Engineering Guidelines for Subdivisions and Development

Part 1
General Requirements
2014

Part 1 General Requirements
Part 2 Guidelines for Design of Roads
Part 3 Guidelines for Design of Drainage
Part 4 Guidelines for Design of Water Reticulation
Part 5 Guidelines for Design of Sewerage Reticulation
Part 6 Guidelines for Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Guidelines for Testing.

Part 1
General Requirements
2014

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PART 1 – GENERAL REQUIREMENTS

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1. INTRODUCTION

These general requirements outline Council's procedures and practices for subdivision and development of land within the Berrigan Shire area.

Council has determined that where a developer proposes, or is required to carry out civil engineering works in connection with a subdivision or development, the civil engineering works are upon completion of all works, and the issue of a Certificate of Completion, to become the responsibility of Council.

These guidelines are to be read in conjunction with the planning instruments and development control plans applying to the site. Applicants are advised to **ensure that all conditions of the Development Consent are addressed within the detailed engineering plans** as a Certificate of Completion/Subdivision Certificate cannot be issued until the Development Consent conditions have been met in full.

The Engineering Guidelines for Subdivision and Development comprise the following:

Part 1 General Requirements
Part 2 Guidelines for Design of Roads
Part 3 Guidelines for Design of Drainage
Part 4 Guidelines for Design of Water Reticulation
Part 5 Guidelines for Design of Sewerage Reticulation
Part 6 Guidelines for Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Guidelines for Testing.

2. GENERAL

National Standards for Subdivision and Land Development are rapidly changing in response to changing community expectations that have an increased emphasis on:

- Community facilities, public open space areas, landscaping and urban design outcomes that are associated with New Urbanism concepts;
- Water sensitive urban design, water conservation and water quality;
- Energy efficiency, sustainability; and
- Community safety and public open space areas.

- To assist in achieving these outcomes, approval will be merits based and consider the overall impact of the development on the community and not solely on compliance with minimum engineering standards.

To encourage the submission of innovative design solutions, staff are available for initial consultation to discuss and facilitate outcomes. In this context these guidelines may be subject to variation with approval from Council where outcomes are linked to environmental and community benefits. There are benefits in following traditional methods of design and standardisation, but users should question the standards and be ready to adopt new and improved procedures. Council strongly supports this approach, based on a hierarchical consideration of planning strategies as follows.

The Planning Systems as defined in:

- Berrigan Local Environmental Plan 2013;
- Land-Use Strategies;
- Overall Subdivision Master Plan;
- Specific Subdivision Stage Plans; and
- Development Control Plan

An important part of the Engineering approval process will be the preparation of an overall Master Plan that provides for the integrated provision of urban landscaping, roads, drainage, water, sewer, gas, lighting, telecommunications and electrical services.

To facilitate the expeditious approval of engineering plans, construction and linen plan release for subdivisions and developments the following approach is encouraged:

- Prior to commencement of design meet with Council to discuss engineering development issues;
- Integrate subdivision work with infrastructure, urban design and community master planning. Submit a Master Plan of the overall subdivision development for inclusion in Councils mapping system;
- Demonstrate the application of Quality Assurance procedures when submitting designs and documents to Council for review with independent documented review by experienced staff prior to submission; and
- Council review will then focus on general compliance with strategy and these guidelines.

3. ENGINEERING DRAWINGS AND SPECIFICATIONS

3.1 DEFINITIONS, QUALIFICATIONS AND EXPERIENCE

The “Council“ means the Berrigan Shire Council. Representation of the Council will be by “a designated officer of Council” with delegated authority. The respective Consultant/Engineer or Surveyor engaged by the Developer shall sign all drawings.

All reference to an “Accredited Certifier” means Accredited Certifier as determined by the Environmental Planning and Assessment Amendment Act 1997.

All references to an Engineer shall be interpreted as a person acceptable for Corporate Membership of the Institute of Engineers Australia or a person with equivalent qualifications and or experience.

All references to a Registered Surveyor shall be interpreted as a person registered under the Surveyors Act, 1929 as amended.

Council requires that design plans be prepared to Council’s standards by a person, either holding qualifications acceptable for Corporate Membership of the Institution of Engineers, Australia, accreditation by the Institution of Surveyors under the Survey Practice Accreditation Scheme for Subdivisional Civil Works 1996 (SPAS 1996), or approved by the Council or Accredited Certifier and/or who has demonstrated experience in the preparation of plans and specifications for land development.

3.2 SUBMISSION OF ENGINEERING DRAWINGS

Initially submit one preliminary set of drawings, catchment plans, stormwater calculations specifications etc. for comment.

Engineering “A1” drawings are to be submitted in triplicate with a covering letter for signature. One set of approved plans will be returned to the applicant.

For uniformity of plan presentation, all plan sizes, lettering, line work and symbols are to conform to AS 1100 - Technical Drawing Standards.

All scales are to be shown in the form of a “bar” and a ratio scale.

All drawings shall include a list of the symbols used.

The following items shall be detailed in the drawings, and be on a separate sheet.

- A Cover Sheet with a Locality Plan and List of Drawings;
- Roads and Kerb and Gutter;
- Stormwater;
- Water Supply;
- Sewerage;
- Landscaping Plan;
- Dust, Erosion and Sediment Control Plan;
- Telecom;
- Electricity, and
- Traffic Management Plan.

3.3 SUBMISSION OF CONSTRUCTION SPECIFICATION

The specification is the responsibility of the applicant, and is to include reference to requirements contained within Council's Engineering Guidelines, together with the appropriate standard specifications selected from other sources.

Specifications must be supplied with the drawings to allow site assessment of works.

3.4 APPROVAL OF ENGINEERING DRAWINGS AND SPECIFICATION

The Council or Accredited Certifier will review the Civil Engineering Drawings and Construction Specification for compliance with these guidelines. It is the entire responsibility of the person(s) or company submitting the documents, to ensure that the designs and specification are technically correct and comply with the following:

- Council's Subdivision Guidelines;
- Relevant Australian Standards;
- Relevant Local, State and Federal Government Legislation; and
- Council's Development Consent for the Subdivision.

The Council's approval is conditional on the above basis and does not relieve the developer from rectifying any errors or omissions, which become evident during construction. The approval is current for two years. If work has not substantially commenced inside the period of currency of the development consent, the Council may require that revised Engineering Drawings and Construction Specification be submitted for approval with the new Development Application. The developer is required to comply with Council's current Engineering Guidelines.

3.5 COMMENCEMENT OF WORKS

Before the developer commences the civil engineering works, engineering plan(s) and specification of the proposals shall be submitted to and approved by the Council or by the Accredited Certifier. Once a Construction Certificate is issued and before the site works are commenced Council must be notified at least two days prior to commencement (section 81a(2)(b) of the Act).

3.6 DEVELOPERS RESPONSIBILITY

When Consent of a subdivision or other development includes conditions of construction which are embodied in the approved plans and specification, the onus is primarily on the applicant to whom the approval is given to ensure that the work is completed in accordance with plans and specifications and is to the satisfaction of the Council or Accredited Certifier. The Subdivision Certificate will generally not be released until all engineering works (including works as executed plans) are completed and all other conditions of the development consent are satisfied (section 109J(2) of the EP&A Act).

The contractor carrying out subdivisional works is responsible to the developer, not the Council for constructing and maintaining the works to the approved standards to the satisfaction of the Council or Accredited Certifier.

4. INSPECTION OF WORKS

4.1 INSPECTION AND UNINTERRUPTED ACCESS

The whole of the road, drainage, kerb and gutter, water and sewerage construction works, which the developer is required to carry out in respect of a development will be inspected under the direction of the Council; or an Accredited Certifier.

All works are to be carried out to the entire satisfaction of the Council or Accredited Certifier. The Contractor/developer is to provide uninterrupted access for the examination of any facilities, works and materials as requested by the Council, or the Accredited Certifier.

4.2 PUBLIC SAFETY

The developer will be held responsible for the safety of the public to the extent that the works being undertaken influence or impact on the safe and efficient passage of the public through and/or around the works. The developer shall not obstruct the free passage of the public unless public safety is at risk and no other means of ameliorating that risk is readily available. The developer shall provide all watchmen, lights, barriers, signs and fences necessary to prevent any accidents to the public or private damage or loss. The developer shall provide, erect and maintain all necessary temporary roads, bridges, footways, drains and supports and protection in order to ensure the above.

4.3 DAMAGE TO SERVICES

Enquire as to the location of all services with ‘Dial before you Dig’ and the relevant service authority. Where proposed works have the potential to conflict with services, physically locate the services on site and document on plans.

In the event of any of the abovementioned services being damaged or interrupted, the developer shall forthwith notify the responsible authority and take all necessary steps to provide for the safety of the public and to have the damage repaired as quickly as possible. The cost of all repairs is the responsibility of the developer.

4.4 TRAFFIC CONTROL

Signs, barricades, barriers, warning lights, etc. shall be placed where works are in progress and in accordance with AS 1742 - “Manual of Uniform Traffic Control Devices”.

Comply with RMS Traffic Control at Work Sites.

The developer should ensure safe, continuous movement of traffic with a minimum of disturbance, in public roads. Prepare and implement an approved traffic management plan. Traffic control devices are to comply with RMS requirements. Signs, barricades, barriers, warning lights, etc., should be in accordance with AS 1742 Part 3 - “Manual of Uniform Traffic Control Devices”.

4.5 FIRE FIGHTING PROVISION

The developer shall provide and maintain adequate fire fighting equipment and take adequate fire protection measures during the works and shall take action to prevent damage to, or destruction by fire of bushland trees, shrubs or grasses.

4.6 WORK WITHIN RAILWAY PROPERTY

Before starting any work across a railway line or railway property, the developer shall obtain from the Rail Authority, an approval in writing to commence such work. The developer shall comply with all requirements of the Rail Authority and complete such work to the Rail Authorities satisfaction.

4.7 NOTIFICATION

Provide the name, address and telephone number of the contractor at least seven days prior to the proposed date of commencement of any construction;

The developer shall provide 24 hours prior notice in respect of the following:

- Completion of formwork/stringlines for kerb and gutter;
- Opening of trenches ready for pipe laying;
- Placing of pipes in trenches prior to backfilling;
- Placing and pouring of concrete;
- Testing of water and sewer mains;
- Completion of subgrade preparation before placing of pavement;
- Completion of each pavement layer ready for testing; and
- Sealing of roadworks.

The developer shall, if required by the Council or Accredited Certifier, submit dockets from the supplier of ready-mixed concrete in order that the quality of the concrete supplied may be checked.

The developer shall, within seven days of the sealing of any pavement, supply to the Council or Accredited Certifier all supply dockets and spraying records in respect of such work.

The Council or Accredited Certifier shall inspect the works to ensure that the works are constructed in accordance with Council requirements and the approved plans.

The Council or Accredited Certifier does not carry out the functions of "Superintendent" as defined in the General Conditions of Contract - AS 2124. The developer is required to appoint a Consultant to carry out this function.

5. FEES AND CONTRIBUTIONS

5.1 SUBDIVISION/DEVELOPMENT INSPECTION FEES

Fees for Council Examination of Engineering Drawings and Inspection of Subdivision works are as prescribed by Council from time to time. For those developers who elect to use Council for the examination of engineering drawings and/or inspection of subdivision works these fees are to be paid prior to the release of the "linen plans".

5.2 SERVICES/FACILITIES AND HEADWORKS CONTRIBUTIONS

The services provided by Council for which developer contributions may be currently obtained include:

- Open Space and Recreational Facilities;
- Commercial Centre Car Parks;
- Stormwater Drainage;
- Sewerage and
- Water Supply

These contributions are payable prior to the issue of the Subdivision Certificate and are based on the current Section 94 Contribution Plan under the Environmental Planning and Assessment Act 1979 and Section 64 of the Local Government Act 1993. Works associated with the Section 94 and Section 64 developer contribution plans are as described in detail in those documents.

5.3 TESTING OF WORKS

Testing for compliance of works with the Drawings and Specifications shall be undertaken by the Contractor as part of a Quality Assurance Program as approved by the Council or Accredited Certifier. The Council may prescribe additional tests to determine that acceptable standards of workmanship have been achieved in relation to its interests in the subdivision but otherwise the full cost of Quality Assurance testing will fall onto the Contractor and/or Developer. Where additional tests show that acceptable standards of workmanship are not being achieved all additional testing costs will be at the developers cost.

6. BONDS AND GUARANTEES FOR PERFORMANCE

The linen plan will not be signed and released by the Council or Accredited Certifier until certification is provided that all engineering works have been completed.

A maintenance bond is required from the developer prior to the issue of the Subdivision Certificate to the value of 5% of the contract price of the subdivision or $200 whichever is greater. The developer is to submit a copy of the successful Tenderers' bid for the Construction of the Subdivision Works to allow this bond to be determined.

Bank guarantees must not have an expiry dates.

Bonds and Guarantees for performance are at the discretion of Council.

6.1 DEFERRED WORKS

Subject to mutual agreement between the Developer and Council, where Council determines that it is not practical to physically construct works and that the deferment of works will result in improved community outcomes through co-ordination with other works, Council may consider a payment equivalent to the full cost of construction of the works. Deferred works typically relate to minor road widening that includes kerb and gutter extensions, footpaths and driveways.

7. WORKS-AS-EXECUTED (W.A.E.) PLANS

Following the completion of engineering works in a subdivision or development, "Works-as-Executed" transparency plans are to be prepared by a registered surveyor professional engineer and forwarded to the Council prior to the release of the final plan of subdivision.

The W.A.E. plans shall include the following:

- Notation that all works have been completed in accordance with the approved plans and specification (including approved variations and amendments);
- Any departure from the approved plans;
- Any additional work that has been undertaken;
- The location of conduits, subsoil lines, stub mains and interlot drainage lines, etc.;
- W.A.E. levels on pipeline long sections showing the constructed invert levels of each pipe at each pit and pipe dimensions;
- The location (including footprint) of any site fill, the natural surface levels, finished surface levels and compaction achieved;
- All other details which have a bearing on the extent of works and their acceptance by Council;
- W.A.E. locations of stop valves, hydrants, sewer manholes, sewer junctions, interlot drainage inlet points and stormwater drainage manholes;
- The Registered Surveyor or the Engineer must certify the W.A.E. plans. CCTV is to be used in accordance with current applicable standards to locate all sewer junctions, and confirm the integrity of the installation. A DVD format record is to be provided to Council as part of the conditions of compliance for the works;
- Locate and measure depth of Council services using GPS equipment and submit to the Council in electronic format appropriate for overlay on Council's mapping system;(tolerance to be +/-10 mm); and

- The following certificate is to be appended to each page of the plans and signed by the supervising Surveyor or Engineer:

I hereby certify that engineering works shown on the plan are Works-As-Executed and have been constructed in accordance with the plans and specifications approved by the Council/Accredited Certifier (strike out whichever is inapplicable).

Name: _____

Signature: _____

Capacity: _____

Date: _____

The Registered Surveyor responsible for the Linen Plan of survey covering the subdivision is to supply a signed certificate stating that all pipes and associated pits are located wholly within the respective easements. This certificate must be supplied prior to the release of the linen plan of subdivision.

A statement certifying that all works have been completed in accordance with the construction certificate must be produced with the W.A.E.'s rough example. "All works on these plans are now complete and all dimensions and fittings shown have been checked for accuracy". Signed and dated to be completed before Linen release.

- An electronic copy, of W.A.E. plans in the form of CD, DVD, email, etc is to be supplied by the developer in ACAD format (version 2000 or better) with AHD. Levels and MGA Co-ordinates.

8. CERTIFICATION OF COMPLETION OF WORKS

8.1 NOTIFICATION OF COMPLETION

When the Developer (or his Consultant) is of the opinion that Works of Subdivision have been completed, the Developer shall, in writing, request the Council or Accredited Certifier to issue a Certificate of Completion of Works.

Within 14 days of the receipt of the request, the Council or Accredited Certifier shall inspect the works and shall issue a Certificate of Completion or shall give the Developer, in writing, the reasons for not issuing the above. The Developer or his Contractor shall be present for the inspection and assist the Council or Accredited Certifier with the checking of levels and opening of manholes, etc as required.

8.2 MAINTENANCE OF WORKS

The Maintenance Period will be 12 months and will commence on the date of the issue of the Certificate of Completion.

The Maintenance Bond will be to the value of 5% of the Contract price of the subdivision or $200 whichever is greater. To this end the Developer is to submit a copy of the successful Tenderers' bid for the construction of the subdivision works to allow the bond to be determined. This bond will be held by Council to cover any defects or omissions, which may arise or become apparent in the Maintenance Period.

At any time during the Maintenance Period, the Council may direct the Developer to rectify any omission or defect in the work, which exists at Certified Completion or becomes apparent prior to the expiration of the Maintenance Period. If defects or omissions are not rectified to the satisfaction of the Council, Council will be at liberty to rectify the same and apply the maintenance bond for payment of the cost thereof.

The nature of some defects, eg water main breaks, sewer main connections etc., may necessitate Council's immediate repair. The maintenance bond may be used for the costs unless the Developer elects to pay Council separately.

Council requires five working days notice to allow checking of W.A.E. from the time of submission to the time of release.

9. SURVEY AND SETTING OUT REQUIREMENTS

9.1 CENTRELINE MARKING

9.1.1 Urban

The Centreline of the proposed road shall be pegged at a maximum spacing of 20 metres. Recovery pegs shall be placed on both sides of the road (off-set approximately 15 metres) at each curve tangent point (T.P.) and at spacing's of no more than 150 metres on straights.

9.1.2 Rural/Rural Residential

The centreline pegging shall be as required for urban roads except that the spacing shall be 40 metres and the provisions of RMS Standards shall apply in respect to the pegging of curve transitions. Comply with longitudinal and cross sectional intervals in Part 2 of the Guidelines For the Design of Roads.

9.2 DATUM AND CO-ORDINATES

The survey shall be undertaken on Australian Height Datum and MGA co-ordinates.

9.3 BENCH MARKS

Bench Marks shall be established within the works area at intervals not exceeding 100 metres and in accordance with sound surveying practice.

9.4 SURVEY CONTROL MARKS

All plans of survey are to show connection to at least two survey control permanent marks where such exist in the vicinity of the subdivision or where practicable. In the case where it is intended to open a new road at least two control marks per sheet of the subdivision plan are to be established in the road by the Surveyor and connected to the nearest allotment corner.

The survey control marks shall be in accordance with the “Survey Practice Regulations, 1990”. Two copies of the locality sketch plans of the marks placed are to be forwarded to the Council with the final plan of subdivision.

9.5 LOT BOUNDARIES

Lot boundaries shall be established to the standard required by” Survey Practice Regulation, 1990”, prior to the final inspection of works.

10. MISCELLANEOUS

10.1 PUBLIC LIABILITY INSURANCE

Contractors engaged on Development or Subdivision Works shall take out Public Liability Insurance to the value of **$20** million. The policy shall specifically indemnify Council from all claims arising from the execution of the works.

Council will check annually on each Contractor’s public liability insurance.

10.2 COMPLIANCE WITH ACTS AND LEGISLATIVE REQUIREMENTS

It is the responsibility of the Developer or his Contractor to ensure that all works are undertaken in a safe and efficient manner. The Contractor shall ensure compliance with the Occupational Health and Safety Act and any other relevant Acts, Ordinances and Regulations in New South Wales.

10.3 LOCATION OF SERVICES

The location and offset of services shall be as per Council’s Standard Drawing for service locations.

All services shall generally run parallel to the road centreline and shall cross the road centreline as close as possible to perpendicular to it unless otherwise approved by the Council.

11. REFERENCES AND STANDARDS

The format of the guidelines has been simplified by making reference to both National and State Standards where applicable. Where these standards vary from the referenced standards the variations are highlighted and cross-referenced. The current version of the referenced standard will apply. These guidelines shall take preference over the referenced standards. In addition to the criteria outlined in this manual, any relevant acts, regulations and Australian Standards will apply.

Referenced standards include the following:

Part 2 Guidelines for Design of Roads

- The RMS Road Design Guidelines;
- The Australian Model Code For Residential Development (1995);
- Building Regulations 2006 Part 4;
- Australian Road Research Board "Pavement Design for Light Traffic: a supplement to the Austroads Pavement Design Guide";
- Classified Road and Industrial road pavements are to be designed in accordance with "A Guide to the Structural Design of Road Pavements" - AUSTROADS;
- Guide to Residential Streets and Paths, Cement Concrete and Aggregates Australia;
- VicRoads Standard Specification for Roadworks and Bridgeworks Section 702;
- Guide to Geometric Design of Major Urban Roads AUSTROADS;
- Guide to the Geometric Design of Rural Roads – AUSTROADS;
- Guide to Traffic Engineering Part 14 – Bicycles – AUSTROADS;
- Australian Standard AS 1428 – "Design for Access and Mobility;
- Australian Rainfall and Runoff;
- "Manual of Uniform Traffic control Devices" Roads, Intersections, Traffic Control Devices, Cycle Ways, Vic Roads Road Design and Car Parks in accordance with AS 1742 Parts 1-13 and the guidelines;
- AS 1742 Manual of Uniform Traffic Control Devices;
- WSA;
- RMS Traffic Control at Work sites;
- AUSTROADS "Guide to Traffic Engineering Practice Part 11 – Parking";
- AS 2890; "Parking Facilities"
- AS 3798 "Guidelines on Earthworks for Commercial and Residential Development;
- Clear zone (refer to RMS Standard Drawings);
- RMS Standard Specifications for Roadworks and Bridgeworks; and
- Guide to Traffic Engineering Practice Part 5 Intersections at Grade, AUSTROADS.

Part 3 Guidelines for Design of Drainage

- Australian Rainfall and Runoff (AR&R); and
- Publications of the National Building Technology Centre for Roof Drainage.

Part 4 Guidelines for Design of Water Reticulation

- Water Services Association of Australia (WSAA) "Water Supply Code of Australia (WSA 03);
- AS 2280; Ductile Iron Pipes and Fittings;
- AS 1477; PVC Pipes and Fittings for Pressure Applications;
- AS 1432; Copper tubes for Plumbing, Gas Fitting and Drainage Applications;
- AS 2544; Grey Iron Pressure Fittings;
- AS 4799; Installation of Underground Utility Services and Pipelines with Railway Boundaries;
- BCA.

Part 5 Guidelines for Design of Sewerage Reticulation

- Water Services Association of Australia (WSAA) "Sewerage Code of Australia (WSA02);
- Section 88b of the Conveyancing Act 1919; and
- AS 1260 Non-Pressure PVC Pipes and Fittings.

Part 6 Landscaping and Measures for Erosion, Sedimentation and Pollution Control

- Native Vegetation Act 2003
- Berrigan Local Environmental Plan 2013
- Development Control Plan
- Water Management Act 2000
- Department of Environment and Heritage
- Protection of the Environment Operations Act 1997

Part 7 Guidelines for Testing

- AS 3798, Guidelines on Earthworks for Commercial and Residential Developments;
- RMS Specification for Densely Graded Base (DGB) 20;
- RTA Test Methods T601, T603, T605, T606 and T612;
- RTA DCM Materials Specification DCM 3151;
- Sewerage Code of Australia (WSA02) Part 3 Construction; Second Edition Version 2.3; and
- Water Supply Code of Australia (WSA03) Part 3 Construction; Second Edition Version 2.3.

Engineering Guidelines for Subdivisions and Development

Part 2
Roads
2014

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1. INTRODUCTION

This section of the Engineering Guidelines for Subdivisions and Developments outlines Council's recommended practice for the design of rural and urban roads. It is in no way a comprehensive 'Design Manual' and it is to be read in conjunction with and as a supplement to referenced standards.

The Subdivision and Development Guidelines comprise the following:

Part 1 General Requirements
Part 2 Roads
Part 3 Stormwater Drainage
Part 4 Water Reticulation
Part 5 Sewerage Reticulation
Part 6 Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing.

2. URBAN ROADS

The following section applies to the provision of roads in urban areas, the classification of these roads as urban will be a determination of the Council.

2.1 PLANS

A1 Plans should include the following:

- Cover sheet with locality plan and drawing list;
- Lot Boundaries and Numbers;
- Road Centreline Chainages, Radii, Tangent Points and Deflection Angles;
- Benchmarks at spacing's of 100 metres within the development site;
- Street Names and North Point;
- Bar Scales;
- Existing surface levels, features services and structures;
- Proposed Service Crossings;
- Road Reserve and Carriage width;
- Australian Height Datum;
- A schedule of symbols;
- Radii on Kerb Returns and Kerb Lines;
- Vehicular Crossings;
- Contours and Finished Surface Levels on Lot Corners;
- Details of abutting roads and streets necessary to ensure matching in of levels and grades; and
- 1:500 Scale.

Infrastructure service design is not to be undertaken in isolation rather as an integrated approach that anticipates conflict. For complex intersections where there is potential for service conflict, show service levels in section.

2.2 CENTRELINE LONGITUDINAL SECTION

The centreline longitudinal section should include the following:

Scales 1:500 horizontal; 1:100 vertical

- Chainages;
- Reduced level of existing surface and of design level of road, left and right kerbs where variations in crossfall occur and building lines;
- Design grades;
- Length of vertical curves; and
- Existing and proposed services.

Longitudinal levels at:

- 20 metre intervals on straight grades;
- 5 metre intervals in vertical curves; and
- At all intermediate changes of grade.

Longitudinal sections and cross sections should be taken along existing intersecting roads (approx. 50 metres) to enable kerb returns, dish crossings and drainage design.

2.3 CROSS SECTIONS

Cross sections are to be viewed from the direction of increasing chainage. Information to be provided as follows:

- 20 metre intervals;
- Natural scales of 1:100;
- Chainage;
- Reduced levels of existing surface; and
- The design level and cross fall of pavement;

Typical cross sections shall provide information as follows:

- Type of kerb & channel;
- Batters of cuttings and embankments are to be shown beyond the property alignment;
- Depth and type of material in each layer of pavement;
- Type of surfacing;
- Subsoil drainage (if required);
- Pavement and nature strip crossfalls;
- Footpath offset;
- Service corridors;
- Landscaping;
- Road width between inverts;
- Centreline; and

- Road crown.

2.4 KERB RETURNS

Kerb profiles should be shown for all kerb returns, cul-de-sac bulbs and turning tees.

A scale of 1: 200 horizontally and 1:20 vertically is suggested. Levels at ¼ points. Kerb return radius shall be 7.5 metres in residential streets and 12 metres for industrial areas. Where bus routes are provided vehicle-turning paths shall be provided for at intersections.

2.5 STANDARD ROAD CLASSIFICATIONS AND ASSOCIATED WIDTHS

The guidelines below are **not** to be considered as inflexible development standards. The principles detailed in the Australian Model Code for Residential Development (1995) are generally supported. Accordingly, developers/subdividers are advised that Council will consider and, to some degree, encourage departures from the below guidelines where it can be clearly established such departures:

- Improve environmental and water quality outcomes;
- Improve landscaping and urban design outcomes;

and

- Are regarded as contributing to the amenity of the area.

Changes to road width standards, should be considered in the context of an integrated approach:

- New Urbanism Principles;
- Land-Use Strategies;
- Master Plan's for towns; and
- Subdivisional Master Plans.
- For road widths narrower than six metres Council reserves the right to consider these on a case-by- case basis.

The road hierarchy comprises; Arterial; Collector; Local access; Cul-de-sac and minor access.

Table 2.1 – Road Standards, Urban Street Network

Classification of Road	Arterial	Collector	Local Access	Cul-De-Sac & minor access
Maximum traffic Volume (vehicles/day)	5000-7000	3000	1000	150
Number of dwellings	500-750	300	100	15
Carriageway Width (m)	13	11	8	6
Footway Width (m)	2 x 5.5	2 x 5.5	2 x 3.5 or 2x 5.5	2 x 3.5
Road Reserve (m)	24	22	15 or 19	13
Lane Provision	2 Moving Parking	2 Moving Intermittent Parking	2 Moving Intermittent Parking	2 Moving Intermittent Parking
Maximum desirable speed (km/h)	40-60	30-50	20-30	15-25
Maximum design speed (km/h) (for sight distance calculations)	60	60	40	30
Footpaths	Both sides	Both sides	One side	Not required
Cycle Ways	2.5m wide shared cycleway footpath on one side	Marked	On road shared	On road shared
Kerb and Channel	150 mm high integral barrier	Integral barrier or semi mountable	Integral barrier or semi mountable	Semi mountable

Roads used as bus routes are usually designed to local distributor standards, i.e. 13 metre carriageway width or provision for two moving and two parking lanes. Where bus routes are provided in low traffic environments then consideration may be given to a reduction in width and or the provision of indented bus bays, however such approval will only be considered on a case-by-case basis.

Standard road widths are measured between kerb inverts as shown on the standard drawings.

On street paved or sealed parking, at the rate of one car per two lots, being provided off the carriageway, within street reserves where street pavement is less than eight metres and the street provides access to more than eight dwellings. Details are to be incorporated in Construction plans.

2.6 KERB AND CHANNEL

All urban streets are to have sealed pavement with kerb and channel.

Alternative kerb and gutter treatments that achieve water sensitive urban design outcomes are encouraged subject to prior approval as part of concept development.

The design of kerb and channel shall comply with drainage requirements of Australian Rainfall and Runoff.

Kerb types are as shown on Council's Standard Drawings.

Variations are subject to Council approval.

2.7 ROAD SURFACING

All new roads should be 10/7 two coat sprayed seals with the following exceptions:

- Widening of existing roads - Seal to match the existing;
- Industrial subdivisions or developments requiring heavy vehicle access - 40mm Asphaltic Concrete (AC);
- Court bowls - 40mm Asphaltic Concrete (AC); and
- Highways - to be determined in consultation with the RMS.

2.8 ACCESS AND VEHICULAR CROSSINGS

Unless kerb is of a mountable type approved by Council, vehicle-crossovers are to be provided into each allotment and are to be in accordance with Council Standards and are to be within the following width ranges. Vehicle crossovers for subdivision are to be provided at the time of house construction.

Table 2.2 Vehicular Crossings

	Minimum Width (m)	Maximum Width (m)
Residential Crossing	3	7.5
Light Industrial Crossing	3.6	8
Heavy Industrial	3.6	12

Note: Widths are at the property boundary and do not include splays.

Where kerb and gutter is provided:

- Access and vehicular crossovers are to be a minimum of 1000 mm clear of all drainage structures on the kerb and gutter and are not to interfere with the existing pubic utility infrastructure, including council drainage structures. Where driveway impacts on these structures it is to be located clear of the driveway;
- Where kerb and gutter is not required by Council construct concrete vehicular access to the lot incorporating a preferred 375 mm diameter concrete stormwater pipe and concrete headwalls. Where it is impractical to construct a 375 mm pipe, a reduced pipe size or concrete dish crossing may be considered subject to approval on a case-by-case basis;

- Property access is to provide for forward entry and exit for other than single residential development;
- Access to adjacent properties may be fully combined or alternatively separated by a minimum distance of two metres;
- Access to residential corner allotments shall be at least six metres from the road intersection property boundary;
- The portion of the crossing that passes through the footpath is to be designed to AS 1428 'Design for Access and Mobility';
- A design car template should be used to check access;
- On steeper sites that includes battle axe blocks the design and construction of the driveway is to account for stormwater;
- Bridge type gutter crossings are not permitted;
- Multiple driveways to each lot are discouraged and require specific approval, and
- Road access to cuttings is to be clear of services located in the embankment.

2.9 STAGED ROAD CONSTRUCTION

Where roads are constructed in stages as part of staged subdivision development, a permanent type barricade is to be constructed at the end of each stage to warn motorists of the dead-end and prevent their passage beyond. Such barricades are to be removed when it is safe for through traffic to use this road and approval from Council has been received in writing.

The barricade should be made from a D4-2-1 Chevron or similar (refer AS 1743 - 2001).

2.10 ROAD CROSSINGS

All conduit trenches should be at a grade of not less than 1% and should be clearly located on relevant drawings. Trench backfill is to be compacted gravel or 3% cement stabilised sand to Subgrade level.

2.11 TRAFFIC GENERATION

A local area traffic management plan shall be provided for the subdivision as part of the agreed Master Plan. This plan shall detail average annual daily traffic volumes (AADT), within the subdivision, assess the impacts of traffic on the surrounding street network. Where adverse impacts are identified traffic mitigation measures shall be implemented.

Qualified traffic consultants shall determine projected traffic volumes that account for existing traffic patterns, predicted future development and associated traffic generation.

In the absence of sophisticated traffic modelling, an assessment of trip traffic generation shall be based on 10 vehicle trips per allotment per day.

2.12 PAVEMENT DESIGN

2.12.1 Flexible Pavements

Road pavement design shall be based on the provision of flexible road pavements as follows:

- Australian Road Research Board 'Pavement Design for Light Traffic: a supplement to the AUSTROADS pavement design guide'; and
- Classified Road and Industrial road pavements are to be designed in accordance with 'A guide to the Structural Design of Road Pavements' AUSTROADS.

A minimum design life of 20 years should be used to determine the pavement thickness.

Designers are to submit traffic loading calculations based on Australian Road Research Board 'Pavement Design for Light Traffic: a supplement to the AUSTROADS pavement design guide'.

Design Subgrade CBR values should be determined by either Geotechnical Engineering Consultants and/or agents of an N.A.T.A. registered laboratory. The investigation will include 'logging' of test holes to a depth not less than 1 metre below design Subgrade levels (unless rock is encountered). Soil samples should be taken at the design depth and CBR tests undertaken after soaking the samples for four days.

The frequency of test holes should be in accordance with Australian Road Research Board 'Pavement Design for Light Traffic: a supplement to the AUSTROADS pavement design guide'.

A copy of the site investigation report including test results should be submitted with the pavement design and the Engineering Drawings.

The minimum pavement thickness shall be 200 mm for roads and 150 mm for carparks.

2.12.2 Rigid Pavement Design

Requires approval prior to the commencement of design.

2.13 SUBSOIL DRAINAGE

Subsoil drainage, if required, is to be provided as per the Standard Drawing and is to be drained to an appropriate stormwater pit. Flushing points are to be provided at all upstream ends. The minimum grade for subsoil drainage is 1:250 with an absolute minimum grade of 1:300.

2.14 GEOMETRIC STANDARDS

The geometric design of arterial roads is to be based on the current AUSTROADS design standards for urban roads for an 80 km/hour travel speed.

The design of all other urban roads is to provide smooth, safe trafficable horizontal and vertical alignments, adequate sight distance with consideration being given to the road classification requirements, pedestrian access to each allotment, provision for utilities and stormwater drainage.

The design speed to be used for a particular road is as per Table 1 –Road Standards for the

Urban Street Network.

For design speeds up to 60 km/hour, the use of transition curves is not considered necessary.

The minimum radius of horizontal curves is: -

Table 2.3 Minimum Radius of Horizontal Curves

Minimum Deflection Angle	Minimum Radius (m)
75°	20
60°	33
40°	65
30°	75
20°	100

Where the deflection angle is 90° and travel speed is not an issue, the size of the horizontal curve is to be related to the turning requirements of vehicles such as single unit trucks (removalist vans and garbage trucks). Details on the relationship between speed, radius and tangent lengths are referred to in AMCORD.

2.15 VERTICAL ALIGNMENT

The maximum permissible grade on an arterial road is to be 8%, with a minimum grade of 0.5%.

The maximum permissible grade on all other roads is to be 16% for a maximum distance of 50 metres and 12% where the length of straight grade exceeds 50 metres. The minimum grade is 0.33%.

A maximum permissible grade of 10% (1 to 10) should be used adjacent to street intersection, locations of poor visibility, horizontal curves of radius 15 metres or less and at cul-de-sacs. Turning circles in cul-de-sacs on steep grades should have grades less than 5%.

Council's drainage requirements on steep grades may involve special structures and extensive piping through easements. Refer also to AR&R limitations on velocities.

Kerb and channel is to have a desirable minimum grade of 0.50% (1 in 200) with an absolute minimum of 0.33% (1 in 300). Saw tooth shaped profiles that are reliant upon pipe drainage are discouraged. Special consideration is required for directing of the major flow path of water to designed flow paths.

Roads are to be designed to provide accessibility to the adjacent footpaths in accordance with AS 1428.2 – 1992 Design for Access and Mobility.

Grades through intersections are not to exceed 4% to provide for stationery vehicles queued at intersections.

2.16 VERTICAL CURVES

Vertical curves are to be provided at all changes of grade and where practical should coincide with the horizontal curvature. The values given in 'Guide to Road Design -Part 3 – Geometric Design' are applicable to urban conditions in the relevant ranges.

Eccentric vertical curves will only be accepted in difficult design situations with prior written approval.

2.17 PAVEMENT CROSSFALLS

The normal crossfall on bituminous pavements should be 3%.

The maximum crossfall permitted is 6% and will occur in super-elevated curves sideling land and road intersections.

Super-elevation of horizontal curves is to be based on the current AUSTROADS design policy for urban roads.

2.18 OFFSET CROWN

The crown may be shifted towards the higher side of the road. The crown should be not closer to the kerb line than 2.0 metres to ensure that the kerb retains capacity to transport stormwater flows. The designer is to assess the storm water capacity of the system.

2.19 SPLIT LEVEL CARRIAGEWAYS

Use of split-level carriageways are not permitted.

2.20 BATTERS

All roads should be cleared full width and 0.5 metres inside the lot boundaries, or to a sufficient width to include cut and fill batters.

Footpaths reserves should be formed so as to extend 0.3 metres past the road alignment into the adjacent allotments to enable fences to be constructed at road level. Road batters should lie wholly within the adjacent allotments commencing 0.3 metres beyond road boundaries.

- Such batters should be 1 vertical to 6 horizontal to allow for safe maintenance. Steeper batter slopes of 1 vertical to 4 horizontal are a minimum requirement; and
- Where the developer provides special treatments to these batter slopes that reduce maintenance and occupational health and safety issues, then steeper slopes may be tolerated subject to Council approval.

2.21 BATTER ENCROACHMENT

Where any cutting or filling undertaken by a developer, whether shown on the plan or not, encroaches on any private or crown property, is retained by an existing structure, or could possibly undermine or remove the support of any existing structure, the developer should either:

a. Take out an easement of support over such batter in favour of Council and pay such compensation as may be satisfactorily arranged with the owner or decided by a judicial body; or
b. Construct an engineer designed retaining wall.

2.22 ROAD EMBANKMENTS

Road embankments exceeding two metres in height, (measured vertically from the top of batter to the intersection of a batter line) sloping steeper than or equal to one vertical to four (4) horizontal with the natural surface should be protected by means of a safety fence. Safety fences should not be used on road boundaries opposite residential allotments.

2.23 ROAD RESERVE BOUNDARIES

Road boundaries may be curved, but where they are to be fenced as chords, these should be not less than six metres. Where a number of such chords occur adjacent to each other, they should, as far as possible, be practically equal.

2.24 CUL-DE-SACS, Y-HEADS AND T-HEADS

- Demonstrate compliance with the turning path requirements for service vehicles;

- The kerb line radius of a cul-de-sac should not be less than 9.5 metres;
- Special provision should be made to take drainage from down hill cul-de-sacs through easements or drainage reserves that accommodate extreme flood events via underground drainage or via overland flow paths. The capacity of the major drainage system should be the 1 in 100 year ARI stormwater event. As there is potential for upstream stormwater pits to block allow for overland flow paths of water through public owned land and reserves rather than private property;
- Safety in design principles require street lighting to be located to improve the safety and the illumination of any pathways or reserves;
- Y heads & T heads are to be minimum length of 13 metres from the centreline intersection to end; and
- Design intersections that provide for solar orientation of blocks.

2.25 PATHWAYS, LANES AND FOOTPATHS

2.25.1 Definitions

A Lane is a public road of width greater than three metres but not greater than six metres and is to be used primarily for access to the rear of premises.

A Pathway is a public road of width three metres or less. The maximum width to be adopted for pathways is three metres and is primarily for the use of pedestrians and/or cyclists.

A Footpath Reserve is that part of a public road exclusive of the carriageway and in the case of residential roads may not be less than two metres in width. Residential roads are public roads used primarily for access to residences.

2.25.2 Lanes

Lanes dedicated to the public as access from or between roads, or as access to public gardens and recreation space should be cleared, formed, graded, sealed, kerb and channelled and drained and be suitable for vehicular access. In general, the maximum permissible grade to be used in lanes should be 15%.

2.25.3 Pathways

Pathways dedicated to the public as access from or between roads, or as access to public garden and recreation space should be designed in accordance with ‘safer by design principles’. These pathways should be clear and provide uninterrupted lines of site with lighting located at the ends of the pathway.
In general, the maximum permissible grade to be used in pathways should be 15%.

The maximum permissible grade to be used in pathways providing access to public gardens and reserves shall be 7%.

2.25.4 Footpaths,

Pedestrian Access and Mobility

Footpaths are required as part of subdivision development as per Table 2.1. These footpaths are to be provided consistent with the requirements of Council's Pedestrian Access and Mobility Plan.

Table 2.4 Footpath Requirements

Footpath Width	1.5 metres
Shared footpaths and cycle ways	2.5 metres
Footpath materials	Reinforced concrete SL72 125 mm thick, at time of subdivision.
Location of the footpath	300 mm from the property boundary
Requirement for footpath	Refer to Table 2.1 Road Standards for the Urban

Design in accordance with AUSTROADS 'Guide to Road Design Part 6A. – Pedestrian and Cyclist Paths'.

Perambulator ramps should be provided at all kerb crossings.

The requirement for footpaths is dependent on road classification and Council planning for footpaths and cycle ways.

Design is to be in accordance with Australian Standard AS 1428 – 'Design for Access and Mobility'.

Footpath Crossfalls

In areas where the footpath reservation is to be totally paved from the top of the kerb to the adjacent boundary, the crossfall is to be 1 in 50 towards the kerb (2%).

In areas where the footpath is unpaved or partially paved, crossfall from kerb to the adjacent boundaries is to be 1 in 35 towards the kerb (3%). Alternative treatments that achieve water sensitive urban design outcomes are encouraged subject to prior approval as part of the concept design development. The design of footpath crossfalls shall comply with the drainage requirements in Australian Rainfall and Runoff. 1% ARI flows shall be contained within the road reserve, public reserves or piped.

Vehicle access is to be checked using standard vehicle templates.

2.26 CYCLEWAYS

Cycleways are to be provided in accordance with Council's cycleway plan that encourages alternative forms of transport. Cycleways shall be designed in accordance with AUSTROADS 'Guide to Road Design Part 6A. – Pedestrian and Cyclist Paths'.

2.27 STREET SIGNS

Street signs are to be erected at all street intersections and are to be in accordance with Councils standard drawings and requirements.

2.28 HALF WIDTH CONSTRUCTION

Where proposed subdivisions or developments front an existing sealed road and the existing pavement is of adequate strength and the vertical alignment is satisfactory, the existing pavement may be retained. The remainder of the half width construction is to be carried out to the equivalent standard of full width construction.

Should the Council determine the existing pavement to be unsatisfactory, then the pavement construction is to be extended to the road centreline.

In all cases, the new seal should extend to the road centreline to avoid irregularities.
Any unsealed road must be sealed to a minimum width of 6m as per this manual for the entire length of the development.

2.29 INTERSECTIONS

- Intersection design should be based on the 'AUSTROADS Guide to Road Design – Part 4 - Intersections and Crossings – General';
- 'T' junctions should be adopted in preference to four-way intersections. Where staggered 'T' junctions are to be provided, the intersecting roads should be located a minimum distance of two times stopping distance for the travel speed along the through-road (1.5 second reaction time);
- Roads should intersect at not less than 70°;
- The minimum centreline spacing between intersections is 50 metres in urban areas;
- Four-way intersections or cross intersections shall be designed with roundabouts; and
- Where intersections are in a configuration likely to cause traffic problems, the construction of traffic islands, or such traffic facilities are required to provide traffic control and safety.

2.30 TURNING MOVEMENTS FOR DESIGN VEHICLES

Turning movements shall be provided for the design vehicle. Prior to commencement of design process consultation is required with Council to determine the design vehicles for the different street classifications. The fire emergency services vehicle is frequently the design vehicle.

Vehicle turning movements must allow for left turn from the left lane without crossing lanes for design vehicles. Where requested, traffic movement paths shall be presented using such packages as 'Autoturn' or similar. Clearance of 500 mm shall be provided to the total swept path.

2.31 LOCAL AREA TRAFFIC MANAGEMENT

Traffic Management devices are to be designed in accordance with AUSTROADS publication 'Guide to Traffic Management Part 8: Local Area Traffic Management' may be required as a condition of Development Consent. Alternatively, developers may elect to

install these devices where appropriate. The use and installation of the devices should be in accordance with Australian Standard 1742.13- 2009 - Local Area Traffic Management.

2.32 GUIDE POSTS

Guideposts and protection fencing are to be provided in accordance AS 1742, AUSTROADS and RMS guidelines.

2.33 SIGNPOSTING AND PAVEMENT MARKINGS

Signposting and pavement markings are to be provided where required in accordance with "Manual of Uniform Traffic control Devices" Roads, Intersections, Traffic Control Devices, Cycle Ways and Car Parks in accordance with AS 1742 Parts 1-13 and the guidelines.

2.34 CAR PARKING

Car parking is to be provided in accordance with

- DCP and LEP;
- AUSTROADS 'Guide to Traffic Management Part 11 – Parking'; and
- AS 2890.

Indented parking will only be considered as part of an integrated solution that enhances environmental and aesthetic outcomes such as for water sensitive urban design and entry features.

The developer is responsible for providing parking associated with the development onsite. Parking on the street is regarded as being additional to development generated parking and is for general public parking.

All car parking and manoeuvring surfaces are to be bitumen sealed or equivalent.

2.35 FLOODING

The design of the road system must account for the major flow paths associated with flood events as the piped stormwater drainage networks typically account for flow paths of water during minor events, the flow path of water during major events frequently involves the road network. In particular intersections shall be designed to direct the major flow path of water in accordance with an approved subdivision master plan.

Road longitudinal section sag points must direct flows to major open channels or intersections. Sag points mid block are discouraged and will only be approved if consistent with an agreed drainage master plan. Direction of water to cul-de-sacs, Y-heads and T-heads is discouraged.

2.36 EARTHWORKS

In all new development areas lot filling is to ensure that finished surface levels are 300 mm above the 1% ARI flood levels. Where infill development occurs consult with council regarding local requirements and council flood policies.

Fire trails are to be graded to divert stormwater and graded to divert waters away from residential properties to either drainage reserves or road reserves.

Filling of depressions requires consent, as there is potential to redirect the major flow path of water and for subsequent land settlement. Earthworks are to be in accordance with AS 3798 'Guidelines on Earthworks for Commercial and Residential Development'.

2.37 TESTING OF ROADS

All pavement courses, surfacing and Subgrade are to be tested in accordance with an approved testing regime and are to demonstrate that the pavement meets the requirement of the specification.
Refer to part 7 Testing.

2.38 STREET LIGHTING

Comply with the current Australian Standard as is to provide for pedestrian and vehicular movements.

Lighting designs are to be prepared by consultants approved for lighting design by the energy authority and Council.

2.39 ROAD SAFETY AUDITS

A road safety audit may be required to be undertaken of the road design to provide documentary evidence that the road design has taken into account risk and safety issues.

3. RURAL/RURAL RESIDENTIAL ROADS

In addition to the forgoing section relating to urban road design this section applies to the provision of roads and access to rural and rural residential areas. Council is responsible for making the determination of areas where rural residential design standards apply.

3.1 DEFINITIONS, QUALIFICATIONS AND EXPERIENCE

New road widths require discussion with Council and should generally be in accordance with the following:

Table 3.1 Rural/Rural Residential

AADT	ROAD RESERVE	CARRIAGEWAY	SHOULDER	FORMATION
<0-20	20	6.0	1.2	8.4
20-200	20	6.5	1.2	8.9
200-1000	20	6.5	1.8	10.1
>1000 (and all B double routes)	25	7.0	1.8	10.6

Note:

- In all cases AADT is that predicted at the end of the design period (usually 20 years);
- The designed pavement thickness is to extend for the full formation; and
- The road reserve width is nominal only and consideration is to be given to the extent of cut and fill batters, catch drains, intersection layout requirements, and provision for public utilities adjacent to the road reserve boundary. A minimum allowance of three metres from the batter point to the boundary is to be provided.

3.2 PLAN

Plans should be drawn at a scale of 1:1000 and show lot boundaries and numbers, road centreline chainages, radii and bearings, road names, locality sketch and a north point.
Road numbering shall be in accordance with rural addressing principles.

Plans should show the following;

- The location and reduced level of the bench marks used in the survey works;
- The location of vehicular entrances;
- Existing drainage structures;
- Trees;
- Public utilities;
- Schedules including location and reduced levels of recovery pegs and/or control points for co-ordination surveys; and
- All datum references referred to Australian height datum.

3.3 LONGITUDINAL SECTION

A longitudinal section of the centreline of the roads should be supplied at scales of:

- 1:1000 horizontal; and
- 1:100 vertical.

The longitudinal section of the centreline of roads should show:

- Chainages;
- Reduced level of existing surface and of design level of road;
- Design grades;
- Length of vertical curves;
- Have done drainage information; and

- Extent of roadworks.

Longitudinal levels are to be at:

- 40 m intervals along straight alignments and horizontal curves exceeding R1000 m;
- 20 m intervals for horizontal curves between R 150 m and R 1000 m;
- 10 m intervals for horizontal curves less than R 150 m; and
- All intermediate changes of grade.

Longitudinal sections and cross sections should be taken along existing intersecting roads for a sufficient distance to enable design requirements to be satisfied.

3.4 CROSS SECTIONS

Cross sections are to be at:

- 40 m intervals along straight alignments and horizontal curves exceeding R1000 m;
- 20 m intervals for horizontal curves R1000 and less;
- All culvert sites; and
- The SS, TS, TP and SC of each horizontal curve.

The scale should be 1:100 natural.

Cross sections should not be terminated at the property alignment but should be levelled sufficiently beyond the road boundaries to enable batters of cut and fill to be shown.

Cross sections should show:

- Chainages;
- Reduced level of existing surface;
- Design surface levels on the road centreline;
- Cross falls;
- Centreline offsets;
- Lateral dimensions if pavement and formation widths vary; and
- Batter slopes that vary from those shown on the typical cross section.

Typical cross sections shall show:

- Pavement details;
- Typical width;
- Subsoil drainage; and
- Road surfacing.

3.5 PAVEMENT DESIGN

Road pavements are to be designed in accordance with the Australian Road Research Board Publications:

- Rural Residential Pavement design for local traffic: a supplement to the AUSTROADS pavement design guide; and

- Rural Sealed Local Roads Manual.

A minimum design life of 20 years should be used to determine the pavement thickness.

Designers are to submit traffic loading calculations.

Design subgrade CBR values should be determined by either Geotechnical Engineering Consultants and/or agents of a NATA registered laboratory. The investigation will include "logging" of test holes to a depth not less than one metre below design subgrade levels (unless rock is encountered). Soil samples should be taken at the design depth and CBR tests undertaken after soaking the samples for four days.

The frequency of test holes should be in accordance with 'Pavement Design For Local Traffic: a supplement to the AUSTROADS Pavement Design Guide'.

A copy of the site investigation report including test results should be submitted with the pavement design and the Engineering Drawings.

The minimum acceptable pavement depth is 200mm.

3.6 GEOMETRIC STANDARDS

The Geometric design of rural roads is to be based on AUSTROADS – 'Guide to Road Design - Part 3 – Geometric Design'.

The design speed to be used for a particular road should be the legal road speed limit for that road.

3.7 SIGHT DISTANCE

Adequate horizontal and vertical sight distance should be provided for the design speed in accordance with 'Guide to Road Design -Part 3 – Geometric Design'.

Vehicular access to properties is not permitted where the design stopping sight distance is

unavailable. Where practical, the horizontal and vertical curves should coincide.

3.8 VERTICAL ALIGNMENT

The maximum permissible grade on an arterial road is to be 8%.

The maximum permissible grade on all other roads is to be 16% for a maximum distance of 150 metres on straight alignment.

The maximum permissible grade of 10% (1 in 10) should be used adjacent to street intersections, locations of poor visibility, horizontal curves of radius 15 metres or less and at cul-de-sacs. Turning circles in cul-de-sacs on steep grades should have grades less than 5%.

3.9 PAVEMENT CROSSFALLS

The normal crossfall on bituminous pavements should be 3% and the normal crossfall on unsealed shoulders should be 4%.

The maximum crossfall permitted is 6% and will occur on super-elevation curves and road intersections.

3.10 CLEARING AND GRUBBING

All road reserves should be cleared approximately 0.5 metres beyond the extent of roadworks. All trees to be removed must be clearly marked on the plan with a diameter of the canopy and the trunk represented diagrammatically on the plan. Native and threatened species impacts are to be identified and are subject to approval.

3.11 VEHICULAR ACCESS

Roads should be located and designed so that vehicular access can be readily obtained at every lot of a subdivision. Where the natural surface slopes steeply to or from the road, the access to each lot should be given special consideration. Preference for limitation of the number of access points to the road network.

Access to rural properties shall provide safe access and egress, having regard to fire risk.

The driveway access is to be all weather sealed construction from the edge of the existing road to the property boundary. Where there is a sealed road, the first 10m shall be sealed.

All vehicle access is to be 4.88 metres minimum wide culverts.

End walls to be trafficable when located within a clear zone (refer to RMS standard drawings.

Hydraulic capacity shall be a minimum of 1 in 5 years.

Install a 375 mm minimum diameter pipe culvert in the table drain.

Calculate pipe flows in the drain and provide capacity for 1 in 100 year overland design flows. For flows in excess of the pipe capacity check flow path to ensure that risk to the public and physical assets is minimised or eliminated. Major flow path of water are to be clear of the edge of gravel and sealed roads.

3.12 BUS ROUTES

Where there is potential for future access by school bus services turning provision is required.

3.13 GUIDE POSTS

Guideposts and protection fencing are to be provided in accordance AS 1742, AUSTROADS and RMS guidelines.

3.14 ROAD NAME SIGNS

Road name signs are to be manufactured to accord with Council's Standard and should be erected at all intersections. The road name and colour of signs are to be in accordance with an approved sign location drawing.

3.15 INTERSECTIONS

'T' junctions should be adopted in preference to four-way intersections. Where staggered 'T' junctions are to be provided Intersection design should be based on AUSTROADS publication 'Guide to traffic engineering practice part 5 intersections at grade'.

Roads should intersect at not less than 70°.

Where intersections are in a configuration likely to cause traffic problems, the construction of traffic islands, or such traffic facilities as required providing traffic control and safety.

3.16 PUBLIC UTILITIES

All public utilities in subdivisions should be provided underground. An early approach is to be made to those authorities for their requirements regarding conduits, contributions, layout plans and other relevant details.

The location of proposed conduits beneath the carriageway is to be shown on the plans. Location markers are to be installed following completion of works and attached to kerb where kerb exists.

3.17 STEEP GRADES

Where grades exceed 6%, a one-coat bitumen seal is to be provided on the road shoulders. Where shoulders are sealed, edge line marking is to be provided.

Where the grade of the table drain exceeds 6% and scouring is likely, a concrete lined drain is required.

Where the terrain permits, batters in the region of 4 horizontal to 1 vertical are desirable. Proposed batters of greater slope than 4 horizontal to 1 vertical require separate approval.

3.18 SIGNPOSTING AND PAVEMENT MARKINGS

Signposting and pavement markings in accordance with Australian Standard AS 1742 - Manual of Uniform Traffic Control Devices", are to be provided where required.

3.19 FIRE TRAILS

Fire trails are to be provided as part of an integrated network that improves community safety from the risk of fire.

Fire trails are to have a desirable maximum grade of 1 in 200. In localised sections steeper grades will be permitted with these sections requiring erosion treatment of gutters and drains.

3.20 ROAD SURFACING

The carriageway of Rural/Rural Residential roads should be sealed to a minimum standard of 10/7 two coat spray bitumen seal.

The shoulder adjacent to a barrier centreline is to be widened to 3.0 metres.

Application rates of aggregates and binder, and the Average Least Dimension of aggregates, shall be submitted for approval prior to commencement of sealing on-site.

3.21 DUST SUPPRESSION

Consideration is on a case-by-case basis having regard to

- Existing impacts on buildings within 100 metres;
- Potential future impacts;

3.22 CAUSEWAYS AND FLOODING

Rural roads that include causeway crossings require calculation of flows and recurrence interval of events. Direction from Council will be required on the design criteria and risk assessment approach required.

3.23 EROSION PROTECTION

Where water is concentrated such as for piped culverts design outlet systems that minimise erosion potential.

3.24 SPLAYS AT INTERSECTIONS

Provide splays at intersections.

3.25 RURAL ROAD DESIGN PHILOSOPHY

Rural road pavements are typically elevated in comparison to urban pavements, which are depressed to provide for the major flow path of surface water.

3.26 GUARDRAILS

Provide in accordance with AUSTROADS standards.

3.27 MAINTENANCE

The road reserve area shall be constructed with batter and drain slopes that permit routine access for mowing. This requires desirable minimum batter slopes of 4 horizontal to 1 vertical.

3.28 STANDARD DRAWINGS

All work is to be in accordance to approved Council Standard Drawings.

3.29 RURAL ADDRESSING

Signs are to be manufactured and placed in accordance with Council's Rural Addressing specifications

Rural Addressing numbers will be issued for each property by Council.

4. DRAWINGS

Table 4.1 Standard Drawings

No.	Description	Drawing No.
1	Standard Kerb Profiles	STD-R-10
2	Australian Standard Kerb Profiles Acceptable for use in the City of Albury.	STD-R-11
3	Standard Perambulator Ramp on New Construction	STD-R-20
4	Standard Residential Invert on New Construction	STD-R-30
5	Standard Residential Crossing including Removal of Kerb	STD-R-31
6	Standard Residential Invert on Existing Construction	STD-R-35
7	Joining of Residential Crossing onto Existing Drive Invert	STD-R-32
8	Joining of Residential Crossing onto Existing Invert (Pre 1993 Standard)	STD-R-36
9	Standard Light Industrial Crossing	STD-R-33
10	Standard Heavy Industrial Crossing	STD-R-34

Engineering Guidelines for
Subdivisions and Development

Part 3
Stormwater Drainage
2014

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1. INTRODUCTION

This section of the Engineering Guidelines for Subdivisions and Developments outlines Council's recommended practice for the design of stormwater and drainage systems. It is in no way a comprehensive 'Design Manual' and it is to be read in conjunction with and as a supplement to referenced standards.

The Subdivision and Development Guidelines comprise the following:

Part 1 General Requirements
Part 2 Roads
Part 3 Stormwater Drainage
Part 4 Water Reticulation
Part 5 Sewerage Reticulation
Part 6 Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing.

2. GENERAL

Stormwater drainage design is to be based on the current version of Australian Rainfall and Runoff. The aims and principles of the Australian Rainfall and Runoff (AR&R) outline" that the main purpose of the urban stormwater drainage system is to collect and can convey stormwater to receiving waters, with minimal nuisance, danger or damage." Other objectives are listed as:

- Limitation of pollutants entering receiving waters and other adverse impacts of urbanisation, such as erosion and sedimentation;
- Water conservation; and
- Integration of large-scale drainage works into town planning schemes, with multiple use of land for drainage, recreation or transportation.

AR&R then lists the following four fundamental guiding principles:

1. Descriptions and analysis of stormwater drainage systems should be based on measured or observed real system behaviour.
2. Drainage systems must be viewed in relation to the total urban system.
3. Drainage systems should be designed and operated to maximise benefits to the community.
4. Designers should be influenced by professional considerations such as ethics, standardisation and innovation.

The objectives and guiding principles are important considerations that must be taken into account when determining stormwater drainage strategies and plans for subdivisional development. This signals a change in emphasis from the original approach where " the main purpose of the urban stormwater drainage system was to collect and can convey stormwater to

receiving waters, with minimal nuisance, danger or damage". Council strongly supports this approach, based on a hierarchical consideration of planning strategies as follows.

- The Planning Scheme;
- Land-Use Strategies;
- Berrigan Shire Council Stormwater Management Plan 2008;
- Berrigan Shire Council Section 94 Contributions Plan (Drainage);
- Overall Subdivision Drainage Master Plan; and
- Specific Subdivision Stage Drainage Plans.

As infrastructure planning for Council is evolving the strategy plans for stormwater will change with time. In the absence of a detailed strategy the intent is that Council will work with a developer to encourage subdivision and development works that are consistent with an holistic approval to stormwater drainage, water quality and water sensitive urban design principles.

3. WATER SENSITIVE URBAN DESIGN (WSUD)

Stormwater drainage design is to include the principles of Water Sensitive Urban Design in subdivisional works. Include in the inception meeting with Council officers, discussion and agreement on Water Sensitive Urban Design and the extent to which these principles can be incorporated into the subdivision master planning and urban landscaping. Integrate the management of the urban water cycle with urban planning and design. Urban stormwater is to be managed as both a resource and for protection of receiving waters. Encourage outcomes that promote the retention of water on site.

3.1 WATER SENSITIVE URBAN DESIGN INCLUDES

- The sustainable management of the Water Cycle;
- Principles of water consumption;
- Water recycling;
- Waste minimisation; and
- Environmental protection.

3.2 THE ENVIRONMENTAL BENEFITS INCLUDE

- Improving the urban landscape;
- Reduction of the export of pollution from the site;
- Retardation of storm flows; and
- Reduced irrigation requirements.

3.3 CONTEXT

Council's consideration of water sensitive urban design elements into subdivision design will consider the following:

- Lifecycle cost implications on the maintenance of the infrastructure;
- The maintenance period and the success of the initial establishment;
- Community safety and the safety of maintenance staff;
- The provision of consistent shire wide themes that recognise individuality of each locality;
  and
- Focus on larger systems rather than high maintenance smaller systems.

3.4 REFERENCES

Water Sensitive Urban Design is to be undertaken in accordance with the general principals outlined in the following references.

- Water Sensitive Urban Design
  Melbourne Water 2005
  WSUD Engineering Procedures
  CSIRO publishing
- Urban Stormwater
  Best practice
  Environmental Management Guidelines
  Victorian Stormwater Committee 1999
- Australian Runoff Quality
  A guide to water sensitive urban design

The purpose of these references is to assist designers and referral authorities in the checking of designs. These documents are not intended to be decision making guides for the selection, integration and locating WSUD elements, which are covered in Australian Runoff Quality Guidelines.

4. STORMWATER DRAINAGE CALCULATIONS

All drainage design calculations shall be undertaken in accordance with the current version of Australian Rainfall and Runoff. The most appropriate method of calculation should be selected, having regard to the magnitude of flows and the potential for flooding.

Typically the RATIONAL METHOD is the best known method for urban drainage design and is suited to small subdivisional design where larger flows are not anticipated. The Rational Method is not suited for flood modelling.

Q = CIA/360
Q is design flow rate cubic metres per second
I is rainfall intensity mm/hr

urban is area in ha
C is coefficient of runoff (also Cy, Cy*).

Rational assumptions are based on statistical analysis of data to produce a “standard” design flow rate or discharge.

4.1 FACTORS EFFECTING ESTIMATES OF FLOWRATES

There is an inherent variability in rainfall and runoff values as this data is obtained from fitted statistical distributions. Council has adopted a major/minor drainage network philosophy for street drainage in accordance with Australian Rainfall and Runoff.

4.2 CATCHMENT DISCHARGE

Developments shall be designed such that the rate of discharge will not increase as a result of development, unless otherwise approved by Council in accordance with an integrated catchment wide drainage strategy. This shall consider events that include the 1% ARI event.

4.3 STANDARDS OF PERFORMANCE

The pipe drainage network shall be designed for average recurrence interval flows as follows.

Table 4.1 Design Recurrence Intervals, Berrigan Specific

Type of Development	Design Average Recurrence interval
Residential Areas	1:10 ARI
Industrial and Commercial Areas	1:20 ARI

4.4 STANDARD OF PERFORMANCE

There are a range of performance levels that need to be designed that include:

- Maintenance requirements (frequent event);
- A convenience or nuisance reduction requirement (infrequent event);
- A flood damage prevention requirement (severe or rare event); and
- A disaster management requirement (extreme event).

It is emphasised that there is inherent variability in rainfall or run off values obtained from fitted statistical distributions. Designers must allow for stormwater events larger than that calculated as part of the design process, to occur without causing damage to property or life.

4.5 PROPERTY DRAINAGE

- Roof drainage systems are to be sized by rules based on a simplified Rational Method applied to roof surfaces. (AR&R makes reference: Refer to Publications of the National Building Technology Centre.)

- Provide minimum 450 mm concrete pit with metal grate connected to Council pipe system with 100 mm connection. Approved precast pits are acceptable;
- Provide easements in rear of block drainage that are in favour of Council;
- Individual properties may drain to the kerb and gutter or alternatively to a piped underground drainage system where provided; and
- Identify and protect overland flow path with easements and the provision of uninterrupted flow.

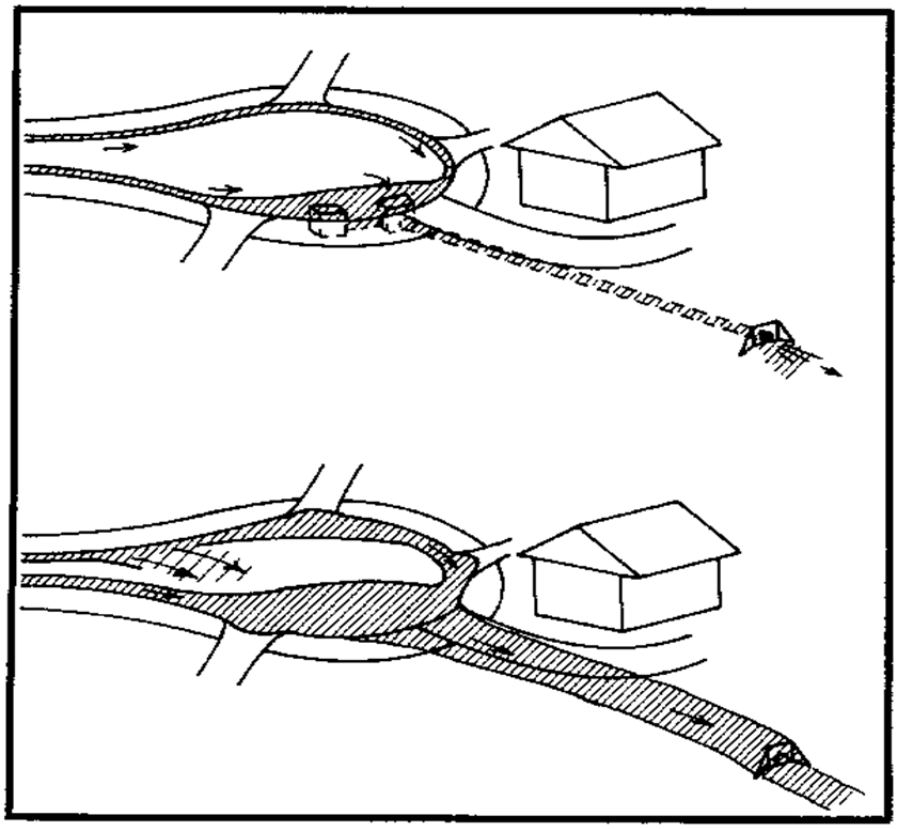


Figure 3.1 - Example from AR&R

4.6 PIPE SYSTEM DRAINAGE

When considering street drainage and the major/minor concept, major drainage is not to be confused with trunk drainage. The concept relates to drainage systems operating during storms of large magnitude. The minor system is the gutter and pipe network capable of carrying runoff from minor storms. Pipes are sized to carry flows from low ARI, which in residential areas is 1 in 10 years to prevent nuisance flooding of streets. Overflows are then routed along streets and drainage reserves. Hydraulic capacities of flow paths are to be checked for 100 year ARI events. Overflow calculations need to determine the route for these overflow quantities ensuring hazardous situations do not arise on streets and footpaths, and that buildings are protected from floodwaters.

4.7 STORMWATER DRAINAGE PITS

4.7.1 Location

Provide stormwater drainage pits at spacing's to limit gutter flow spread to 2 to 2.5 metres on any section of road other than a kerb return where the width is limited to 1 metre.

The maximum spacing between pits is approximately 90 metres subject to hydraulic calculations demonstrating acceptable flow widths and stormwater velocity.

Provide extended double grated gully pits at sag points.

Check inlet capacity of stormwater drainage pits match or exceed design pipe inflow.

4.7.2 Drainage Pit Design

- Standard pits should be provided in drainage lines at all changes in grade, level or direction and at all pipe junctions;
- The minimum clearance from the top of the manhole to the design water level in the pit should be 150 mm;
- Pipe junctions where the deflection angle of the major flow is exceeds 90º should be avoided;
    - Pipe grading across pits should be designed on the following basis: shall be as follows:
    - No change in direction or diameter – minimum 50 mm;
    - No change in diameter but direction change – minimum 70 mm;
    - Changes in diameter should shall be graded obvert to obvert;
    - Every endeavour is to be made to maintain flow velocities through pits and excessive drops will not be permitted;
    - Pits are to be located and constructed in accordance with Council's Standard drawings. Precast pits are acceptable subject to prior Council approval of the type and design;
    - Minimum size drainage pits that require physical access are to be 1050 mm.

4.8 SURFACE RUNOFF AND TRAVEL TIMES

4.8.1 Kinematic Wave Equation

Stormwater design shall account for overland flow prior to discharge to the pipe network.

The recommended formula to determine time of overland flow is the "Kinematic Wave" equation.

There are restrictions on the use of this formula as this expression applies to planar or sheet flow of water. The maximum length applicable should not exceed 60 metres. Consider a supposedly flat playing field, where water would concentrate into rivulets. A surface roughness or retardance coefficient "n*" is used which is not to be confused with Manning's "n".

$$t = 6.94 (L.n^*)^{0.6} / I^{0.4} . S^{0.30}$$ (14.2 AR&R 1987)

where t is overland flow time (minutes),
L is flow path length (m),
n* is a surface roughness or retardance coefficient,
I is rainfall intensity (mm/h), and
S is slope (m/m)

Note:
The lower the value of n*, the more conservative or the greater the flows. n* is normally taken as varying for 0.15 to 0.20 for residential overload flow.

Table 4.2 Surface Roughness or Retardance Factors

Surface Roughness or Retardance Factors	
Surface Type	**Roughness Coefficient n***
Concrete or Asphalt	0.010 - 0.013
Bare Sand	0.010 - 0.016
Gravelled Surface	0.012 - 0.030
Bare clay-Loam Soil (eroded)	0.012 - 0.033
Sparse Vegetation	0.053 - 0.130
Short Grass Prairie	0.100 - 0.200
Lawns	0.170 - 0.480

Where overland flow is concentrated, naturally or by design, into an earth or grass lined channel, Manning's Formula for open channel flows can be used to estimate flow times and characteristics:

$Q = A.V = AR^{2/3} S^{1/2}/n$

where Q is flowrate (m^3/s),
A is the cross-sectional area of flow (m^2),
V is velocity (m/s),
P is the wetted perimeter of flow (m),
R is hydraulic radius (m), equal to A divided by P,
S is longitudinal slope (m/m), and
n is a roughness coefficient

Alternatively gutter flow times can be estimated from design aids.

Estimates of overland flow times are not highly accurate and gutter flow times added to these flow times need not be calculated precisely.

In applying the Rational Method note that the minimum duration for which rainfall intensity data applies is five minutes.

Consider a typical residential block with a 2% fall from the rear to the front. The Kinematic Wave equation would indicate that the travel time over the block would be 15 minutes.

Table 4.3 Manning's Roughness Coefficients

Manning's Roughness Coefficients "n" for Open Channels	
Surface Type	**Suggested n Values**
Concrete Pipes or Box Sections	0.011 - 0.012
Concrete (trowel finish) Concrete	0.012 - 0.015
(formed, without finishing) Sprayed	0.013 - 0.018
Concrete (gunite)	0.016 - 0.020

Manning's Roughness Coefficients "n" for Open Channels	
Bricks	0.014 - 0.016
Pitchers or Dressed Stone in Mortar	0.015 - 0.017
Random Stones in Mortar or Rubble	0.020 - 0.035
Masonry	0.025 - 0.030
Rock Lining or Rip-Rap Corrugated	0.020 - 0.033
Metal (depending on size) Earth	0.018 - 0.025
(clear)	0.025 - 0.035
Earth (with weeds or gravel)	0.035 - 0.040
Rock Cut	0.030 - 0.035
Short Grass	0.035 - 0.050
Long Grass	

4.9 DIMENSION OF FLOW

- Limit flow width to 2 to 2.5 metres, along kerb and gutter and 1 metre around kerb returns for a 1:10 year ARI storm;
- Gutter flows are not to overtop the kerb;
- Free board for floor levels of habitable rooms in properties 300 mm;
- Product of depth and velocity 0.4m^2/s for safety of pedestrians or 0.6 to 0.7 m^2/s for the stability of parked vehicles; and
- Bypass flows shall not exceed 15% of total pit flow.

4.10 PIT ENTRY CAPACITIES

Hydraulic design calculations must demonstrate adequate capacity of the stormwater drainage network to accept the design flows.

4.11 ESTIMATION OF FLOWRATES BY THE RATIONAL METHOD

A peak flowrate for a particular time of concentration is calculated. While this is adequate for design, the model is unsuitable for the simulation of drainage system behaviour in actual storms.

4.12 PARTIAL AREA EFFECTS

The time of concentration most commonly used is the full area time, which is the travel time for runoff from the longest flow path. Partial area calculations may be approximated by obvious partial catchment areas and for partial areas based on the concentration times of impervious zones directly connected to the pipe system.

4.13 RUNOFF COEFFICIENTS 'C'

In the current version of Australian Rainfall and Runoff, a "probabilistic" interpretation of the value of C is used. This represents the ratio of runoff to rainfall frequency curves. It does not represent the ratio between runoff and rainfall volume or the ratio of their peak rates.

The probabilistic interpretation covers the whole range of events involving different combinations of rainfalls and antecedent conditions using the equation below, which determines a runoff coefficient for the catchment for any ARI based on the 10-year ARI runoff coefficient for the entire catchment (C_{10}) and a conversion factor known as a 'frequency factor' (F) for that ARI.

$$C_y = F_y \times C_{10}$$

Where: C_y = y - year ARI runoff coefficient for the entire catchment
F_y = y - year ARI frequency factor (see Table 4.44 for values)
C_{10} = 10 - year ARI runoff coefficient for the entire catchment

Table 4.4 Urban Frequency Factors

ARI (Years)	Frequency Factor (Fy)
1	0.8
2	0.85
5	0.95
10	1.0
20	1.05
50	1.15
100	1.2

Given this, in order to determine the runoff coefficient for the entire catchment it is necessary to use the following equations to determine the 10-year ARI runoff coefficient (C_{10}). This value is determined by combining the runoff coefficient of the pervious and impervious areas of the catchment, and is as such largely dependent on the fraction impervious (f).

$$C_{10} = (0.9xf) + (C^1_{10} x (1-f))$$
$$C^1_{10} = 0.1 + (0.0133x(^{10}I_1 - 25))$$

Where: C_{10} = 10 - year ARI runoff coefficient for the entire catchment
f = Impervious fraction of the catchment (value must be between 0.0 and 1.0)

C^1_{10} = 10 - year ARI pervious area runoff coefficient

$^{10}I_1$ =10 – year ARI, 1 hour rainfall intensity for the location (obtained from locations IFD data)

4.14 FRACTION IMPERVIOUS

Typical fractions for impervious areas are:

	f
Open Space/Parkland	0.00
Residential Areas (Ultimate Development)	0.35
Normal House Block	0.42
Duplex Block	0.57
Road Reserve Including Roads and Footpath	0.85

In situations where more accurate estimates of impervious area fractions can be determined the accurate estimates should be used in preference to the typical fractions given above.

4.15 RAINFALL DATA AND INTENSITY

The Rational Method uses uniform rainfall patterns taken from Intensity Frequency Duration (IFD) relationships. Refer to Appendix A.

4.16 PIPE SYSTEM HYDRAULICS

Hydraulic grade calculations may be used for the design of pipe systems in accordance with examples provided in AR&R. This model is preferred, as it is better able to model real behaviour, and allows for surcharging of pits, and pressure flows and to produce more efficient designs.

4.16.1 Limiting Velocities

The minimum allowable velocity for design is normally taken as 1m/s.

The absolute minimum allowable velocity is 0.6 m/s to provide self-cleansing velocities.

This hydraulic requirement is a different approach to the minimum grade approach. The basis of the minimum grade approach relates to construction problems and tolerances. Minimum grades of 1/300 are acceptable for normal pipeline design.

4.16.2 Calculation of Pipe Friction

The Colebrook-White Equation is recognised as the best relationship for the full range of turbulent pipe flows. It follows the curved lines shown on the Moody Diagram. Manning's formula is valid in the completely turbulent section only; but prone to error in the transition zone. Subject to approval by Council, Manning's calculations may be accepted.

The Colebrook-White Equation:

$$V = -0.87\sqrt{(2g.D.S)}\ \log_e\left[\frac{k}{3.7\ D} + \frac{2.51v}{D\sqrt{(2g.D.S)}}\right]$$

Where g is gravitational acceleration (m/s^2),
D is diameter (m),
S is energy line slope (m/m),
k is pipe wall roughness (m), sometimes given as e, and
v is the kinematic viscosity (m^2/s).
normally 1.0×10^{-6}

Table 4.5 Colebrook-White Equation Pipe Friction

Pipe Material	Hydraulics Research Recommendations k Value (mm) for Pipe Conditions:			SAA Recommendations k Value (mm) for pipes concentrically
	Good	**Normal**	**Poor**	**Jointed and clean**
Concrete				
Spun precast, "0" Ring Joints	0.06	0.15	0.3	0.03 to 0.15
Monolithic construction against rough forms	0.06	1.5	-	
Asbestos Cement	0.015	0.03	-	0.015 to 0.06
uPVC				
With Chemically Cemented Joints	-	0.03	-	
with Spigot and Socket Joints	-	0.06	-	0.003 to 0.015

Design wall roughness should reflect conditions well into the service life of the pipe. Thus for concrete pipes a value of K = 0.3 mm is suitable, i.e. somewhere between "good" and "poor".

4.17 PIPE CONSTRUCTION

Pipes are to be reinforced concrete pipe (RCP) rubber ring jointed with a minimum diameter of 300 mm.

Twin – walled corrugated polypropylene pipes may be used with Council's approval. All fittings and repairs to manufacturers details only. Cover on pipe to be supplied as per manufacturer's specifications or designed by a qualified engineer.

The minimum cover under road pavements is 150 mm below Subgrade level or 450 mm below pavement surface level whichever is greatest.

The minimum diameter of inter-allotment drainage pipes is 225 mm with the exception of one lot where 150 mm pipes may be provided. Inter-allotment drainage pipe materials may be other then concrete but are subject to Council approval.

The minimum cover over inter-allotment drainage is 300 mm.

No reduction in pipe diameter is allowed for pipe reaches progressing down stream. Council will consider other materials on a case-by-case basis.

4.18 DRAWINGS

Table 4.6 Standard Drawings

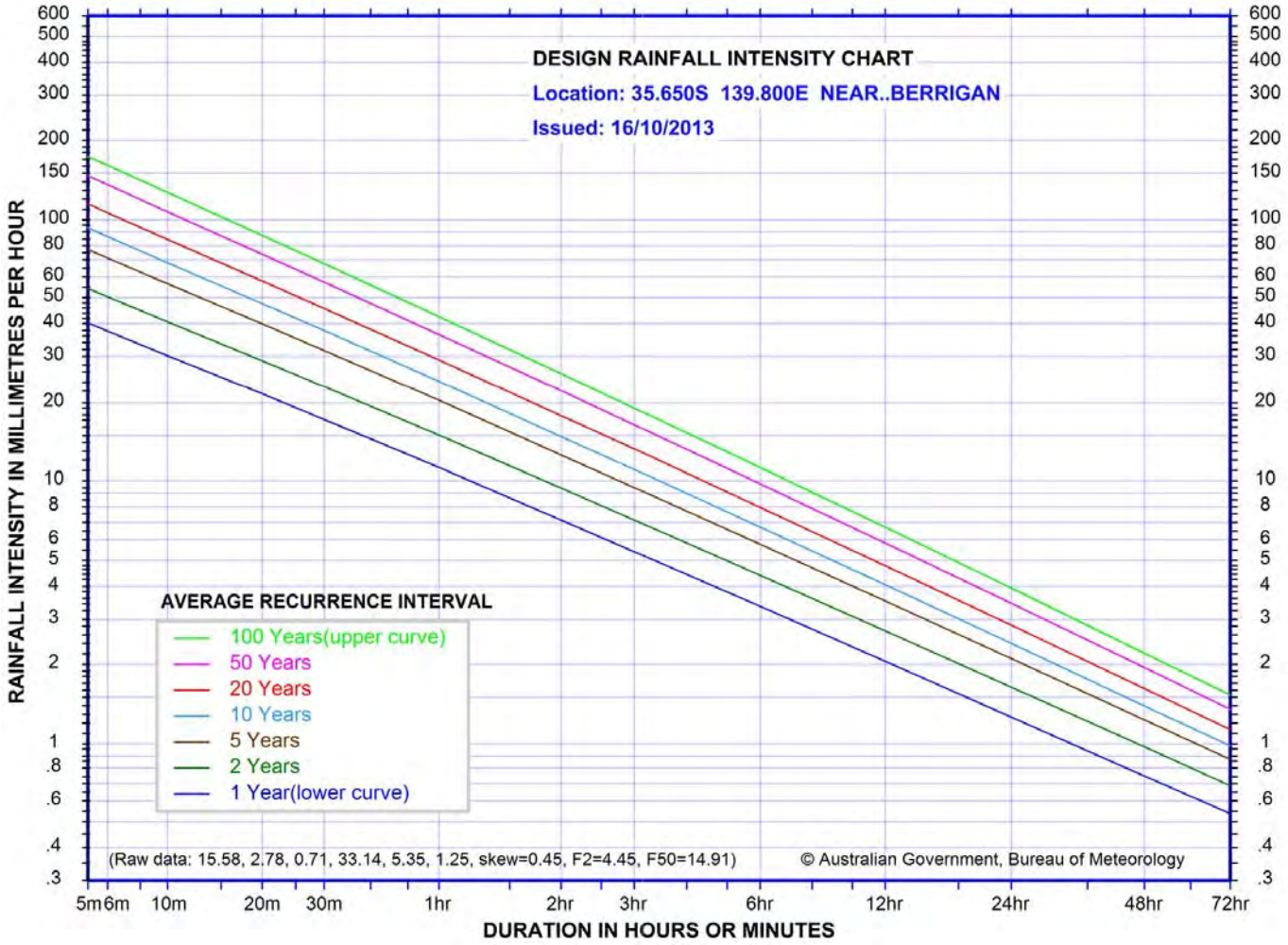
Item	Description	Drawing No.
1	Grated Gully Pits	STD-D-10
2	Grated Gully Pits in Semi Mountable Kerb and Gutter	STD-D-11
3	Standard Side Entry Pits	STD-D-20
4	Special Side Entry Pits for Standard Kerb and Gutter	STD-D-21
5	Special Side Entry Pits for Semi-Mountable Kerb and Gutter	STD-D-22
6	Grates and Frames for Grated Gully Pits	STD-D-25
7	Standard Drainage Manhole	STD-D-30
8	Property Inlet Pits	STD-D-40
9	Surface Inlet Pit	STD-D-50
10	House Connection to Pipes Under Kerb and Gutter	STD-D-60
11	Standard Concrete Headwalls for 300 to 900 Diameter Pipes	STD-D-70
12	Standard Subsoil Drainage	STD-D-80
13	Standard Trench Details	STD-D-90

Appendix A –RAINFALL DATA

As there are only minor variations within the Council area, rainfall data for the town of Berrigan will be used for the whole of the Berrigan Shire. The following Table A1 shows rainfall intensities various storm durations and average recurrence intervals. A corresponding graph is shown on the following page.

Table A1 – BERRIGAN SHIRE STORM RAINFALL INTENSITIES

STORM DURATION	1 Year ARI	2 YEAR ARI	5 YEAR ARI	10 YEAR ARI	20 YEAR ARI	50 YEAR ARI	100 YEAR ARI
5Mins	40.4	54.6	76.9	93	115	147	174
6Mins	37.5	50.7	71.3	86.1	106	136	161
10Mins	30.2	40.7	56.9	68.4	84	107	127
20Mins	21.6	28.9	40	47.8	58.3	73.8	87
30Mins	17.2	23	31.6	37.7	45.8	57.7	67.9
1Hr	11.3	15	20.4	24.1	29.1	36.4	42.6
2Hrs	7.12	9.43	12.6	14.8	17.8	22.2	25.8
3Hrs	5.39	7.12	9.47	11.1	13.3	16.4	19
6Hrs	3.34	4.38	5.76	6.7	7.96	9.78	11.3
12Hrs	2.06	2.69	3.5	4.04	4.77	5.82	6.69
24Hrs	1.26	1.64	2.11	2.41	2.83	3.43	3.92
48Hrs	0.751	0.971	1.23	1.39	1.62	1.95	2.21
72Hrs	0.54	0.69	0.87	0.98	1.13	1.35	1.53


DESIGN RAINFALL INTENSITY CHART
Location: 35.650S 139.800E NEAR..BERRIGAN
Issued: 16/10/2013
RAINFALL INTENSITY IN MILLIMETRES PER HOUR
600
500
400
300
200
150
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
.8
.6
.4
.3
AVERAGE RECURRENCE INTERVAL
100 Years(upper curve)
50 Years
20 Years
10 Years
5 Years
2 Years
1 Year(lower curve)
(Raw data: 15.58, 2.78, 0.71, 33.14, 5.35, 1.25, skew=0.45, F2=4.45, F50=14.91)
© Australian Government, Bureau of Meteorology
5m
6m
10m
20m
30m
1hr
2hr
3hr
6hr
12hr
24hr
48hr
72hr
DURATION IN HOURS OR MINUTES

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1. INTRODUCTION

This Part of The Council's "Engineering Guidelines for Subdivisions and Development" is related to water reticulation. Reference to the Council will include reference to the Council as the Water Authority.

The design of water reticulation shall generally be in accordance with the latest version of the Water Services Association of Australia (WSAA) "Water Supply Code of Australia (WSA 03). **This part of The Council's "Engineering Guidelines" take precedence over WSA 03** (ie. these are The Council's requirements which may be different to WSA 03).

The other parts of the "Engineering Guidelines for Subdivisions and Development" are as follows:

Part 1 General Requirements
Part 2 Roads
Part 3 Drainage
Part 4 Water Reticulation
Part 5 Sewerage Reticulation
Part 6 Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing.

This part of the "Engineering Guidelines" is set out in the same order as WSA 03 for ease of cross-referencing.

2. GENERAL

The Council (as the Water Agency) will not provide a "Concept Plan" for the localised water supply system. This is the responsibility of the "Designer" and particularly so if the proposed development is going to be staged (i.e. developed in stages). The Council will, however provide details of items (a) to (h) inclusive as specified in Clause 1.5.2 of WSA 03 where available.

If such a staged development is proposed the "Designer" shall provide an indicative overall concept plan of the development at the time of submitting the first stage to The Council for approval. This concept plan shall not be binding with respect to the proposed layout/staging; however, the final number of tenements cannot differ by more than 20% between the original concept plan and the ultimate constructed development.

All development in bush fire prone areas is to comply with the RFS NSW planning for bushfire protection.

3. SYSTEM PLANNING

3.1 System Planning Process

3.1.1 Extending/upgrading an existing water supply system (Refer WSA

2.1.1) In lieu of (a) and (b) of this Clause of WSA 03, the "Planner/Designer" shall:

a. Take into account points (i), (ii) and (iii) which will be provided by The Council in designing the extension/upgrade of an existing water supply system to ensure that it adequately services any existing and any future customers on that system.
b. Provide details of the proposed extension/upgrade in the preliminary/early phases of the design in particular existing and future customers, to The Council to allow it to be "trialled/modelled" in The Council's network analysis and determine its impact on the existing water reticulation system.
c. The outcome of this trialling may lead to The Council placing additional requirements on the proposed extension/upgrade and/or the developer to augment the existing system to meet the demands of the proposed extension/upgrade.

3.2 Demands (Refer WSA 2.2.1)

Demand rates shall be in accordance with Table 2.1 unless the demand of the proposed development is known and exceeds those values in Table 2.1 in which case the "known" demand shall be used.

3.3 System Hydraulics

3.3.1 Minimum allowable service pressure (Refer WSA 2.4.3.3 and Table 2.2)

The minimum allowable service pressure shall be 100 kPa (10 m head) throughout the reticulation system when meeting a peak instantaneous demand of 0.15 litres/second/tenement. These minimum pressures are to be achieved with the relevant supplying water storage reservoir two thirds full.

Where the pressure does not meet the Council requirement this may be registered on the title as determined by the Council.

3.3.2 Pressure variation analysis (Refer WSA 2.4.4)

Where distribution and reticulation systems are designed to control diurnal pressure variations, the diurnal demand factors are to be used for each customer category. Consult with the Council prior to undertaking any analysis to determine requirements.

3.3.3 Determining supply zones (Refer WSA 2.4.4)

The Council has no issue with different supply zones. The creation of **different pressure zones is not preferred** and "Planners/Designers" should discuss this issue with the Council in the early stages of the design phase in an attempt to eliminate such zones. Pressure zones shall be consistent with The Council's existing system.

3.4 Pumping Stations (Refer WSA 2.6 (C))

A standby pump of the same capacity as the duty pump is required. Provision shall be made in the design and ultimate operation for the standby and duty pumps to be alternated.

The design of any water pump station **must be** undertaken in consultation with the Council's' Water and Wastewater Mechanical and Electrical Group.

3.5 Service Reservoirs (Refer WSA 2.7)

The minimum capacity for any service reservoir shall be on one day supply at peak demand.

The reservoir should be located at an elevation such that the water level when the reservoir is
2/3 full provides not less than the minimum allowable service pressures at the customer's services under peak demand conditions (Table 2.2 of WSA –03 modified as per 2.4 above). Reservoirs are to be designed as part of an overall system and are to be located at elevations consistent with other reservoirs within the same pressure zone.

4. HYDRAULIC DESIGN

4.1 Sizing Of Mains

4.1.1 Minimum pipe sizes (Refer WSA 3.2.2)

The minimum acceptable pipe size is 100 mm diameter for "residential" areas and 150 mm diameter for commercial and industrial areas.

The minimum pipe size for the bowls of courts, cul-de-sacs shall be 50 mm copper (65 mm nominal diameter if polyethylene (PE) pipe is being used), however fire hydrants must have a minimum main diameter of 100 mm on the supply side.

4.1.2 Fire flows (Refer WSA 3.2.4)

The following applies in addition to Clause 3.2.4 of WSA
03:

A minimum supply head of 10 metres is to be achieved at any fire hydrant within the reticulation system when drawing 10 litres/second from the individual hydrant and meeting a peak instantaneous demand of 0.10 litres/second/tenement throughout the system. A tenement is deemed to be the demand relating to a typical residential lot. Where the demand differs from that of a standard tenement the anticipated water supply demand for each development shall be used in undertaking the above calculations.

4.2 Design Pressures

4.2.1 Maximum design pressure (denoted on design drawings) (Refer WSA 3.4.2)

The maximum design pressures are not required to be recorded on the 'design drawings' as per Clause 3.4.2 of WSA 03. However they should be shown on an overall concept plan at strategic locations that shall be included with the design computations provided to Council when the design is submitted for approval.

4.2.2 Empirical Sizing of Reticulation Mains (notes) (Refer WSA

3.2.3) Minimum class 12

4.3 Pipe And Fittings Pressure Class

4.3.1 Minimum pressure class (Refer WSA 3.7.2)

The minimum pipe and fittings pressure class for reticulation mains shall be PN 35 where ductile iron cement lined (DICL) pipes are used and Class 12 DIOD where uPVC rubber ring jointed pipe are used.

4.4 Pipeline Materials (Refer WSA 3.8)

The following pipeline materials are currently approved for use however other materials may be considered but will require the Council approval on a case-by-case basis.

4.4.1 Property Service Connections

PN 35 ductile iron cement lined (DICL) spigot and socket, rubber ring jointed pipe manufactured in accordance with AS 2280. If DICL flanged pipe is to be used the class shall be flange class pipe.

Type 'A'; copper pipe manufactured in accordance with AS 1432.
NOTE: Copper is only permitted for the bowl sections of courts and cul-de-sacs and property services. Pipeline fittings for joining Copper pipe to be silver soldered.

Class 16 PE is only permitted for the bowl sections of courts and cul-de-sacs and property services. However if the property service has to cross a road PE can only be used if it is inserted into a sleeve pipe of minimum Class 16. Sleeved pipes shall be installed so that water hammer and pressure fluctuations do not cause pipe movement with the conduit.

Pipeline fittings for joining PE to be only those approved by the Council; and Pipeline fittings for joining DICL and/or uPVC pipes shall be cast or ductile iron, cement lined and conforming to AS 2544 and AS 2280 respectively. If gibault joints are used they shall be the elongated type.

Copper tube Type A and Polyethylene (PE) pipe with trace wire is approved for use in property service connections. Copper tube is not approved for water reticulation use other than Courts and Cul-de-sacs. However if the property service has to cross a road, copper tube and Polyethylene (PE) pipe with trace wire is to be inserted into a sleeve pipe of

minimum Class 16. Sleeved pipes shall be installed so that water hammer and pressure fluctuations do not cause pipe movement within the conduit.

4.4.2 Watermains DN100 to DN360

Between DN100 and DN250 water mains shall be constructed in:

PVC-M (AS/NZS 4765), Series 1 or 2 minimum PN 16 rubber ring joint. PVC must be lilac coloured where used in reuse or raw water systems;

PVC-O (AS/NZS 4441), UNDER REVIEW.

DICL (AS/NZS 2280), PN 35 rubber ring joint, polyethylene wrapped AS 3680; if DICL flanged pipe is to be used the class shall be flange class pipe;

Place tracing wire in all PVC and Polyethylene trenches.

4.4.3 Watermains DN375 and larger

DN300 and over water mains shall be constructed in:

DICL AS/NZS 2280, PN 35, rubber ring joint, polyethylene wrapped AS

3680; Series 2 PVC Rubber Ring Joint minimum PN 16.

4.4.4 Fittings

Pipeline fittings for joining DICL, DIOD and/or uPVC pipes shall be conform to AS 2544 and
AS 2280 respectively. If gibault joints are used they shall be the elongated type or vari gib type.

5. GENERAL DESIGN

5.1 General Requirements

5.1.1 Design tolerances (Refer WSA 4.1.1)

The following shall apply in lieu of Clause 4.1.1(a) and (b) (ii):

“The alignments shall be calculated to the nearest 5 mm and expressed/shown on the drawings to two decimal places with the rounding application being 0.4 mm rounded down to the second decimal place and rounded up to the second decimal place of a metre.

The horizontal alignment shall be referenced to GMA.

5.1.2 Levels (Refer WSA 4.1.2)

In addition to the requirements of Clause 4.1.2; where a longitudinal elevation forms part of the design drawings levels shall be specified at:

- Every 15 metre interval; and
- Horizontal changes if alignment where a bend(s) is used;
- Vertical changes if alignment where a bend(s) is used.

5.2 Location Of Watermains

5.2.1 General (Refer WSA 4.3.1a)

Additional to clause 4.3.1a watermains are to be located on the nature strip with the pipe 2.7 metres from the property boundary. Alternative alignments are subject to approval from the Council.

5.2.2 Watermains near trees (Refer WSA 4.3.9)

In lieu of Clause 4.3.5 of WSA 03 the 'specialist advice' shall be sought from Council's Parks and Recreation Section. Further, the Parks and Recreation Section may require portions of the main to be underbored – this shall be specified on the Design Drawings. Particular attention is required in relation to the impact on the tree route system from the cumulative impact of the construction of all services and works.

5.2.3 Railway reserves (Refer WSA 4.3.5)

In addition to watermains being laid within railway reserves (either along or across them) being authorised by the Railway owner and complying with AS 4799, the design and ultimate construction shall comply with the requirements of the Railway owner.

5.2.4 Crossing Creeks or Drainage Reserves (Refer WSA

4.3.10) Stabilisation or directional bore as approved by the Council.

Pipes under existing roadways are to be encased or directionally bored as approved by the Council.

5.3 Connection Of New Mains To Existing Mains (Refer WSA 4.7)

Where it is necessary to connect to, tap into, or relocate an existing water supply main, The Council Staff should carry out this work at the developer's expense.

The developer should lodge payment for the work in advance and give 14 days notice of when connection is required.

The Council will provide all pipes and fittings required to complete the connection or tapping at the developer's expense.

5.4 Property Services (Refer WSA 4.9)

A common property service, which is then further divided to service additional properties, IS NOT PERMITTED.

Property services shall be located such that the point where the meter assembly is located is within 300 mm of the property side boundary or in the middle of the property. Coordinate service design with other services.

5.5 Obstruction Of Clearances

5.5.1 Deviation of mains around structures (Refer WSA 4.3.10)

The maximum individual joint deflection for DICL in either the horizontal or vertical plane or a multiple joint (i.e. where there is deflection in both planes) shall be not more than 75% of the manufacturer's recommendation.

Pipe deflection for DIOD uPVC shall be to Manufacturers Specifications (ie. No deflection in joints, deflection bends at mid point of pipe).

6. STRUCTURAL DESIGN

6.1 Pipe Anchorage

6.1.1 Thrust Blocks (WSA 5.9.2)

Blocks to be designed in accordance with paragraph 5.9.2. Placement generally in accordance with WTA 1205/1207.

6.1.2 Anchor Blocks (Refer WSA 5.9.3)

Precast anchor blocks shall be used in all instances.

6.1.2 Restrained Elastomeric Seal Joint Water Mains (DICL) (Refer WSA

5.9.4) Not accepted.

7. APPURTENANCES

7.1 Stop Valves

All stop valves shall be clockwise closing.

7.1.1 Gate valves (Refer WSA 6.4.1)

7.1.2 Stop valves for transfer/distribution mains (Refer WSA 6.2.2)

7.2 Air Valves

7.2.1 Installation design criteria

Air Valve Types to be only those approved by the Council.

7.2.2 Air valve types (Refer WSA 6.4.2)

Air Valve Types to be only those approved by the Council.

7.3 Swabbing Joints (Refer WSA 6.7) Not required.

7.4 Hydrants

7.4.1 Hydrant types (Refer WSA

6.8.3) Only spring type hydrants

accepted.

7.4.2 Hydrant Spacing (Refer WSA 6.87)

Fire hydrants are to be provided in the main at maximum spacing of 60 metres and flushing hydrants are to be installed at all dead ends, including temporary dead ends for the purpose of flushing the main in addition to fire fighting. In addition provide hydrants / fire protection in accordance with BCA and fire authority requirements.

Table 7.1 Average Day Demands for New Domestic Properties

Class of Building	Fire Fighting Flow (L/s)
1. Properties that are zoned for commercial (3) or industrial (4) purposes in the relevant LEP.	10
2. Any property not included in Category 1.	10

7.4.3 Hydrant Locations (Refer WSA 6.8.8)

Always in Road Reserve in accordance with Fire Authority requirements.

7.5 Fire Fighting Flows

Table 2.6 Appendix 2B outlines the requirements for fire fighting. Note that the water supply system is not designed to fight bushfires. To check for fire fighting adequacy a flow in accordance with Table 2.6 should be applied at selected points within the reticulation system in addition to peak hour flow on a 95 percentile peak day demand. Under these conditions, the pressures at the selected point and the surrounding water supply system should not fall below that specified.

When checking a property for fire fighting adequacy, the fire flow should be taken from the closest hydrant to the property.

In commercial and industrial areas or in areas of high rise buildings a minimum of 100 mm diameter pipes should be used unless otherwise specified. Special fire fighting requirements exist for some large industries or in cases where fire could be especially severe.

The water systems are not designed, nor intended, to fight bush fires where flows in excess of the design allowances nominated here are attempted to be drawn from the system.

7.6 Unaccounted Water

An allowance equivalent to 15% of the average demand is to be made for unaccounted water resulting from leakage in the water distribution system and meter inaccuracies. Peaking factors are not to be applied to unaccounted water.

7.7 Disinfection Of Watermains

All new watermains are to be disinfected prior to connection to the Council system. Disinfection must be carried out by approved contractor.

8. DESIGN REVIEW AND DRAWINGS

8.1 Design Review (Refer WSA 7.1) Submit a water supply check list.

8.2 Design Drawings (refer WSA 7.2)

Provide longitudinal sections for trunk mains in accordance with WSA.

9. STANDARD DRAWINGS

Berrigan Shire standard drawings take precedence over WSA.

Engineering Guidelines for Subdivisions and Development

Part 5
Sewerage Reticulation
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PART 5 - SEWERAGE RETICULATION

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1. INTRODUCTION

This Part of The Council's "Engineering Guidelines for Subdivisions and Development" is related to sewerage reticulation. Reference to the Council will include reference to the Council as the Sewerage Authority.

The Design and Construction of sewerage reticulation shall generally be in accordance with the latest version of the Water Services Association of Australia (WSAA) "Sewerage Code of Australia (WSA02**)".**

However this part of The Council's "Engineering Guidelines" takes precedence over the WSAA Standards. (ie. these are The Council's requirements which may be different to WSA 02).

The other Parts of the Engineering Guidelines for Subdivisions and Development are as follows:

Part 1 General Requirements
Part 2 Roads
Part 3 Stormwater Drainage
Part 4 Water Reticulation
Part 5 Sewerage Reticulation
Part 6 Landscaping and Control Measures for Erosion, Sedimentation and Dust Control
Part 7 Testing

This part of the "Engineering Guidelines" is set out in the same order as WSA 02 for ease of cross-referencing.

2. GENERAL

2.1 Scope (Refer WSA 1.1)

The design of sewage pumping stations (SPSs) is addressed in WSA 04 2001 Sewage Pumping Station Code of Australia. The Council has an objective of minimising the number of pump stations to reduce ongoing maintenance costs and liabilities. Pump station and rising main shall be in accordance with the Council Standards. These standards encourage a consistent approach to telemetry, electrical, pumps and maintenance issues throughout the system.

This Part of The Council's "Engineering Guidelines for Subdivisions and Development" is related to sewer reticulation. Reference to the Council will include reference to the Council as the Water Authority.

3. SYSTEM PLANNING

3.1 Assessment Of Future Loads (Refer WSA2.3.2)

4. FLOW ESTIMATION (REFER WSA 3)

4.1 Design Flow Estimation Method (Refer WSA 3.2)

Flow estimation assumptions shall be given in the concept plan.

4.1.1 Traditional Design Flow Estimation Method (Refer WSA 3.2.2)

The method for determination the design flow shall be in accordance with the methodology specified by the water agency as follows.

5. DETAIL DESIGN

5.1 Detail Design Considerations (Refer WSA 4.2)

5.1.1 Catchment Design (Refer WSA 4.2.1)

Where future development has the potential to occur beyond the estate, estate sewer reticulation is to be consistent with a catchment master plan. In the absence of a master plan prepared by the Council a master plan must be prepared by the developer to an extent necessary to determine sewerage component sizing and location within the estate so that orderly development can occur.

Estate sewerage reticulation shall be extended through the estate to service future upstream catchments. Sewer extension to service the upstream catchment shall be subject to Council approval at the cost of the Council. Easements shall be created as part of an approved estate master plan to enable sewer construction that is not dependent and restricted by estate staging and lot release. Construction may be either directed by the Council or alternatively constructed by the Council or its representatives.

5.1.2 Design Accuracy (refer WSA 4.2.2)

Location in plan shall be referenced to MGA coordinates.

5.1.3 Easements (Refer WSA 4.2.5)

Where Community or Shared Title occurs, The Council's sewer responsibility ends at the property connection point (typically where the property vertical is located as visible on site outside of easement/MH inside the boundary line of the property). There will be one connection to service the combined community lots. The Council may require an easement to be created over part or the entire infrastructure. Refer also public and private property (refer WSA 4.3.4).

5.2 Horizontal Alignment Of Sewers (Refer WSA 4.3)

Road Crossings are perpendicular to the road centreline unless otherwise approved.

5.2.1 Public and Private Property (Refer WSA 4.3.4)

Sewers located in property other than owned by The Council are to have an easement in favour of The Council. The Developer is responsible for obtaining this easement; the release of the Deposited Plan of Subdivision is subject to the creation of this easement. The Developer is to transfer to The Council sewer easements provided in the subdivision and execute a transfer and grant of easement in favour of The Council pursuant to Section 88b of the Conveyancing Act 1919, as amended. The minimum width of sewer easement should be 3.0 metres.

Development that requires the submission of a development application to the Council for approval will require the provision of an easement over existing sewer infrastructure.

5.2.2 All changes in direction using MH (Refer WSA 4.3.5)

An internal MH through drop between inlet pipe and outlet pipe is required as follows:

Deflection Angle	Drop (mm)
0° to 45°	30
46° to 90°	50
91° to 120°	100

Deflections between 91° to 120° are by approval only. Deflections greater than 120° through Maintenance Holes are not permitted.

5.2.3 Horizontal Curves in Sewers (Refer WSA 4.3.7)

Typically not accepted but the corporation may approve curved sewers on a case-by-case basis.

5.3 Obstructions And Clearances (Refer WSA 4.4)

Sewer mains located within lots adjacent to stormwater drainage lines shall be a minimum of 750 mm clear of the stormwater pipe.

The Council has a preference that buildings not be located over sewer mains. Where this is unavoidable subject to approval of the Council, buildings may be constructed over sewer reticulation mains provided they are constructed so that no load from the structure is transmitted to the sewer main and the portion of the main under the building (and for a distance outside of the building shall be 2 metres minimum) is laid in cement lined, sulphate resistant, or ductile iron pipe equivalent to Class PN 35. Refer to standard drawing Class 18 uPvc DIOD (ductile iron

outside diameter compatible). This concession is made primarily for buildings in established areas and will not be extended to new subdivisions unless special circumstances prevail.

5.4 Pipe Sizing And Grading (Refer WSA 4.5)

5.4.1 General (refer WSA 4.5.1)

Sewers shall be designed for PWWF capacity. The maximum and minimum allowable loadings for various pipe diameters are as shown in Appendix of these standards.

5.4.2 Minimum pipe sizes for maintenance purposes (Refer WSA 4.5.4)

The minimum sewer main diameter is 150 mm.

5.4.3 Minimum grades for sewers (Refer WSA 4.5.7)

At the ends of lines the minimum grade is 1 in 80.

5.4.4 Minimum grades for self cleansings (Refer WSA 4.5.7)

The maximum grade of reticulation sewer is limited to 1 in 10.

The minimum grades are shown in a table attached in Appendix A.

The values of Colebrook White roughness to be used in the design of gravity sewers are:

Table 5.1 Values of Colebrook White roughness

Nominal Pipe Size (mm)	Full Flow - for estimation of Peak Hydraulic Capacity	Partial Flow - for estimation of Self-Cleansing Flows
150-300	k = 0.6 mm	k = 1.5 normal k = 3.0 for control lines
375-600	k = 0.6 mm	k = 3.0 mm
Above 600	k = 1.5 mm	k = 6.0 mm

Note: Control Lines are those lines that affect the overall depth of the system.

The minimum grade for property sewers is 1 in 60.

5.4.5 Minimum cover over sewers (Refer WSA 4.6.3)

In accordance with WSA.

As a guide –

Private Residential Property (No Traffic)	400mm
Private Residential Property (Traffic)	600mm
Footpaths	900mm
Roadways	1200mm

5.4.6 Minimum Depth of Sewer Connection Point (Refer WSA 4.6.5)

The depth of the junction is to be such that any location within the lot can be drained to it via a pipe with a minimum 300 mm of cover laid at a grade of 1 in 60. The pipe is to be located parallel to boundaries and account for raft slab construction.

5.4.7 Depth of Connection Point (refer WSA 4.6.5.4)

Table 5.2 Property Sewers

Maximum depth to invert	2.0 metres
Termination of sewers that provide for future connection	Mark with tape and marker post

5.4.8 Vertical Curves (refer WSA 4.6.7)

Not accepted.

5.4.9 Compound Curves (refer WSA 4.6.8)

Not accepted

6. PROPERTY CONNECTION (REFER WSA 5)

6.1 Limitation Of Connection To Sewers (Refer WSA 5.2)

Written approval is required from the Council for connection to the existing Council sewerage system. All work is to be carried out by Council approved contractors at the developers' expense. Seven days prior notice is required. All materials are to be supplied by the Developer.

All work conducted on live sewers is to be in accordance with the relevant Occupational Health and Safety Regulations, and Confined Spaces Regulations.

6.2 Methods Of Property Connection (Refer WSA 5.3.1)

Table 6.3 Methods of Property Connection

WSA 5.3.3 Buried interface method (type A)	Approved.
WSA 5.3.2 IO interface method	Not approved
Reference	WSA standard drawing WAT 1107

6.3 Location Of Connection Points (Refer WSA 5.6)

Where an unsewered dwelling is located on land that is being developed, the Developer shall connect the dwelling to the sewerage reticulation at his cost as part of the subdivision work. The Developer shall be responsible for the removal of any septic tanks and backfilling of the excavation to the satisfaction of Council. All new sewer mains and MHs must be tested prior to the dwelling being connected.

6.4 Y Property Connections (Refer WSA 5.7)

Not accepted.

7. MAINTENANCE STRUCTURES (REFER WSA 6)

7.1 Types Of Maintenance Structures (Refer WSA 6.1)

a)	Maintenance Holes	accepted.
b)	Maintenance Shafts	not accepted
c)	Termination Maintenance Shafts	subject to Council approval on a case by case basis

7.2 Spacing Of Maintenance Structures (Refer WSA 6.3)

MH maximum spacing is 80 metres.

7.3 Maintenance Holes (Refer WSA 6.6)

All maintenance structures shall be maintenance holes (MH) unless otherwise approved by the Council.

Maintenance holes are required at all dead ends exceeding 30 metres in length. Sewer mains (referred to as junction and lead) that exceed 10 metres in length are sidelines that require a MH with a 150 mm connection where they enter the main at the downstream end. MHs are not to be located in road carriageways without specific approval of the Council.

Where the development is utilising existing sewer mains or junctions, the mains, MHs or junctions must be upgraded to meet the current guideline requirements.

7.3.1 Types of MH Construction (refer WSA 6.6.2)

Cast insitu or precast units are to be as approved by the Council. Tapers (cones) are not permitted on maintenance holes unless approved by the Council.

PE and other plastics are not accepted.

MH is to be constructed as fully cast insitu or fully precast assemblies.

7.3.2 Ladders, Step irons and Landings. (REFER WSA 6.6.8)

Not required.

7.4 Maintenance Shafts (ms). (refer WSA 6.7)

MS not accepted, TMS accepted.

8. ANCILLARY STRUCTURES (REFER WSA 7)

8.1 Water Seals, Boundary Traps And Water Sealed Mh's (Refer WSA 7.2)

Not required

8.2 Gas Check Mh's (Refer WSA 7.3)

Not required

8.3 Inverted Syphons (Refer WSA 7.8)

Not accepted

9. STRUCTURAL DESIGN (REFER WSA 8)

9.1 Products And Materials (Refer WSA 8.2)

Reticulation Pipes and Fittings must be in accordance with the manufacturers and relevant Standards. The following materials are approved for use:

Table 9.1 Approved materials for use

Gravity sewer reticulation pipelines may be constructed from uPVC non pressure pipe and fittings (AS 1260) minimum class SN8.
Ductile Iron, PN35, lining type to be confirmed with the Council. NOTE: Portland cement concrete lining is not acceptable.
DIOD uPVC.

Other materials may be considered however these materials will require approval on a case-by-case basis.

All pipes should be rubber ring jointed.

10. STANDARD DRAWINGS (REFER WSA-02)

11. PUMPING STATIONS AND PRESSURE MAINS (WSA04)

Where a development requires a sewage pumping station and associated pressure main the design and construction shall be in accordance with WSA04 – 2005 – Sewerage Pumping Station Code.

Developers should ensure that Council's technical services department is contacted in relation to mechanical and electrical components and provision for telemetry connections.

12. PRESSURE SEWERS (WSA07)

All properties within urban zone (RU5) shall be serviced by gravity reticulation.

Properties adjacent to the urban zone (RU1/RURAL) will be permitted to install and connect to approved low pressure systems that discharge to the existing gravity reticulation.

Low pressure sewer systems shall be designed and constructed in compliance with WSA07 – 2007 - Pressure Sewer Code as required.

APPENDIX A

Sewer Capacity Grading Table

	Pipe size 150			Pipe size 225			Pipe size 300			Pipe size 375		Pipe size 450		Pipe size 525		Pipe size 600		
	Tenements			Tenements			Tenements			Tenements		Tenements		Tenements		Tenements		
Grade	Min K (in mm)		Max	Min K (in mm)		Max	Min K (in mm)		Max	Min K (in mm)	Max	Min K (in mm)	Max	Min K (in mm)	Max	Min K (in mm)	Max	Grade
	1.5	3.0	0.6	1.5	3.0	0.6	1.5	3.0	0.6	3.0	0.6	3.0	0.6	3.0	0.6	3.0	0.6	
80	1	1	221															80
90	3	2	208															90
100	6	4	196	11	8	609												100
110	9	7	186	15	11	580												110
120	13	10	178	20	15	553	28	22	1225									120
130	18	14	170	25	20	530	33	27	1175									130
140	23	18	164	31	25	510	38	32	1129	39	2081							140
150	30	24	158	36	30	492	43	36	1089	44	2007							150
160	35	30	152	14	35	475	49	41	1053	49	1941	58	3188					160
180	48	41	143	52	45	446	61	52	989	61	1825	71	300					180
200	65	56	135	66	57	422	76	65	936	75	1727	86	2839	98	4313			200
220				83	71	401	92	79	890	90	1642	103	2703	116	4104			250
250				113	97	374	120	105	832	117	1536	131	2527	146	3840	163	5511	300
300	204	176	119	186	161	339	184	159	755	172	1395	188	2296	207	3492	227	5013	350
350				324	283	312	269	234	695	242	1287	259	2118	281	3222	305	4627	400
400							389	340	648	332	1199	347	1975	370	3006	396	4316	450
450							577	507	608	448	1120	454	1855	475	2826	504	1060	500
500							1175	1039	575	602	1066	585	1757	600	2674	628	3843	550
550										809	1013	747	1670	748	2544	773	3656	600
600										1191	967	953	1596	926	2430	940	3494	650
650												1126	1531	1138	2331	1134	3351	700
700												1630	1471	1400	2242	1362	3222	750
750												2829	1420	1732	2162	1628	3109	800
800														2185	2089	1948	3006	850
850														2925	2024	2341	2926	900
900																2850	2825	1000
1000																5668	2673	

Engineering Guidelines for
Subdivisions and Development

Part 6
Landscaping and Measures for Erosion, Sedimentation and Pollution Control
2014

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PART 6 - LANDSCAPING AND MEASURES FOR EROSION SEDIMENTATION AND POLLUTION CONTROL

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1. INTRODUCTION

This section of the Engineering Guidelines for Subdivisions and Development outlines Council's recommended practice for the **Landscaping and Measures for Erosion, Sedimentation and Pollution Control**. It is in no way a comprehensive "Design Manual" and it is to be read in conjunction with and as a supplement to referenced standards.

The Subdivision and Development Guidelines comprise the following:

Part 1 General Requirements
Part 2 Roads
Part 3 Drainage
Part 4 Water Reticulation
Part 5 Sewerage Reticulation
Part 6 Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing.

2. GENERAL

The object of these Guidelines is to:

- Encourage the implementation of environmental buffers and provide opportunities for repair and enhancement of natural systems especially for lands that were previously degraded;
- Encourage developers to appreciate landscape design as a fundamental and critical element of a development proposal and to include landscape design considerations at an early stage in the planning process.
- Protect the environment against soil erosion and soil loss from subdivision sites;
- Improve Water Quality;
- Prevent the degradation of drainage systems, waterways and the River Murray, from the deposition of soil, polluting substances and other foreign material from subdivision sites; and
- To minimise disturbances and provide necessary control measures to prevent loss of soil.

Relevant Acts and Guidelines include but are not limited to:

- Water Management Act 2000 (Part 3 management plans);
- Protection of the environment and operations Act 1997 (covers water, air, noise, pollution and waste);
- Native Vegetation Act 2003 No 130 (regulates clearing);
- Fisheries Management Act 1994 (protects fisheries and habitat);

- Noxious Weeds Act 1993 (control of noxious weeds);
- The Local Government Act 1993;
- Catchment Management Act 1989;
- Environmental Planning and Assessment Act 1979;
- Soil conservation Act 1938;
- Managing Urban Stormwater: Soils & Construction (Landcom); and
- State Environmental Planning Policies (Murray River SEPP 14, 44, 55).

3. LANDSCAPING FOR SUBDIVISIONS

General:
Prior to development of a landscape concept it is recommended that you carry out preliminary discussions with the appropriate Council Officer regarding the existing landscape features and concepts that will reinforce the character of the area and preserve the local native habitat.

3.1 LANDSCAPE GUIDELINES

A landscape plan will be required. The level of detail will depend on the size, scale and location of the development site. At a minimum, detail to include:

- Existing trees and landscape elements accurately plotted to scale;
- Species selection – including approximate height reached at maturity;
- Purchasing criteria;
- Planting schedule;
- Planting methodology; and
- Maintenance schedule.

At the initial stage of planning it is important that the trees to be retained on the development site are identified by a qualified arborist.

A tree protection plan is developed for the retained trees during the complete development phase. Refer to Table No 1 for design concepts that assist in the preservation of mature trees on a development site.

Council's nominal rate of street tree planting is one medium size tree every 15 metres or as directed. Tree purchase and planting is to be carried out as per Berrigan Shire Council standards. These standards are available on request.

At the completion of the planting and development of all reserves and street trees a handover inspection is to occur with the appropriate Council officer. Reserves to be dedicated to Council will only become Council's responsibility following the handover inspection and satisfactory completion. A letter stating the satisfactory completion of landscape works will be sent to the developer.

A maintenance period of a minimum of 12 months will apply unless otherwise nominated by Council. Following this period the release of the landscape bond will occur upon receipt of a written request.

Undesirable species are listed in Table No 2. These species are able to be removed without consent as exempt development.

3.2 CAR PARK LANDSCAPING

Ensure that car parking areas are landscaped to provide shade, define parking areas and improve the aesthetics of parking areas.

The development is to enhance the overall appearance of the streetscapes or streetscape elements including the street tree planting and other significant landscape elements.

4. NOXIOUS WEEDS

Under the Noxious Weeds Act 1993 Central Murray County Council is authorised to enforce the control of these plants. The NSW Department of Primary Industries makes regular updates the noxious weeds list for the Central Murray Region.

The Noxious Weeds Act 1993 requires that the growth and spread of all class 4 noxious weeds to be controlled according to the measures specified in the Central Murray Class 4 Noxious Weed Management Plan. The vegetation management plan prepared for the site is to include the listing of noxious weeds on site and the proposed control methods in dealing with these weeds.

4.1 CLEARING OF VEGETATION

The recommended flow of information is as follows:

- Identify the type of activity;
- List the applicable legislation and comply;
- Prepare a planning document for each activity;
- Type of activity whether exempt or complying; and
- Refer to the consent authority.

Clearing of vegetation is to comply with the following:

- The provisions of Clause 5.9 of Berrigan Local Environmental Plan 2013 and Chapter 8 of Berrigan Development Control Plan;
- The removal of trees, shrubs and ground cover shall be minimised to protect the ground surface from erosion;
- Removal of trees exceeding 200 mm in diameter and or 5 metres in height shall be undertaken only in accordance with Development or Building approvals. Any trees to be removed should be clearly identified on a plan;
- A plan should accompany each Development Application showing clearly the genus

location and health of all existing trees that exceed 200 mm in diameter and or 5 metres in height either on-site or on adjoining lands and within two metres of boundaries of the subject site. Removal of any trees will not be allowed before development approval unless written Council consent is obtained. In addition to Council requirements, approval may be required under the Native Vegetation Conservation Act.

- Minimal clearing of vegetation, including trees less than 4.5 metres in height, may be undertaken without consent or in accordance with approved plans for the following purposes:

    * Survey or geotechnical investigations where clearing is limited to obtaining site lines or essential vehicle access;
    * Reduction of the fire hazard in accordance with:
      - The Rural Fires Act 1997
      - NSW RFS Planning For Bushfire Protection 2006
      - According to the needs of a fire radiation zone at the direction of council, providing the material is removed in a way that does not disturb the ground surface;
- In compliance with a notice for the destruction of noxious weeds or vegetation harbouring vermin;
- Activities not requiring development consent, providing the material is removed in a way that does not disturb the ground surface, as in (ii) above, and/or the land is not within 20 metres of an urban stream (Section C) and/or the gradient is not steeper than 1(V):4(H) or not covered by the Native Vegetation Conservation Act.

For subdivisional work clearing must be limited to 2 metres from the edge of any essential construction activity as shown on the approved engineering plans.

All reasonable care must be taken to protect other vegetation from damage during construction. This will include the following:

- Clearly marking trees to remain;
- Avoiding compaction of ground within the drip line of trees to remain;
- Clearly delineating the area of disturbance and keeping all vehicles, building materials and refuse within that area. These areas are to be clearly marked exclusion zone;
- Limiting the number of access points to the site; and
- Clearly restrict access to no go areas and provide exclusion fencing prior to the commencement of works on site.

4.2 ESTABLISHMENT OF VEGETATION

- Promote revegetation of disturbed areas;
- Conserve native vegetation;
- Equal consideration should be given to native grasses, legumes, shrubs and trees;
- Consider seasonal conditions to match the time of year to seedling germination and survival;
- Replace or re-establish any damaged vegetation;

- Perennial vegetation is preferable;
- Revegetate 90% of the disturbed areas within eight months of the initial revegetation plantings and; and
- Revegetation must comply with an approved Master Plan, the Master Plan must comply with any other relevant strategy policy plan or the like relevant to vegetation management.

4.3 TABLE NO 1 – TREE MANAGEMENT ON A DEVELOPMENT SITE

IMPACT OF TREE	CONSTRUCTION ACTIVITY	METHODS TO MINIMISE TREE DAMAGE
Root Loss	Stripping site or organic surface soil during mass grading.	Restrict stripping of topsoil around trees. Any woody vegetation to be removed adjacent to trees should be cut at ground level and not pulled out by equipment, or root injury to remaining trees may result.
Root Loss	Lowering grade, scarifying, preparing subgrade for fills and structures.	Use retaining walls with discontinuous footings to maintain natural grade as far as possible from trees. Excavate to finish grade by hand and cut exposed roots with a saw to avoid root wrenching and shattering by equipment, or cut with root pruning equipment. Spoil behind cut face can be removed by equipment sitting outside the dripline of the tree.
Root Loss	Subgrade preparation for pavement.	Use paving materials requiring a minimum amount of excavation (eg reinforced concrete instead of asphalt). Design traffic patterns to avoid heavy loads adjacent to trees (heavy load bearing pavements require thicker base material and subgrade compaction). Specify minimum subgrade compaction under pavement within dripline (extra reinforcement in concrete or geotextile under asphalt may be needed).
Root Loss	Excavations for footings and wall foundations.	Design walls/structures with discontinuous footings, pier foundations. Excavate by hand. Avoid slab foundations, post and beam footings.
Root Loss	Trenching for utilities, drainage.	Co-ordinate utility trench locations with installation contractors. Consolidate utility trenches. Excavate trenches by hand in areas with roots larger than 25 mm in diameter. Tunnel under woody roots rather than cutting them.

IMPACT OF TREE	CONSTRUCTION ACTIVITY	METHODS TO MINIMISE TREE DAMAGE
Wounding top of tree	Injury from equipment.	Fence trees to enclose low branches and protect trunk. Report all damage promptly so arborist can treat appropriately.
Wounding top of tree	Pruning for vertical clearance for building, traffic and construction equipment.	Prune to minimum height required prior to construction. Consider minimum height requirements of construction equipment and emergency vehicles over roads. All pruning should be performed by an arborist, not by construction personnel.
Unfavourable conditions for root growth, chronic stress from reduced root systems.	Compacted soils.	Fence trees to keep traffic and storage out of root area. In areas of engineered fills, specify minimum compaction (usually 85%) if fill will not support a structure. Provide a storage yard and traffic areas for construction activity well away from trees. Protect soil surface from traffic compaction with thick mulch.
Unfavourable conditions for root growth, chronic stress from reduced root systems.	Spills, waste disposal (eg paint, oil, fuel).	Post notices on fences prohibiting dumping and disposal of waste around trees. Require immediate cleanup of accidental spills.
Unfavourable conditions for root growth, chronic stress from reduced root systems.	Soil sterilants (herbicides).	Use herbicides safe for use around existing vegetation.

4.4 TABLE NO 2 – UNDESIRABLE PLANT SPECIES

COMMON NAME	SCIENTIFIC NAME	QUALIFICATIONS
NOXIOUS WEEDS		
Castor Oil Plant	Ricinus communis	
Willows	Salix ssp.	
Tree of Heaven	Alilanthus altissima	
Rhus Tree	Toxicodendron succedaneum	

UNDESIRABLE SPECIES		
Bamboo		All species and cultivars.
Celtis ssp.		Specific species.
Cootamundra Wattle	Acacia baileyana	
Golden Wattle	Acacia salignus	
Desert Ash	Fraxinus oxycarpus	
Box Elder	Acer negundo	

5. EROSION, SEDIMENTATION AND POLLUTION CONTROL

Engineering Guidelines for
Subdivisions and Development

Part 7
Testing
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PART 7 - TESTING
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1. INTRODUCTION

This document outlines the Authority's recommended practice for testing roads, water reticulation and sewer reticulation.

This section of the Engineering Guidelines for Subdivisions and Developments outlines the Authority's recommended practice for testing roads, water reticulation and sewer reticulation. It is in no way a comprehensive "Testing Manual" and it is intended to be read in conjunction with relevant Standards that includes:

- Australian Standards;
- RMS NSW Standards;
- Vic Roads Standards;
- WSAA Standards for Water and Sewer; and
- State Government Authority Standards.

The other sections of the Subdivision and Development Guidelines comprise the following:

Part 1 General Requirements
Part 2 Roads
Part 3 Stormwater Drainage
Part 4 Water Reticulation
Part 5 Sewerage Reticulation
Part 6 Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing.

The developer is required to pay for all tests. Forty-eight hours notice is required.

2. ROADS

Test each layer of pavement material and obtain approval for each layer from the Authority or an Accredited Certifier prior to placing of subsequent pavement layers.

2.1 SUBGRADE

Test the Subgrade profile by template and make good irregularities by the addition or removal of material, followed by further rolling as in Table 1

Table 2.1 Subgrade Testing

Subgrade compaction requirement as obtained in the standard compaction test	95% of maximum dry density
Test every 500 mm lift at	Maximum spacing of 100m
Minimum number of samples per road	2 samples
Compulsory Subgrade inspection	In accordance the quality control checklist

All fill material shall comply with the requirements of AS 3798, Guidelines on Earthworks for Commercial and Residential Developments by the submission of test certificates prior to the commencement of work. Samples must represent a particular batch; lot or consignment and test certificates shall be no older than three months.

Every 500 mm lift of Subgrade shall be proof rolled. The Subgrade shall be checked by proof rolling with a roller having an intensity loading of seven tonnes per metre width of roller. Any permanent deformation of the Subgrade under the roller shall be deemed a failure.

Upon completion of final boxing of Subgrade, the geotechnical testing Authority shall inspect the exposed Subgrade to ensure that the samples taken accurately represent the Subgrade condition and shall certify in writing, to the Authority that this is so prior to the placement of the first pavement layer.

2.2 SUB-BASE AND BASE

The sub-base and base shall be density tested at intervals along the road as directed by the Authority.
The minimum requirements are:

Table 2.2 Sub-base and Base Testing

The sub-base and base shall be density tested at	100 metre
Minimum samples per road to be tested	Two
Sub-base course compaction	95% of the maximum dry density as per the modified compaction test.
Base course	100% of the maximum dry density as per the modified compaction test.
Compulsory sub-base and base inspection	In accordance the quality control checklist

2.3 DENSITY TESTING

All tests are to be undertaken and certified by an authorised representative of a laboratory registered by the National Association of Testing Authorities. The developer is to pay for all density testing with density test results supplied to the Authority or an Accredited Certifier for approval.

2.4 PAVEMENT DETAILS

Sub-base and base course material must be initially tested for suitability unless advised otherwise by the Authority or an Accredited Certifier.

The minimum thickness for base course is 100 mm.

No pavement material shall be placed without the prior approval of the Authority.

All sub-base and base course gravel must comply with the following requirements:

Table 2.3 Pavement Details

Sub-base and base course gravel	To VicRoads Standard Specification for Roadworks and Bridgeworks Section 304
Sub-base Gravel Standard	To VicRoads class 3 Standard
Sub-base Gravel Max PI	10
Sub-base Gravel Min CBR	60
Base Gravel Standard	To VicRoads class 2 Standard
Base Gravel Max PI	6
Base Gravel Min CBR	120

2.5 ASPHALTIC CONCRETE

The supply and laying of asphaltic concrete must comply with RMS test method T612.

2.5.1 Stability of mixes

The stability of the job mix shall be between 16KN and 36KN, as determined by the modified "Hubbard – Field Method' i.e. RMS Test Methods T601 and T603.

Mixes with stability of less than 8KN below the limit or more than 12KN above the upper limit shall be removed from the site. For mixes having stability outside the specified ranges, but within the above-mentioned limit for rejection, consideration will be given to acceptance of the mix subject to deduction in accordance with RMS test method T612.

2.6 VOIDS IN COMPACTED MIXES

The design of job mixes shall be such that between 65% and 85% of the air voids in the total mineral aggregate will be filled by the binder when determined in accordance with RMS Test Methods T601, T605 and T606.

2.7 SPRAYED BITUMINOUS SURFACING

Spray seals shall be in one or two applications as specified on the drawings and shall conform with the RMS specification for the supply and spraying of bituminous material (MR Form 898).

Aggregates shall conform to RMS NSW specification for cover of aggregates RMS DCM materials specification DCM 3151 with proof of compliance submitted prior to the commencement of work. Samples tested must represent a particular batch; lot or consignment and test certificates shall be no older than three months.

2.8 APPLICATION RATES

The designed application rates of binder and aggregates and average least dimension of aggregates is to be submitted for approval 48 hours prior to the commencement of works.

2.9 WORK RECORDS

Details of bitumen and aggregate applied are to be recorded immediately after each “run” and submitted for approval prior to acceptance into maintenance period.

2.10 DEFECTIVE WORK OR MATERIALS

Remove defective materials including replacement of binder that has been overheated, deteriorated or contaminated prior to application to the road. Where the Authority considers that work is not in accordance with the specification whether caused by bad workmanship, defective materials or by materials made defective during construction these materials shall be removed at the cost of the developer and contractor.

Alternatively, the Authority may consider accepting defective work subject to conditions.

2.11 FINAL ROAD PROFILE

2.11.1 Pavement Crossfalls

The final road profile shall satisfy the following requirements (if not otherwise stated in the drawings):

Mean Crossfall	3% ± 0.25%
Maximum Crossfall	3.5% (5% in extenuating circumstances)
Minimum Crossfall	>2.5%
Standard Deviation of Crossfalls	0.35%

The above requirements do not apply where the road is super elevated.

2.11.2 Vertical Alignment

The vertical alignment shall not deviate more than ± 0.25% from the value shown on the drawings.

2.12 CONCRETE

Comply with AS 1012 Methods of Testing Concrete.

2.13 SUBDIVISION EARTHWORKS

All earthworks associated with commercial and residential developments must comply with the requirements of AS 3798 “Guideline on Earthworks for Commercial and Residential Developments”.
Plans and specification for all earthworks are to be included with the Engineering Drawings and Construction Specification, for the Authority or Accredited Certifier’s consideration.

Any material deemed to be unsuitable as described in the Australian Standard shall be disposed of from the site.

Any documentation for earthworks, including Works-As-Executed details and testing shall comply with Sections 3 and 7 of AS 3798. A copy of the documentation and test results shall be supplied to The Authority. The Subdivision Certificate will not be issued prior to the receipt and approval of all earthworks documentation.

3. WASTEWATER RETICULATION

3.1 GENERAL (REFER WSA 22.1)

This section relates to sewerage reticulation acceptance testing. The testing of sewerage reticulation shall generally be in accordance with the latest version of the Water Services Association of Australia (WSAA). However this part of the Authority’s “Engineering Guidelines” takes precedence over the WSAA Standards. The “Sewerage Code of Australia (WSA02) Part 3 Construction; Second Edition Version 2.3” has been cross-referenced.

All sewers and maintenance holes shall be subject to testing after construction (NATA accreditation is not mandatory). The tests shall be carried out before issue of the Subdivision Certificate.

Should sewers or maintenance holes fail any test, defects shall be detected and repaired and the test repeated. The process of testing, detection and repair of defects and retesting shall continue until a satisfactory test is obtained.

All lines are to be clear and free from soil, slurry, liquids and other foreign substances at the notification of completion.

3.2 COMPACTION TESTING (REFER WSA 22.1)

All trenches are to be Flood Compacted or as determined by the Authority.

3.3 TEST OF GRAVITATION SEWERS

The testing of gravitation sewers shall be in accordance with the relevant requirements and method of testing specified in Sections 3.4 or 3.5.

Before the test is performed, all pipelaying on the section shall be completed and backfill compacted to the level of the centre of the pipe barrel, and the Developer shall have requested the Authority to check the pipeline for line and grade.

The test may be carried out after risers and/or sidelines are constructed however the Authority will be reliant on the final test conducted immediately prior to acceptance into maintenance.

Any fault detected is to be rectified and a satisfactory test obtained before the remainder of backfill is placed.

3.4 AIR PRESSURE AND VACUUM TESTING OF GRAVITY SEWERS (REFER WSA 22.4)

3.4.1 Equipment

All necessary equipment is to be supplied by the Developer and kept in a condition acceptable to the Water Agency or Accredited Certifier.

Pressure gauges are to be tested daily by static water column. At least one spare gauge per test rig is to be kept on the job at all times.

Compressed air is to be supplied by a compressor capable of supplying at least 1m^3/minute at 35 kPa. The air is to be fed through a pressure-reducing valve capable of reducing pressure from that supply to 28 kPa ± 4 kPa. The air is then to pass through an airtight line fitted with a 150 mm Bourdon type pressure gauge reading from 0 to 50 kPa, a pressure relief valve that may be set to blow off at 28 kPa ± 4 kPa and a gate valve to the pipeline to be tested.

3.5 HYDROSTATIC TESTING

Where the Authority permits hydrostatic testing; the hydrostatic test shall be carried in accordance with the specific requirements of the Authority.

3.6 TESTING OF CONCRETE MAINTENANCE HOLES (REFER WSA 22.4.4)

The Authority may request the leakage testing of MH’s at its discretion.

Where a test is required the test shall be carried out with the maintenance hole cover surround fitted with rendering of the channels and benches completed.

As an alternative to vacuum testing referred to in WSA 22.4.4 subject to the approval of the Water Agency water testing will be undertaken by plugging all pipe openings in the walls and by filling the maintenance hole with water to the lowest point on the top of the maintenance hole cover surround. The plugs shall be positioned in the pipes as near as practicable to the internal face of the maintenance hole.

After allowing 30 minutes for absorption, if not otherwise determined by the Water Agency, the maintenance hole shall be refilled and the loss of water during the following thirty minutes measured. The test on the maintenance hole will be considered satisfactory provided the water lost is less than 3 mm depth in the top section of the maintenance hole for each 1 metre depth of the maintenance hole. The depth of maintenance hole is to be taken from the bottom of the maintenance hole cover recess in the cover surround to the invert of the outlet from the maintenance hole. The plug of the outlet shall be fitted with a suitable release for emptying the maintenance hole on satisfactory completion of the test.

3.7 VISUAL INSPECTION AND MEASUREMENT FOR INFILTRATION (REFER WSA 22.5)

Whenever the pipeline is subjected to a significant head of groundwater (i.e. 1500 mm or more above the obvert of the sewer main) provided that groundwater is at least 150 mm above any sideline it shall be visually inspected for infiltration.

The Developer shall propose full details of the method by which the infiltration is to be measured and rectified.

The Developer at his own expense shall determine the head of groundwater by a method acceptable to the Water Agency or Accredited Certifier.

3.8 TESTING OF SEWER RISING MAIN

Rising mains including low pressure sewer rising mains shall be pressure tested in accordance with this subclause in order to detect excessive leakage and defects in the pipeline including joints, thrust and anchor blocks, if any.

Pipelines shall be tested in sections approved by the Water Agency or Accredited Certifier as soon as practicable after each section has been laid, jointed and backfilled, provided that: -

- If so specified or if the Developer so desires, some or all of the pipe joints shall be left uncovered until the whole of the section has been successfully pressure tested to the satisfaction of the Water Agency or Accredited Certifier; and
- The pressure testing shall not be commenced earlier than seven days after the last concrete thrust or anchor block in the section has been cast.

For the purpose of this subclause, a section shall be defined as a length of pipeline, which can be effectively isolated for testing, eg. by means of main stop valves.

Unless otherwise approved by the Water Agency or Accredited Certifier, pressure testing shall not be carried out during wet weather.

During pressure testing, all field joints, which have not been backfilled, shall be clean, dry and accessible for inspection. During the pressure testing of a pipeline each stop valve shall sustain at least once, 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.

Before testing a pipeline section, it shall be cleaned to the satisfaction of the Water Agency or Accredited Certifier and filled slowly with water, taking care that all air is expelled. Purging of air from rising mains shall be promoted by opening air valves. In order to achieve conditions as stable as possible for testing by allowing for absorption, movement of the pipeline and escape of entrapped air, the section shall be kept full of water for a period of not less than 24-hours prior to the commencement of the pressure testing.

The hydrostatic test pressure which shall be applied to each section of the pipeline shall be such that at each point of the section, the test head shall be equal to or greater than the design head specified or shown on the Drawings, but shall not exceed same by more than 20%.

The specified test pressure shall be maintained as long as required by the Water Agency or Accredited Certifier, while they examine the whole of the section, and in any case not less than eight hours. For the purpose of determining the actual leakage losses, the quantity of water added in order to maintain the pressure during the period of testing shall be carefully measured and recorded.

The pressure testing of a section shall be considered to be satisfactory if:

a. There is no failure of any thrust block, anchor block, pipe, fitting, valve, joint or any other pipeline component:
b. There is no visible leakage; and
c. The measured leakage rate does not exceed the permissible leakage rate as determined by the following formula:

$$Q_1 = \frac{(0.000532 + C)\, D.L\, (H^{1/2})}{1_p}$$

Where:

Q1 = permissible leakage rate (litres per hour)
C= a co-efficient as specified hereunder for the particular pipe material and type of joint
D= nominal diameter of pipe (mm)
L = length of section tested (km)
H= average test head (m)
1_p = average pipe length (m)

If the measured leakage rate does not exceed that rate calculated by the simplified formula for the type of pipe tabulated hereunder, the determination of the permissible leakage rate on the

basis of the formula specified in (c) above will not be necessary. The following simplified formulae are based on the co-efficient "C" and average pipe lengths contained in that tabulation.

Table 3.1 Simplified approach to leakage rates

Pipe Type	Simplified Formulae	Co-Efficient "C"	Nominal Pipe Length (M)
C.I. & D.I.	$Q_1 = 0.0105\ DL\ (H)^{½}$	0.0548	5.5
uPVC	$Q1 = 0.01\ DL\ (H)^{½}$	0.0568	6.0

Any failure, defect, visible leakage and/or excessive leakage rate, which is detected during the pressure testing of the pipeline or during the Maintenance Period shall be made good by the Developer at his expense.

3.9 INSPECTION PRIOR TO BACKFILLING

All sewerage lines shall be inspected and approved by the Water Agency or Accredited Certifier after laying and jointing and prior to the placing of any backfilling.

This may be relaxed for deep sewers with written approval of the Authority of a work method that allows for constant backfilling of the trench for safety purposes.

4. WATER RETICULATION

4.1 GENERAL (REFER WSA 9.1)

This section relates to water reticulation acceptance testing. The testing of water reticulation shall generally be in accordance with the latest version of the Water Services Association of Australia (WSAA). However this part of the Authority's "Engineering Guidelines" takes precedence over the WSAA Standards. The "Water Supply Code of Australia (WSA03) Part 3 Construction; Second Edition Version 2.3" has been cross-referenced.

All water reticulation shall be subject to testing after construction (NATA accreditation is not mandatory). The tests shall be carried out before release of the Subdivision Certificate.

Should the water reticulation fail any test, defects shall be detected and repaired and the test repeated. The process of testing, detection and repair of defects and retesting shall continue until a satisfactory test is obtained.

4.2 ACCEPTANCE TESTING (REFER WSA 19)

4.2.1 Pressure Testing (Refer WSA 19)

All pipelines including services shall be pressure tested to detect and repair leakage and defects in the pipeline including joints, thrust and anchor blocks, if any. The method of setting up and carrying out the test shall be in accordance with the requirements of WSA pressure testing section 19.4.

Pipelines shall be tested in sections approved by the Water Agency or Accredited Certifier as soon as practicable after each section has been laid, jointed and backfilled provided that:

- If so specified or if the Developer so desires, some or all of the pipe joints shall be left uncovered until the whole of the section has been successfully pressure tested to the satisfaction of the Water Agency or Accredited Certifier; and
- The pressure testing shall not be commenced earlier than seven days after last concrete thrust or anchor block in the section has been cast.

For the purpose of this clause, a section shall be defined as a length of pipeline, which can be effectively isolated for testing, eg by means of main stop valves.

Unless otherwise approved by the Water Agency or Accredited Certifier, pressure testing shall not be carried out during wet weather.

During pressure testing all field joints, which have not been backfilled, shall be clean, dry and accessible for inspection.

During pressure testing of a pipeline each stop valve shall sustain at least once the full test pressure on one side of the valve with no pressure on the other side for at least 15 minutes.

Before testing a pipeline section, it shall be cleaned to the satisfaction of the Water Agency or Accredited Certifier and filled slowly with water, taking care that all air is expelled. Purging of air from reticulation shall be prompted by opening hydrants.

In order to achieve conditions as stable as possible for testing by allowing for absorption, movement of the pipeline and escape of entrapped air, the section shall be kept full of water for a period of not less than 24-hours prior to the commencement of the pressure testing.

The minimum hydrostatic test pressure, which shall be applied to each section of the pipeline, shall be 400KPa.

Should the various works not be sufficiently completed to enable the supply to be thus provided when the pipeline is ready for testing, the time for testing shall be postponed until such is the case. Alternatively, the Developer may adopt other measures for supplying the water, but shall have no right to claim for any expenses that may be incurred thereby.

All expenses in connection with testing shall be borne by the Developer. The Developer shall have no claim for compensation or damages in respect of any postponement of the testing.

4.2.2 Disinfection

All new or replacement water mains equal or greater than 100 mm diameter must be disinfected prior to being brought into service. Bacteriological testing and disinfection procedures shall be in accordance with WSA 19.5 and 20.

Disinfecting can only be carried out by appropriately authorised personnel to the Authority's Disinfection Procedures.