface of the completed trench conforms to the adjacent surface.

Dry weather conditions: If dry weather conditions have persisted after the original backfilling, including during the Defects Liability Period, consolidate the trench before removing surplus materials from the site.

Disposal of surplus material: Submit for approval proposal for spreading the surplus material neatly in the vicinity of the trench to avoid future erosion of the backfill and adjacent ground surfaces. This is a **WITNESS POINT**.

Tunnelling: If tunnelling under paving, kerb and gutter or other improved surfaces in lieu of trenching, backfill to restore full support to those surfaces.

Bushland

Environmental: Carry out bushland restoration works in conformance with the Environmental Regulator.

Promote rapid re-growth: Restore the works area to as near as practicable to the pre-existing condition and leave the site in a condition that will promote rapid re-growth of native bush plant species.

Topsoil: Return stockpiled topsoil to its pre-construction location and place to minimise erosion.

Pre-existing vegetation: Use pre-existing vegetation as a seed source and place branches and/or logs across the slope to intercept runoff.

4.13 CONSTRUCTION CONFORMANCE

Work-as-executed details

Operation and maintenance: Submit work-as-executed details and operation and maintenance information as follows:

- Work-as-executed drawings in the same format as the design drawings and certified by a Registered Surveyor.
- Show the actual location and alignment of pipelines. Include the size, type, levels of pipelines, valve and hydrant chamber types and cover details and easement requirements for maintenance.
- Asset register data as directed.

Video record of internal condition: Provide a video recording of the internal condition of all mains at the time for Practical Completion of the Contract.

1362 SEWERAGE SYSTEMS – PUMP STATIONS (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide sewerage pump stations as documented.

Precedence
Precedence: The technical requirements of any standard drawing provided by the Water Authority, used in conjunction with and in conflict with this worksection, take precedence.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:

- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *1101 Control of traffic.*
- *1361 Sewerage systems – reticulation (Construction).*
- *1391 Service conduits.*
- *1392 Trenchless conduit installations.*

1.3 REFERENCED DOCUMENTS

General: The following documents are incorporated into this worksection by reference:

Standards
Australian standards

AS 1111	ISO metric hexagon bolts and screws—Product grade C
AS 1111.1-2000	Bolts
AS 1111.2-2000	Screws
AS 1112	ISO metric hexagon nuts
AS 1112.1-2000	Style 1 - Product grades A and B
AS 1272-1974	Unsintered PTFE tape for thread sealing applications
AS 1349-1986	Bourdon tube pressure and vacuum gauges
AS/NZS 1359	Rotating electrical machines - General requirements
AS/NZS 1359.5:2004	Three-phase cage induction motors - High efficiency and minimum energy - performance standards requirements
AS 1627	Metal finishing - Preparation and pretreatment of surfaces
AS 1627.4-2005	Abrasive blast cleaning of steel
AS 1657-1992	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS 1680	Interior lighting
AS/NZS 1680.2.4:1997	Industrial tasks and processes
AS 2053	Conduits and fittings for electrical installations
AS/NZS 2053.2:2001	Rigid plain conduits and fittings of insulating material
AS/NZS 2053.7:2002	Rigid metal conduits and fittings
AS 2417-2001	Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1 and 2
AS 2528-1982	Bolts, studbolts and nuts for flanges and other high and low temperature applications
AS/NZS 3000:2007	Electrical installations (known as the Australian/New Zealand Wiring Rules)

AS/NZS 3190:2011	Approval and test specification - Residual current devices (current-operated earth-leakage devices)
AS/NZS 3439:various	Low-voltage switchgear and controlgear assemblies
AS 3518-2004	Acrylonitrile butadiene styrene (ABS) compounds, pipes and fittings for pressure applications
AS 3571	Plastics piping systems - Glass-reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin
AS 3571.1-2009	Pressure and non-pressure drainage and sewerage (ISO 10467:2004, MOD)
AS 4058-2007	Precast concrete pipes (pressure and non-pressure)
AS 4198-1994	Precast concrete chambers for sewerage applications
AS/NZS 4680:2006	Hot-dipped galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4961:2003	Electric cables - Polymeric insulated - For distribution and service applications
AS 60529-2004	Degrees of protection provided by enclosures (IP Code)
AS 60947	Degrees of protection provided by enclosures (IP Code)
AS 60947.5.1-2004	Control circuit devices and switching elements - Electromechanical control circuit devices

Water Services Association of Australia (WSAA)

WSA 02:2002	Sewerage Code of Australia Version 2.3.Parts 0-4. Includes Planning & Design, Products & Materials, Construction and Standard Drawings. (CD)
WSA 04:2005	Sewage Pumping Station Code of Australia Version 2.1. Parts 0-4.(Part 4 standard drawings) CD
WSA 06:2008	Vacuum Sewerage Code of Australia Version 1.1 Parts 0-4
WSA 07:2007	Pressure Sewerage Code of Australia Version 1.1 Parts 0-4 and WSA 07 Standard drawings (CD)
WSA 101:2008	Industry standard for submersible pumps
WSA 121:2004	Industry standard for biofilters for odour control

Other publications

ASTM A240/A240M:2012	Standard specification for chromium and chromium-nickel stainless steel plate, sheet and strip for pressure vessels and for general applications

1.4 STANDARDS

General

Pump stations: To WSA 04.

Vacuum station: To WSA 06.

Pressure sewerage pump units: To WSA 07.

1.5 INTERPRETATIONS

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- BWL: Bottom water level.
- FAL: Flood alarm level.
- MH: Maintenance holes.
- MTWL: Maximum top water level.
- NPSHR: Net positive suction head required.
- RTU: Remote telemetry unit.
- PLC: Programmable logic controllers.
- PTFE: Polytetrafluroethylene.
- SCADA: Supervisory control and data acquisition system.
- SCA: Switchgear and control assembly.
- TWL: Top water level.
- WSAA: Water Services Association of Australia.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Commissioning: Running of the plant and equipment to make sure flow through the pumping system, carrying out any necessary testing and making adjustments until it is ready and suitable for normal starting and running under service conditions.
- Electricity distributor: Any person or organisation that provides electricity from an electricity distribution system and includes distributor, supply authority, network operator, local network service provider, electricity retailer or electricity entity, as may be appropriate in the relevant jurisdiction.
- Pre-commissioning: Preparation of plant or equipment so that it is in a safe and proper condition and ready for commissioning and operation. It includes all aspects of plant operation such as safety, electrical, mechanical and instrumentation.
- Water Agency: An authority, board, business, corporation, Council or local government body with the responsibility for planning or defining, design, construction and maintenance requirements for a water supply and/or sewerage systems.

1.6 SUBMISSIONS

Approvals

Submissions: To the Superintendent's approval. Submit the following for approval:

- Materials: Off-site certificates of components.
- Calculations: Survey set out of pump stations and quantity calculations.
- Work-as-executed drawings: Include sewerage pump stations information sheets and works.
- Components: Pipes and fittings.
- Samples: For conformity testing to relevant referenced documents.
- Technical data: Product information.
- Execution details: Refer to **HOLD POINTS**.

1.7 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/item	Requirement	Notice for inspection	Release by
MATERIALS			
General			
Authorised products and materials	Submit for approval alternative products and materials	2 weeks before ordering	Superintendent
Electrical requirements			Superintendent
General - Electrical safety and earthing	Test for defects and submit a certificate of safety declaration	1 week	
Practical completion			
Completion of pump station - Demonstration	Demonstrate that pump station is in working order by testing and commissioning	3 working days	
Completion of pump station - Operating and Maintenance Manuals	Obtain approval of the Operating and Maintenance Manuals	*1 week before operating*	

WITNESS POINTS table – On-site activities

Clause title/item	Requirement	Notice for inspection
MATERIALS		

Clause title/item	Requirement	Notice for inspection
General		
Conformance with manufacturers recommendations	Inspect material and products at time of delivery	2 working days
Equipment	Submit proposal for all Electrical products and materials for approval	4 weeks before ordering
EXECUTION		
Establishment	Pump station and equipment location	3 working days
Cable sizing calculations	Submit calculations for supply cables and major submains to equipment.	10 working days before installation
Pre-commissioning	Test and prepare the pump station and submit pre-commissioning record.	3 working days
Commissioning - Notification of commissioning	Give notice of the intention to undertake commissioning	5 working days
Commissioning - Commissioning	Test and commission and submit completed commissioning record sheet	2 working days after operation
Commissioning of odour control system	Carry out commissioning and verification testing	2 working days

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program so that it conforms with the approved products and materials.
- Authorities: Arrange approvals and conform to the local environmental requirements e.g. protection of the environment and heritage areas.
- Control of erosion and sedimentation: Provide an erosion and sediment control plan before starting the works.

3 MATERIALS

3.1 GENERAL

Authorised products and materials

Products and materials: Provide only products and materials authorised by the Water Agency, the drawings and this specification. Submit for approval any alternative or not authorised products and materials. This is a **HOLD POINT.**

Unauthorised material: Remove unauthorised or non-conforming materials from the site within 24 hours.

Conformance with manufacturer's recommendations

Requirement: Conform to manufacturer's recommendations for handling, transport and storage of materials and in a manner to prevent damage or deterioration or excessive distortion. Inspect all products and materials at the time of delivery and reject products and materials not in conformance with this specification and the manufacturers recommendations. This is a **WITNESS POINT**.

On site storage: Maintain protective crating or packaging until immediately before use.

Damaged or defective materials: Do not use damaged or defective materials, including coatings and linings, outside the manufacturer's recommended limits.

Equipment

Manufacturer's warranty: Provide a written warranty from the manufacturer of the equipment, accepting liability for any defect in materials or workmanship which becomes apparent at any time within 2 years after the date of delivery of any piece of equipment.

Material: Minimum material requirement to the WSA 101 Table 2.1.

Approval of electrical products and materials: Submit proposal for all equipment for approval. This is a **WITNESS POINT**.

3.2 PUMP EQUIPMENT

General

Submersible pumps: Provide submersible electric sewage pumps to WSA 101 and the **Pump equipment schedule**.

Independent witness testing: Test all pumps before delivery in conformance with WSA 04 clause 20.9.2 and WSA 101. Provide certificate for testing and the following data:

- Head (m)/quantity (L/s) curve.
- Pump input power curve (kW).
- Pump efficiency curve (%).
- NPSHR curve(s).

Motors: Test motors before delivery and submit certificate in conformance with AS/NZS 1359.5 and WSA 04 clause 20.9.3 or WSA 06 clause 24.10.4.

Vacuum generators: Test vacuum generators before delivery and submit certificate in conformance with WSA 06 clause 24.10.2.

Sewage pumps: Test sewage pumps before delivery and submit certificate in conformance with AS 2417 Grade 2 and WSA 06 clause 24.10.3.

Pump equipment schedule

Requirements	Equip1	Equip2	Equip3	Equip4
Purchasing requirements				
Nominal size (DN x DN)				
pump capacity L/s				
Testing requirements				
Collection tank dimensions mm				
Tank and cover specification				
Class of tank access cover				

3.3 ELECTRICAL EQUIPMENT

General

Requirement: Provide all switchboard(s), control panels, level control devices and level probe support brackets required for each pump station in conformance with WSA 04 clause 20.3 and 20.9.

Switchboards

Requirement: Provide complete switchboards with circuit breakers, contactors, fuses, motor starters, relays, timers, instruments and accessories as documented.

Shop drawings: Submit all shop drawings for approval before manufacture.

Test: Test switchboards before delivery including all tests listed in WSA 04 clause 20.9.1 and provide certificate from the manufacturer.

Switchboard manufacturer: Conform to AS/NZS 3190 and submit certification including ITP and circuit diagrams.

Switchboard type: Outdoor, stationary, free standing, metal-enclosed, cubicle type series with a minimum degree of protection of IP56D in conformance with AS 60529 and the following:

- Securely mount all equipment on suitable mounting panels.
- Individual compartments for segregation of electrical components as documented.
- Provide a steel galvanized channel base.

Fault current: Show prospective fault currents for each installation on the respective power circuit diagrams. Confirm all fault levels with electricity distributor.

3.4 PIPES AND FITTINGS

General

Requirement: Provide pipes and fittings in conformance with the drawings, the schedules and *1361 Sewerage systems – reticulation (Construction).*

3.5 VALVES, HOLES/SHAFTS AND ACCESS COVERS

Valves

Requirement: Provide valves, hydrants, holes/shafts, surface fittings and access covers with the drawings, the schedules and *1361 Sewerage systems – reticulation (Construction).*

3.6 STEEL AND CONCRETE

Structural steel and concrete

General: To relevant NATSPEC worksections from *03 Structure* workgroup.

Ancillary steelwork

Structural steelwork, including ladders, brackets, and covers: To AS 1657.

Cleaning: Abrasive blast cleaning to AS 1627.4 Class 2.5.

Protection: Hot-dip galvanize to AS/NZS 4680.

Step irons: Provide step irons as shown on the drawings or encapsulated in plastic.

Ancillary concrete works

Premixed, normal class concrete: To *0319 Minor concrete works*.

3.7 NUTS, BOLTS AND WASHERS

General

Standard: To AS 1111 and AS 1112, ISO metric series and fitted with washers beneath bolts heads and nuts as follows:

- Stainless steel to ASTM A240/A240M, minimum grade 316.
- Passivated.
- Rolled threads.
- Hexagonal heads.
- To AS 2528 where extreme temperature variations are expected.
- Fit with lock washers/nuts for vibration.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Requirement: Conform to *1101 Control of traffic.*

4.2 ESTABLISHMENT

General

Set out: Confirm pump station and equipment location immediately before construction. This is a **WITNESS POINT**.

Space allocations: Conform to any space allocation agreements, local agreements with land owners or other utility service provider.

Temporary drainage during construction
Requirement: Conform to the requirements of *1361 Sewerage systems – reticulation (Construction).*

4.3 EXCAVATION

General
Requirement: Conform to the requirements of *1361 Sewerage systems – reticulation (Construction).*

4.4 SEWERAGE PUMPS

Construction
General: Construct the sewerage pump station and associated works to the documented levels, grades, materials and methods. Implement and maintain environmental protection measures before disturbing the natural surface on site. Conform to *1152 Road openings and restorations* if work is carried out in roadways.

Miscellaneous structures
Access roads and hardstand areas: Construct access roads and hardstands in conformance with the drawings.

Retaining walls: Construct retaining walls in conformance with the drawings WSA 04 clause 27 and *0293 Crib retaining walls*.

Metalwork: Install associated metalwork in conformance with the drawings and WSA 04 clause 25.

Installation
Requirement: Install pumping station in conformance with the documentation including sewerage pumps, non return valves, mechanical, connections to the network, pipework, manifold, equipment, devices, pressure accumulator tank, power, telemetry, alarms and housing structures.

Preformed pump stations and package pump stations
Preformed components or systems: Conform with AS 3518, AS 3571.1 or AS 4198 and the following:

- Preformed concrete wall units: Manufactured to AS 4058 except as modified as for the requirements for precast MHs.
- Internal joints: Flush.
- A watertight system with a satisfactory surface finish.

Package pump stations: Provide for all components and units in conformance this worksection and the drawings.

Provision for maintenance
Maintenance: Provide for dismantling joints and valves in the pipework to facilitate removal of the pumps for maintenance and the need for surge control devices. Provide all identical and interchangeable pumps with a pump operation ≤ 47.5 Hz and temperature sensors.

Odour control
Odour control system: If required, install an odour control system in conformance with WSA 121, the manufacturer's recommendations and the drawings.

4.5 PRESSURE GAUGES

General
Requirement: Install one diaphragm protected, glycerine oil filled, direct mounting, bottom connection pressure gauge conforming with AS 1349 for centrifugal pump installation.

Protective case: Fabricate from stainless steel in conformance with ASTM A240/A240M or bronze. Provide a case which can be dismantled for cleaning without affecting the accuracy of the gauge.

Calibration: 100 mm diameter gauge face, calibrated in head (m) of water indicating the pump operating head and the pump no-flow head.

Inclusions: Provide each gauge with sized metric equivalent of 3 bronze fittings including gate valve, union, nipple and reducing nipple.

Installation
Requirement: Conform to the following:

- Gauges and fittings screwed into the pipe wall of ductile iron pipes, or pipe fittings, 150 mm and larger. Install a ball valve to allow removal of the gauge where required.
- Pipework < 150 mm: Screw gauges and fittings screwed into a tapping band.

Gauge range: For single or parallel pumps duty 0 to 1.7 times the closed valve head of the pumps.

Mechanical installation of pumps, valves and fittings: Install pumping units in conformance with manufacturers recommendations and WSA 04 clause 24.

4.6 BOLTS AND FLANGES

General

Maximum protrusion: 10 mm past the nut when tightened.

Anti-galling, anti-seize: Apply to threads of all stainless steel fasteners either of the following:

- PTFE, either tape to AS 1272, dipped or sprayed.
- Molybdenum disulphide.

Concrete anchor bolts, nuts, locking nuts and large series washers: 16 mm minimum diameter.
Concrete anchor bolts: Chemical masonry type set to full depth.

Valve pits: Install valve pits in conformance with WSA 04 clause 21.13 and the drawings.

Horizontal tolerance: Conform to the following:

- Pumping station: ± 200 mm displacement from the design position.
- Roads, hard stand areas: ± 200 mm displacement from the design position.

Vertical tolerance for pumping station: ± 100 mm from the design position.

4.7 ELECTRICAL REQUIREMENTS

General

Standards: To AS/NZS 3000.

Proof of conformance: If using type-tested proprietary switchboards or components, provide test certificate from an approved independent testing authority.

Electrical safety and earthing to sewer services: Test for defects in the electrical supply, provide a conductive bridge around the work area if required, notify occupants and electricity suppliers of any change. Provide a certificate of safety declaration to proceed. This is a **HOLD POINT**.

Power system and supply: Continuous monitoring of the availability of incoming power supply, power supply at the station and the control power supply. Provide the following:

Lighting: To AS/NZS 1680.2.4.

Lighting and surge protection: Provide to all incoming power supply and control power supply as documented.

Terminations: Provide suitably rated power and control terminal blocks in the switchboard for termination of incoming wiring in conformance with WSA 04 clause 21.11. Provide a separate terminal for every field cable core including spare cores.

Cable entry: Gland cables entering the outdoor switchboard compartment using non-ferrous metallic or plastic glands with neoprene compression seals and connect the on-flow switch and pump motor cables to the appropriate terminals. Do not joint cables. Gland all cables at the point of entry into switchboards in conformance with WSA 04 clause 21.11.2.

Sealing: At the completion of commissioning tests, seal all conduits into the outdoor switchboard with a non-setting sealing compound to prevent the ingress of vermin.

Painting: Paint all equipment mounting panels, except aluminium alloy and stainless steel components in conformance with WSA 04 clause 21.12.

Lock barrels: Liaise with the electricity distributor to supply a lock barrel for the metering equipment. Standard lock barrels for use on the switchboard are provided by the Superintendent.

Marker tape: Run electrical marker tape 150 mm below the finished ground level directly above the conduits for the entire length of the conduits in conformance with the following:

- Colour: Orange.
- Width: 150 mm wide.
- Warning text: Mark with the words DANGER—ELECTRIC CABLES BELOW or similar.
- Cabling route approval: Route all underground cabling with the approval of the Superintendent.

Brass marking plates: Position on any concrete surround clearly showing the direction of the incoming consumer mains. Mark with the words DANGER – ELECTRICAL CABLES BELOW.

Tools: Make sure that spare parts, tools etc, are packed separately from the main plant and marked Spare Parts, Tools etc, as applicable.

Spare parts: Supply spare parts in conformance with the **Spare parts schedule**.

Spare parts schedule

Item	Requirement			

Electrical installation

Electricity distributor's requirements and metering: Conform to the following:

- Submit an Application for supply.
- Make sure that permanent power is available before the completion of electrical installation.
- Submit an Application for service requirements and Notification of Electrical work.
- Pay all fees associated with the metering including inspection fees and capacity charges.
- Provide copies of all applications.
- Mount the metering equipment inside the switchboard or as shown on the drawings.

Metering equipment: Supply and install the plug-in meter bases or all electricity meters (tariffs) supplied by the electricity distributor:

- Service potential fuses.
- Current transformers metering equipment (if required).
- All necessary wiring and other accessories.
- Key locking facilities.

Cabling

Point of supply: Obtain a service marking from the electricity distributor. Confirm the point of attachment shown on the tender drawings.

Conformance: Conform with AS/NZS 3000, the electricity distributor's requirements, WSA 04 clause 21.4.6 and 21.8.

Cabling: Provide all cabling including consumer mains, motor, control and flow meter cables, conduits and electrical pits.

Power and control cables: To AS/NZS 4961.

Lead-in pole and overhead mains construction: Install poles and aerial cables in conformance with WSA 04 clause 21.4.7 and as documented.

Pole termination method: As shown on the drawings.

Underground cabling: Conform to *1391 Service conduits* or *1392 Trenchless conduit installations.*

Pump cables: Number pumps in sequence from 1 closest to the switchboard. Support pump cables so that no undue bending or stress is evident on the motor cable glands.

Cable sizing: Submit calculations of cable sizing within the proposal for equipment and underground locations. This is a **WITNESS POINT.**

Minimum size: Size consumer mains to satisfy the following requirements:

- Current carrying capacity to suit the maximum demand with an excess current carrying capacity of 30% minimum.
- A voltage drop less than 1.5% to the maximum demand as calculated.
- Single core PVC/PVC cables. XLPE insulated cable may also be used.

Conduits

LD-UPVC and HD-UPVC: To AS/NZS 2053.2.

Galvanized screwed steel conduits, medium protection: To AS/NZS 2053.7.

General: Provide conduits, cable protection, junction boxes and cable trays as documented.

Underground conduits: Install HD-PVC underground conduits as follows:

- Tolerances:
  - . Non-trafficable areas: Minimum 500 mm below the finished ground level.
  - . Trafficable areas: 600 mm below the finished ground level.
- Clear the trench and backfill material of rocks and other foreign matter likely to damage the conduits.

Earthing

Combined earthing system: Provide an MEN earthing system in conformance with AS/NZS 3000, WSA 04 clause 21.5, the electricity distributor and the relevant state Service and Installation Rules.

Earthing conductor: Size and installation to the relevant state Installation and Service Rules and AS 3000. Run the main earthing conductor in conduit to the main earthing electrode.

Earthing connection: Contain the main earthing connection in an earthing electrode connection box,

Pipework: Bond the pump station metallic pipework to the main earth.

Surge diverters: Provide a separate earthing conductor and electrode for the surge diverters. Bond each electrode and label with engraved brass label.

Labelling: Label all major earth connection cables clearly at both ends.

Switchboards installation

Standard: To AS 60947.5.1.

Lifting and placement: Provide appropriate lifting facilities including lifting rods inserted through lifting loops in the switchboard support frame or lifting lugs.

Equipment mounting: Mount switchboards in conformance with WSA 04 clause 21.6.2 and as shown on the drawings.

Barrier to gases: Provide an effective barrier to prevent gases from the wet well entering the switchboard.

Switchboard components

Starter contactors: Provide starter contactors with the appropriate rating for the proposed pumps to AC3.

Terminals: Provide the necessary terminals with terminal and cable numbers in conformance with the drawings.

Switchboard electrical characteristics: Conform to the following:

- Main circuit: 415/240 V, 50 Hz, 3-phase, 4-wire.
- Motor control circuit: 240 V, 50 Hz.
- Common control circuit: 240 and 24 V, A.C.
- Prospective short-circuit current: 14 kA for 1 second or to the actual prospective short-circuit current where greater.
- Peak factor: 2.2.
- Power factor correction (Determined in consultation with the Water Agency).
- Earthing (MEN system).
- Cable entry to switchboard: From below.

Thermal derating of equipment:

- Switchgear installed in indoor switchboards: To the manufacturer's recommended derating or to 88% of the equipments nominal current rating, whichever is the greater.
- Solid state power equipment installed in indoor switchboards: To the manufacturer's recommended derating or to 77% of its nominal 35°C current rating, whichever is the greater.

Switchgear: Confirm Type 2 co-ordination between contactors, motor protection relays and corresponding circuit breakers.

Starter contactors: Confirm starter contactors have the appropriate rating for the proposed pumps to AC3 duty.

Terminals: Provide the necessary terminals with terminal and cable numbers in conformance with the drawings.

Lightning and surge protection: Confirm provision for all incoming power supply and control power supply as documented.

Labelling: Clearly label every item of equipment within or on the switchboard in conformance with WSA 04 clause 21.6.4.

Pump control

Automatic control: Unless shown otherwise on the drawings, provide automatic control of the pump station pumping equipment by way of float switches/probes providing single pump duty operation. Provide switches/probes compatible with those in use in the system.

Levels: Use the following wet well levels in the automatic control of the pump operation system:

- Bottom water level (BWL).
- Top water level (TWL).
- Maximum top water level (MTWL).
- Flood alarm level (FAL).

Duty pump operation in the event of a rise in water level to MTWL: In conformance with the operating procedures for the pump station.

Operation procedure: [complete/delete]

Pump control: Provide control equipment compatible with the existing equipment.

Circuits: Arrange and colour code all main circuit wiring and busbars in conformance with WSA 04 clause 21.7.

Operation: Provide for overriding of the AUTO by turning the starter selector switch to the ON position.

- Manual operation: For use in the event of failure of the telemetry system or for function testing.
- Warning label: Provide a warning label (R/W/R) advising selector switches to be left in the AUTO mode to common control cover.
- Factory tests: In conformance with AS/NZS 3439.

Packing: Protect relays, programmable logic controllers and fittings or remove and pack separately in protected containers. If equipment has been removed, provide cover plates.

Wet-well level sensors

General: Install level sensor probes in conformance with manufacturer's recommendations, WSA 04 clause 21.10 and as shown on the drawings. Include circuits, pump cables, level sensors and terminations.

Completion of electrical works

Notification: Submit to the electricity distributor , the Notification of Wiring completed by the switchboard manufacturer together with the Notification of wiring covering the installation work.

Switchboard metering panel: Attach a copy of the Notification of wiring for the switchboard to the switchboard metering panel.

Verification: Arrange inspection and testing for the electrical works in conformance with the electricity distributor and WSA 04 clause 36.9.

Work-as-executed drawings: Provide electrical installation drawings showing changes that occurred during installation. Show prospective fault current for each installation on the respective power circuit diagrams.

4.8 CONTROL AND TELEMETRY

General

Requirement: Provide telemetry hardware including radio, antenna, surge protection and associated cabling between the RTU in the switchboard and the antenna in conformance with the documentation. Submit proposal for equipment as required.

Telemetry hardware: Conform to the following:

- Compatible with any existing systems.
- Allowing space in the switchboard for future installation of terminals.
- Analogue signals running to an interfacing strip with 2 terminals per signal and of the disconnect type.
- Standby power supply for an 8 hour power supply failure.
- Lightning and surge protection housing within the cubicle.

Telemetry software: RTU/PLC programming and configuration in conformance with the logic drawings, process and instrumentation drawings, configuration list, I/O lists, including central monitoring and display system.

Communication service: Provide a communication service compatible with the existing system.

Alarms and controls: Provide an alarm and control system in conformance with the documentation and the following:

- Do not use flashing lights.
- Wire digital input signals into a dedicated labelled terminal strip.
- Wire all signals from the dedicated terminal strip to an RTU cubicle marshalling terminal strip and then to the RTU.

SCADA: Configure the SCADA database to allow remote monitoring in conformance with WSA 04 clause 22.5 or WSA 06 clause 26.5.

4.9 PRE-COMMISSIONING

General

Pre-commissioning: Test and prepare the pump station in conformance with the pre-commissioning procedure, schedules and record sheets in conformance with Annexure A of this worksection. Submit one signed copy of each completed pre-commissioning record sheet countersigned by the agreed independent witness. This is a **WITNESS POINT**.

Specific requirements for pre-commissioning: Include but are not limited to the following:

- Initial charges of lubricant in addition to any special lubricant requirements for initial flushing or treatment of the system or for running in.
- Physical checks and tests such as:
  - Completeness of assembly.
  - Rotational tests (including checking that the rotation of electrical motors is in the correct direction).
  - Alignment checks.
  - Balancing and vibration checks.
  - Temperature, pressure and flow measurements.
  - Clearances.
  - Belt alignment and tension.
- Electrical and instrument installation tests, including motor insulation tests and checking instruments against certified instruments and correcting as necessary.
- Tests for the correct functioning of automatic and manual control and protection equipment, including simulating danger conditions, mal-operations or failures, to check that all instruments and controls function correctly. These tests also include adjusting instrument set points and alarm settings and proving correct operation of alarms.
- Equipment and system operating tests: Certify conformance of each item and submit a signed copy before commissioning.

4.10 COMMISSIONING

General

Notification of commissioning: Give notice of the intention to begin commissioning. Submit pre-commissioning record sheets and operational and maintenance manuals at the time that notice of commissioning is given. This is a **WITNESS POINT**.

Commissioning: Test and commission the pump station in conformance with the commissioning procedure, schedules and record sheets in conformance with WSA 04 and Appendix B of this worksection. Submit one signed copy of each completed commissioning record sheet countersigned by the agreed independent witness. This is a **WITNESS POINT**.

Supervision: Provide continuous supervision by personnel experienced in the operation of the equipment and have qualified personnel in attendance to carry out all necessary adjustments and/or remedial work during the commissioning tests.

Final testing: Carry out final testing and commissioning (min. 1 day duration) of the electrical services in conjunction with the mechanical equipment (e.g. pump, etc) including setting and adjustment of equipment.

Commissioning of odour control system

Requirement: Carry out commissioning and verification testing in conformance with WSA 04 clause 37.3 and WSA 121. This is a **WITNESS POINT**.

4.11 PRACTICAL COMPLETION

General

Requirement: Conform to the following before the Date of Practical Completion:

- Submit a certificate of approval from the relevant statutory authorities.
- Demonstrate that the pump station is in working order by testing and commissioning. This is a **HOLD POINT**.
- Obtain Superintendent approval of the Operation and Maintenance Manuals. This is a **HOLD POINT**.
- Submit work-as-executed drawings of the pump station.

4.12 CONSTRUCTION CONFORMANCE

Work-as-executed details

Operation and maintenance: Submit work-as-executed details and operation and maintenance information as follows:

- Work-as-executed drawings in the same format as the design drawings certified by a Registered Surveyor.
- Show the actual location the pump station and details including the size and type of pipes, valve and hydrant chamber types, pump details, switchboard equipment details and station structural details.
- Asset register data as directed.

Operation and maintenance manuals

Submit: Provide 3 copies of operation and maintenance manuals at the time of notification of commissioning, include the following information in the manuals:

- Contractor's name, address and telephone number.
- Client's contract number, job name.
- Circuit diagrams.
- Electrical and mechanical layout.
- Workshop fabrication drawings.
- Commissioning manual.
- Pump station general arrangement drawing showing pumps, motors, valves, pipework, switchboard and electrical installation.
- Safe working procedures: For switching and isolating the supply and distribution system.
- Description of operation.
- Maintenance procedures: Recommended maintenance periods and procedures.
- Tools: Particulars of maintenance equipment and tools provided, with instructions for their use.
- Equipment: A technical description of the equipment supplied, with diagrams and illustrations where appropriate.
- Spare parts: A list of the spare parts provided.
- Trouble shooting instructions for pumps, motors, valves and SCA.
- Assembly/disassembly procedures: Step-by-step procedures for dismantling and reassembly of pumps, motors and valves using any special tools.
- Replacement procedures: Step-by-step procedures for replacement of wearing parts such as bearing, seals, wear rings, etc.

Pump and motor curves: Include the following test curves in the manuals:

- Pump witnessed test curves.

- Motor test curves.
- Motor torque/speed/efficiency characteristic curves.

Pumps: Include the following information in the manuals for pumps:

- Manufacture.
- Type and model number.
- Serial number.
- Dimensioned general arrangement drawing of pump and motor.
- Sectional arrangement drawing with parts and list.
- Dimensioned sectional arrangements detailing:
  - . Maximum and minimum shaft/bearing clearance (radial).
  - . Maximum and minimum impeller/bowl clearance (radial).
  - . Maximum and minimum impeller/bowl clearance (axial).
  - . Impeller/bowl wear rings.
  - . Motor/pump coupling-type, make and model number.
  - . Mechanical seals where applicable.

Motors: Include the following information in the manual for motors:

- Manufacture.
- Type and model number.
- Serial number.
- Dimensioned general arrangement drawing.
- Sectional arrangement drawing for submersible motor power cabling where applicable.
- Gland sealing arrangement drawing for submersible motor power cabling where applicable.
- Cables where applicable.
- Terminal block arrangement drawing where applicable.

Valves: Include the following information in the manuals for valves:

- Dimensioned sectional arrangement drawing with parts and material list for all valves.

4.13 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table.**

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause/ subclause**
		PUMPING STATION ELECTRICAL
Marker tape		**General**
Location	150 mm below the finished ground level	
Width	150 mm	
Cabling tolerances		**Cabling**
Non-trafficable areas	500 mm minimum below the finished ground level	
Trafficable areas	600 mm below the finished ground level	
Consumer mains size		**Cabling**
Current carrying excess	30% minimum	
Voltage drop	< 1.5% of maximum demand	
Thermal derating of equipment		**Switchboards installation**

Activity	**Limits/Tolerances**	**Worksection Clause/ subclause**
Switchgear in indoor switchboards	88% nominal current rating	
Solid state power equipment in indoor switchboards	77% of nominal 35°C current rating	
Switchboard electrical		**Switchboard components**
Main circuit	415/240 V, 50 Hz, 3-phase, 4-wire	
Motor Control Circuit	240 V, 50 Hz	
Common Control Circuit	240 and 24 V, A.C.	
Prospective short-circuit current	14 kA for 1 second	
Peak Factor	2.2	
		Bolts and flanges
Bolts and flanges protrusion past the nut when tightened	≤ 10 mm	
Anchor bolts	16 mm minimum diameter	
Valve pits		
Pumping station horizontal displacement from the design position	± 200 mm	
Pumping station vertical displacement from the design position	± 100 mm	
Roads, hard stand area horizontal displacement from the design position	± 200 mm	
		Pressure gauges
Face size	100 mm diameter	
Gauge range for single or parallel pumps duty	0 to 1.7 times the closed valve head of the pumps	
Pump operation	≤ 47.5 Hz	**Sewerage pumps**
Final testing and commissioning of the electrical services	Min. 1 day duration	**Commissioning**

1391 SERVICE CONDUITS

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide electrical and telecommunication conduits and pits as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- *0136 General requirements (Construction).*
- *0152* Schedule of rates – supply projects.
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1152 Road openings and restoration (utilities).*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1074-1989	Steel tubes and tubulars for ordinary service
AS 1289	Methods for 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
AS 1345-1995	Identification of the contents of pipes, conduits and ducts
AS 1379-2007	Specification and supply of concrete
AS/NZS 1477:2006	PVC pipes and fittings for pressure applications
AS/NZS 2032:2006	Installation of PVC pipe systems
AS/NZS 2053:Various	Conduits and fittings for electrical installations
AS/NZS 2053.1:2001	General requirements
AS/NZS 2053.2:2001	Rigid plain conduits and fittings of insulating material
AS/NZS 2053.3:1995	Rigid plain conduits and fittings of fibre-reinforced concrete material
AS/NZS 2053.4:1995	Flexible conduits and fittings of insulating material
AS/NZS 2053.7:2002	Rigid metal conduits and fittings
AS/NZS 2053.8:1995	Flexible conduits and fittings of metal or composite material
AS/NZS 2648	Underground marking tape
AS/NZS 2648.1:1996	Non-detectable tape
AS/NZS 3000:2007	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3750	Paints for steel structures
AS/NZS 3750.9:2009	Organic zinc-rich primer
AS/NZS 3879:2011	Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS and ASA pipes and fittings
AS 3996-2006	Access covers and grates
SAA HB 243:2007	Communications cabling manual - Module 1: Australian regulatory arrangements

Other publications

CCM Communications Cabling Manual 2007	Vol.1 Handbooks, codes and regulations, Vol.2 Standards

1.4 STANDARDS

General

Electricity conduits and pit installation: To AS/NZS 3000 and the requirements of the local electricity network distributor.

Telecommunication conduits and pit installation: To SAA HB 243.

PVC pipe systems installation: To AS/NZS 2032.

1.5 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definitions apply:

- Space factor: Ratio of the sum of the cross sectional areas of the installed cables to the internal cross sectional area of the conduit.

1.6 SUBMISSIONS

Approval

Submissions: To the Superintendent's approval.

Documents

Submit the following for approval:

- Materials: Certificates of conformance of all materials and components before delivery to site.
- Calculations: Survey set out of service conduit works and quantity calculations.
- Work-as-executed drawings: Include service conduit system information sheets and works.
- Components: Conduits and fittings.
- Samples: For conformity testing to relevant standards.
- Technical data: Product information.
- Execution details: Refer to **HOLD POINTS**.

Shop drawings

General: Submit shop drawings showing the following:

- Layout of underground conduits, pits and drainage trenches.
- Invert levels for underground conduits.
- Depth of burial for cables and conduits.
- In situ pits.
- Provision for expansion and ground movement.
- Fabricated columns.
- Footing for columns.

Technical data

General: Submit technical data for the following:

- Ducted wiring enclosure systems.
- Proprietary pits.
- Proprietary columns.

General

Notices and fees: Pay all fees and charges and arrange for all inspections and tests required by the relevant Authority.

1.7 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
MATERIALS			
Conduits			

Clause title/Item	Requirement	Notice for inspection	Release by
General - Components	Provide certificates	Before delivery	Superintendent
EXECUTION			
Conduit installation			
General - Bedding	Bedding thickness and compaction verification	1 working day	Superintendent
Completion			
General - Backfill	Backfill conduits	2 working days	Superintendent

WITNESS POINTS table

Clause title/Item	Requirement	Notice for inspection
EXECUTION		
Conduit installation		
Marking	Marking tape, kerbs	1 working day
Completion		
General	Clean, lids	3 working days

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program for compliance and usage of component and materials.
- Authorities: Arrange approvals and conform with the local environmental requirements.

3 MATERIALS

3.1 CONDUITS

General

Components: Provide certificates of conformance for all materials and components. This is a **HOLD POINT**.

Size of conduit: Unless otherwise shown on the drawings:

- Space factor < 0.5.
- Flexible conduit: 25 mm.
- Conduit (under road): 80 mm.
- Conduit (general underground): 50 mm.
- Telecommunications: To Austel specifications.

Draw cord: Provide polypropylene draw cord in conduits not in use.

Conduit colour: Conform to the following:

- Telecommunications: White.
- Electrical: Orange.

UPVC priming fluid and solvent cement: To AS/NZS 3879.

Marker tape: To AS 2648.1.

Fixings Saddles: Double sided fixed.

Metallic conduits and fittings

Rigid plain conduits and fittings: To AS/NZS 2053.7.

Flexible conduits and fittings of metal or composite material: To AS/NZS 2053.8.

Heavy duty galvanized steel tube: To AS 1074.

Type: Screwed steel.

Saddles: Conform to the following:

- Internal: Zinc plated.
- External: Hot-dipped galvanized.

Corrosion protection of steel conduits: Paint ends and joint threads with zinc rich organic primer to AS/NZS 3750.9.

Non-metallic conduits and fittings

Heavy duty rigid UPVC: To AS/NZS 2053.2.

Flexible conduit: To AS 2053.4.

Joints: Cemented or snap on.

3.2 PITS

General

Pits: Provide cable draw-in pits as shown on the drawings. Sizes given are internal dimensions.

Plastic materials: Must be UV stabilised.

Proprietary pits

Pits: Provide proprietary concrete or polymer concrete moulded pits in conformance with the **Proprietary pit schedule**.

Proprietary pit schedule

Pit number	Type	Size (l x b x d)	Cover marking	Cover type	Security

In situ construction

Pits: Construct walls and bases from rendered brickwork or 75 mm thick reinforced concrete. Provide a waterproofing agent in the render or concrete.

Concrete: To *0319 Minor concrete works*.

Pit covers

Access covers and frames: Conform to AS 3996 and the **Access covers and frames schedule**.

Ductile iron covers size: Width parallel to the lifting ends and undercut. Length is parallel to the direction of cover removal.

Infill material: Bond tile or paver to the concrete bed with an epoxy mortar.

Proprietary products: To the manufacturer's recommendations.

Marking: Mark all covers permanently on the inside of the pit and on the cover by casting, engraving or moulding in bold letters 30 mm high for pit use e.g. Electrical, Telecommunications.

Access covers and frames schedule

Requirements	A1	A2	A3	A4
Cover number				
Load class				
Size				
Aesthetics				
Security				
Seals				
Cover orientation				
Handling				

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General

Control of traffic: Conform with the following:

- Worksection *1101 Control of traffic*.
- **Traffic Guidance Scheme** in *1101 Control of traffic*.

4.2 CONDUIT INSTALLATION

General

Requirement: Lay conduits in straight lines parallel or normal to the carriageway and avoiding unnecessary bends.

Identification: Identify all conduits in conformance with AS 1345 and AS/NZS 3000.

Drawing cables: Install all conduits and fittings before commencing drawing in of cables.

Conduits not in use: Provide a draw cord for the full length of the conduit and 1 m past either end coiled.

Layout of each conduit within the trench: In conformance with the underground services shared trench agreement between the respective service authorities and AS/NZS 3000 clause 3.11.

Conduits under roads and other objects: > 1 m beyond the obstruction.

Cap conduits: Provide a non perishable removable cover before backfilling.

Conduit installation tolerance: Conform to the following:

- ± 50 mm of design line.
- + 20 mm of minimum cover.

Entry into pits and footings : Provide large sweep bends for entry into junction pits and light pole footings. Do not provide more than 180° total change of direction in any run of conduit between pits. Install conduits with ≤ 2 right angled bends for each cable draw-in run.

Termination of conduit in post concrete footings: Terminate > 25 mm inside the recess in the concrete footing.

Cover: > 600 mm and < 800 mm below finished level. If > 600 mm can not be achieved encase in concrete in conformance with AS/NZS 3000 Clause 3.11.4.4.

Bedding: Compacted sand > 50 mm thickness. This is a **HOLD POINT**.

Surround: Provide clean sharp sand ≥ 150 mm around cables and conduits installed underground.

Marking

Marking tape: Lay at approximately 50% of the depth of the conduit and at conduit bends.

Marks in kerb: Route a mark in the face of kerb on both sides of the road indicating the location of the conduit crossing in conformance with the following: This is a **WITNESS POINT**.

- Electrical: The letter ‘E’.
- Telecommunications: The letter ‘T’.
- Height of lettering: ≥ 75 mm.

Temporary markers: If kerb and gutter construction has not commenced, install temporary timber post markers at the conduit crossings so that markings in the face of kerb can be made at the correct locations at the time of kerb and gutter construction.

Joints

Non metallic: Ensure joints are clean of dirt and grease and burrs before cementing together. Provide a solvent cement weld as recommended by the manufacturer.

Metallic: Provide threaded couplings with a minimum 25 mm length of thread on the end of a conduit or conduit bend.

Flexible conduit: Provide proprietary fittings.

4.3 PIT INSTALLATION

General

Termination for conduits to pits: Provide a drilled hole into the pit < 10 mm larger than the outside diameter of the conduit. Turn end of conduits upwards and protrude 50 mm into the pit. Seal around the conduit with an approved flexible sealant. Smooth and free from burrs the end of the conduits.

Pits: Install pits to conform with the following:

- Set flush with the finished level of the surrounding area.
- Shape surrounding area to prevent ponding within 1 m of the pit.
- Numbered.

Location of electrical pits: As shown on the drawings and the following as required:

- Within 4 m of service points for earthing.
- At all junctions and sharp changes in direction of conduits.
- Adjacent to poles.
- Draw in pit every 50 m.

Pit collars: Provide for circular pits before compaction of the backfill material.

Pits installed on batter slopes: Do not install pits on slopes steeper than 3H:1V unless otherwise shown on the drawings.

Bedding: 5 mm nominal size screened aggregate of > 150 mm thick.

Drain: Provide drainage in each pit as follows:

- Drain type: UPVC drain.
- Diameter: 50 mm.
- Grade: Grade the drain to a stormwater drainage pit or discharge through an embankment batter.

4.4 COMPLETION

General

Backfill: Do not commence backfill until conduit system has been inspected. This is a **HOLD POINT**.

Work-as-executed drawings: Record the locations of all conduits.

Pits: Clean of debris and fit lids securely. This is a **WITNESS POINT**.

Testing

Ovality: Test completed conduits for ovality at least 14 days after compaction of completed backfill. Ovality tolerances to manufacturers requirements.

4.5 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	Limits/Tolerances	Worksection clause/subclause
Conduit position generally	± 50 mm	**Conduit installation**
Cover to conduit	Minimum specified – 20 mm	**Conduit installation**
Size of conduits - Space factor - Flexible conduit - Under road - General underground - Telecommunications	 - ≥ 0.5 - 25 mm - 80 mm - 50 mm - Austel	**MATERIALS** **Conduits**
Conduit termination inside footing	> 25 mm	**Conduit installation**
Cover below finished level	> 600 mm and < 800 mm	

Activity	**Limits/Tolerances**	**Worksection clause/subclause**
Bedding - Compacted sand - Surround	> 50 mm ≥ 150 mm	
Kerb Letting height	≥ 75 mm	**Marking**
Pre drilled hole	≤ 10 mm larger than outside diameter of conduit	**Pit installation**
Bedding - Aggregate - Thickness	 - 5 mm - > 150 mm	
Drain diameter	50 mm	**Pit installation**

1392 TRENCHLESS CONDUIT INSTALLATION

1 GENERAL

1.1 RESPONSIBILITIES

Objectives
General: Provide conduit, pipework and pits as documented on the drawings.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- *0136 General requirements (Construction).*
- *0161 Quality (Construction).*
- *0167 Integrated management.*
- *0319 Minor concrete works.*
- *1101 Control of traffic.*
- *1151 Road openings and restoration.*
- *1341 Water supply – reticulation (Construction).*
- *1342 Water supply – pump stations (Construction)*
- *1351 Stormwater drainage (Construction).*
- *1352 Pipe drainage.*
- *1353 Precast box culverts.*
- *1354 Drainage structures.*
- *1361 Sewerage systems – reticulation (Construction).*
- *1362 Sewerage systems – pump stations (Construction).*
- *1391 Service conduits.*

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

AS 1074-1989	Steel tubes and tubulars for ordinary service
AS 1726-1993	Geotechnical site investigations
AS/NZS 2053:various	Conduits and fittings for electrical installations
AS/NZS 2053.2:2001	Rigid plain conduits and fittings of insulating material
AS/NZS 2053.4:1995	Flexible conduits and fittings of insulating material
AS/NZS 2053.7:2002	Rigid metal conduits and fittings
AS/NZS 2053.8:1995	Flexible conduits and fittings of metal or composite material
AS/NZS 4058:2007	Precast concrete pipes (pressure and non-pressure)

Other publications
Australian Society for Trenchless Technology (ASTT)
Guidelines for horizontal directional drilling, pipe bursting microtunnelling and pipe jacking
International Society for Trenchless Technology (ISTT)
(Represented in Australia by the Australasian Society for Trenchless Technology)
Glossary of trenchless terms, 2005

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
ASTT: Australasian Society for Trenchless Technology.
HDD: Horizontal directional drilling.

MT: Microtunnelling.

Definitions

General: For the purposes of this worksection the definitions given in ASTT *Guidelines for horizontal directional drilling, pipe bursting, microtunnelling and pipe jacking* apply. Available at www.astt.com.au.

1.5 SUBMISSIONS

Performance

Requirement: Ensure that the conduit and all aspects of the work meet the performance requirements detailed in this worksection.

Method statement

Methodology: Submit a Method Statement including the following items as a minimum requirement:

- General description of method and sequence of operation.
- Procedures to deal with geotechnical conditions.
- Specialist subcontractors to be utilised.
- Conduit type and specification, including compliance with relevant Australian Standard and suitability to withstand the jacking forces.
- Jointing type and specification.
- Grout type, if required, methodology and equipment for grout injection.
- Mechanical description of any motorised pumping, jacking, horizontal boring, directional drilling or mining equipment intended for use.
- Existing underground utility services:
  - Treatment at conflict locations.
  - Protection of services in zone of influence.
- Survey equipment and methods.
- Direction of installation of conduit.
- Size, depth and position of temporary access pits required.
- Location of temporary spoil site if required and nature of haulage equipment.
- Programmed daily working hours and duration for the operation.
- Strategy for dealing with noise pollution problems.
- Traffic management.
- Dewatering.

Approval

Submissions: To the Superintendent's approval.

Documents

Submit the following for approval:

- Materials: Off-site certificates of components.
- Calculations: Survey set out of service conduit works and quantity calculations.
- Work-as-executed drawings: Include service conduit system information sheets and works.
- Components: Conduits and fittings.
- Samples: For conformity testing to relevant Standards.
- Technical data: Product information.
- Execution details: Refer to **HOLD POINTS**.

1.6 HOLD POINTS AND WITNESS POINTS

Notice

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
MATERIALS			

Clause title/Item	Requirement	Notice for inspection	Release by
Conduits and pipework - General	Documentary evidence	1 week	Superintendent
EXECUTION			
Installation - Bulkheads	Inspection	2 working days	Superintendent

WITNESS POINTS table– On-site activities

Clause title/Item	Requirement	Notice for inspection
EXECUTION		
Completion - General	Inspect pits are clean of debris and lids secure	Progressive

2 PRE-CONSTRUCTION PLANNING

2.1 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program for compliance and usage of component and materials.
- Authorities: Arrange approvals and conform to the environmental requirements.

3 MATERIALS

3.1 CONDUITS AND PIPEWORK

General

Conduits and pipework: To *1341 Water supply – reticulation (Construction), 1342 Water supply –pump stations (Construction), 1352 Pipe drainage*, *1361 Sewerage systems – reticulation (Construction), 1362 Sewerage systems –pump stations (Construction)*and *1391 Service conduits*.

Verification: Provide certificates of conformance for all conduits and pipework materials that they are suitable for the proposed method of trenchless installation in conformance with manufacturer's recommendations. Provide load testing for the conduit or pipework to the following appropriate standards:

- Precast concrete: To AS 4058.
- Heavy duty UPVC: To AS/NZS 2053 series.
- Rigid plain conduits and fittings: To AS/NZS 2053.7.
- Flexible conduits and fittings of metal or composite material: To AS/NZS 2053.8.
- Heavy duty galvanised steel tube: To AS 1074.
- Heavy duty rigid UPVC: To AS/NZS 2053.2.
- Flexible conduit: To AS 2053.4.

This is a **HOLD POINT**.

4 EXECUTION

4.1 GEOTECHNICAL

General

Detailed geotechnical investigations: To AS 1726 to distinguish rock, soil, sand, obstructions and water table. This information will influence the methodology proposed for trenchless installation.

Geotechnical investigation report: Evaluate the supplied geotechnical information and submit notification if there is any additional information required.

4.2 EXISTING SERVICES

General

Requirement: Contact Dial 1100 BEFORE YOU DIG. This is a free service from anywhere in Australia of identifying underground pipe and cables (possible within two working days). See www.1100.com.au. Confirm this contact in the Method Statement.

.Locations: Obtain locations of water, sewer, stormwater, gas, electricity and telephone services. For example: When working around the vicinity of telecommunications plant conform to the 'Duty of Care' document provided by Telstra for essential precautions and approach distances.

For all Telstra DBYD (Dial Before You Dig) enquiries, contact Telstra Plan Services via email – Telstra.Plans@team.telstra.com and Phone: 1800 653 935 for urgent, onsite or optic fibre enquiries.

Services verification: Contact the Utility Authorities' contact names listed in *0136 General requirements (Construction)* to verify the location of services, during the preparation of the Method Statement.

4.3 TRENCHLESS METHODOLOGY

General

Required method: Select from the following options:

- Horizontal directional drilling ASTT specification.
- Pipe bursting ASTT specification.
- Microtunneling and pipe jacking ASTT specification.

Methodology: Propose method of installation best suited to the project and the supplied information as follows:

- Geotechnical assessment.
- Alignment and level design.
- Type of pipe/conduit.
- Type of system.
- Crossing location.
- Pipeline route.

Trenchless assessment guide: Provide any computer analysis performed for the methodology assessment of the project.

4.4 INSTALLATION

General

Concrete work: To *0319 Minor concrete works.*

Permanent and temporary pits or access chambers: To *1351 Stormwater drainage (Construction)*.

Restoration of surfaces of temporary pits: To *1152 Road openings and restoration (utilities)*.

Bulkheads

Bulkheads: Construct bulkheads in conformance with the drawings or as nominated in the proposed methodology. Provide bulkheads and any necessary grouting prior to commencing any construction of adjacent conduits. This is a **HOLD POINT**.

Methodology

General: Provide for the following performance requirements:

- The installation of the conduit by open trenching is not permitted within the length designated for trenchless techniques.
- If appropriate, eliminate voiding around the conduit by grouting prior to completion of works, with material and methodology of grouting described in the Method Statement.
- The line and grade of the conduit: Conform to the drawings within the tolerances indicated on the Drawings or stated in **Tolerances** when not explicitly shown on the drawings.
- All joints flush to the internal conduit walls and watertight after installation.
- After installation of the conduit laid by trenchless techniques and prior to any grouting procedures, provide bulkhead walls at locations shown on the drawings and conforming with **Bulkheads**.
- Ensure that the installation of the conduit does not affect any adjacent building foundations and will provide for consistent support before, during and after installation.

- Prevent endangerment of the stability or health of the root systems of trees designated for maintenance with Council's Tree Preservation Officer.
- Provide a register of training and experience for the contractor's personnel.

Protection measures

Protection: Protect adjacent buried pipes or sensitive surface structures.

Protection measures: Select from the following options:

- Access chambers.
- Surface movement monitoring devices.

4.5 TOLERANCES

Requirements

General: Install the conduit in conformance with the horizontal and vertical alignment shown on the Drawings subject to the following definition of tolerances:

- Determine by registered survey the position of both the inlet and outlet of the conduit to conform with the drawings for horizontal position to a tolerance of ± 30 mm.
- Vertical tolerance at the inlet/outlet of the conduit where installation commences: ± 10 mm.
- The average grade of the conduit to conform with the grade as shown on the drawings: ± 0.05%.
- The conduit alignment at all joints: ± 5 mm deflection in any direction at 1.5 m from the joint.

4.6 COMPLETION

General

Work-as-executed drawings: Record the locations of all conduits.

Pits: Clean of debris and fit lids securely. This is a **WITNESS POINT**.

Testing

Ovality: Test completed conduits for ovality tolerances to manufacturers requirements.

CCTV: Provide CCTV footage for installed pipeline and conduit.

4.7 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of limits and tolerances table

Activity	**Limits/Tolerances**	**Worksection Clause/ subclause**
Conduit position – inlet/outlet		
Horizontal	± 30 mm	Tolerances/Requirements
Vertical	± 10 mm	Tolerances/Requirements
Conduit grade	± .05%	Tolerances/Requirements
Conduit alignment at joints - Deflection 1.5 m from joint	± 5 mm	Tolerances/Requirements