TAMWORTH REGIONAL COUNCIL

Engineering Design Minimum Standards for Subdivisions & Developments

Version 1

March 2019

Replacing Engineering Design Guidelines for Subdivisions and Developments Version 5

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PART 1

General

Requirements

1 GENERAL REQUIREMENTS

1.1 Introduction

The Engineering Design Minimum Standards for Subdivision and Development have been compiled to outline Council's general procedures and practices in respect of the engineering design requirements for subdivision and development of land within the Council area.

The following minimum standards have been prepared in order to facilitate the expedient processing of engineering plan submissions, issue of Construction Certificates and release of Subdivision Certificates. Applicants should be aware that each development is required to be treated on its merits and that approval is dependent on the overall impact of the development on the area and not solely in compliance with minimum engineering standards.

Council welcomes the submission of innovative design solutions and staff are available for initial consultation to discuss and assess the prospects for approval.

Any proposed departures from these standards are to be submitted to council prior to submitting nonconforming plans in accordance with the Design Departures section of this document. Any application for a departure from these Minimum Standards is to include details of alternative options considered and reasons these alternatives are not suitable. Reduction in lot yield alone will not be sufficient reason for non-conformance with these Design Minimum Standards.

All applicants are advised to ensure that all conditions of the Development Consent are addressed within the detailed engineering plans.

Part 1 of the Minimum Standards outlines Council's general engineering requirements. The detailed engineering design requirements are given in Parts 2 to 6.

Part 2 Minimum Standards for Design of Roads

Part 3 Minimum Standards for Design of Stormwater Drainage

Part 4 Minimum Standards of Water Reticulation

Part 5 Minimum Standards of Wastewater Reticulation

Part 6 Minimum Standard for Landscaping

1.2 General

It is important to recognise 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 will generally become the responsibility of Council for ongoing asset management.

Before the developer commences the civil engineering works, a satisfactory engineering plan of the proposals should be submitted to and approved by the Council.

When approval to a subdivision or other development includes conditions of construction which are embodied in the approved plans and specifications, 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.

A contractor carrying out subdivision works is responsible to the developer, not the Council.

The developer should nominate to Council, the person or firm, with whom correspondence relating to the technical aspects of the development should be exchanged.

The Council will hold the developer (applicant), to whom the development approval was issued, solely responsible for constructing the required development works to Council's satisfaction and maintaining them during any specified period.

The developer should nominate to the Council for approval prior to commencement of construction, the name of the contractor who is to carry out the work associated with the development. Details of experience and technical expertise in similar works and the financial capabilities of the contractor to carry out the works are also required by the Council.

The Council will not require the details above for contractors previously approved.

1.3 Definitions

Developer
Any reference to Developer in all sections of these Minimum Standards will be taken as the Owner(s) and or Financial Contributor(s) of the proposed works.

Developer's Representative
Any reference to Developers Representative in all sections of these Minimum Standards will be taken as any company or person(s), acting for or on behalf of the Developer. This includes but is not limited to designers, civil contractors, planners and other persons engaged by the Developer.

Director
Any Reference to Director in Parts 2, 3 & 6 will be taken as a reference to the Director of Regional Services Director, and any reference to Director in Parts 4 & 5 Water and Waste or their nominated representative

Engineer
A person with a qualification from an accredited program listed as acceptable for Membership of The Institution of Engineers Australia, a person who has been assessed as meeting the Stage 1 Competency Standard as assessed by Engineers Australia or a person with equivalent qualifications and experience.

Minimum Standards
Any reference to Engineering Design Minimum Standards, Design Minimum Standards or Minimum Standards in this document shall be taken as a reference to this document being "Engineering Design Minimum Standards for Subdivisions and Developments".

Registered Surveyor
A person registered under the Surveying and Spatial Information Act, 2002.

1.4 Changes to these Engineering Design Minimum Standards for Subdivisions

From time to time Council will make changes to these Design Minimum Standards. A current copy of the Design Minimum Standards will be available at www.tamworth.nsw.gov.au. It is the responsibility of the Developer to ensure that all aspects of submitted drawings comply with the most current set of design minimum standards as at the date the final designs have been submitted for assessment. Changes as part of major updates to these Design Minimum Standards are recorded in Part 7 Document History and Changelog of this document.

1.5 Submission of Engineering Drawings and Specifications

All documentation supporting a Construction Certificate application must be submitted in electronic format with a hardcopy covering letter and completed Construction Certificate Application Form.

The documentation supporting a Construction Certificate application must be complete in its entirety and satisfy all requirements of the consent, Council's Engineering Design Minimum Standards for Subdivisions and Developments and Council's Development Control Plan.

The covering letter shall detail the contents supplied in the electronic media and the number of Lots included in the application. The fee payable at this point shall only be "Construction Certificate for Subdivision (per Lot)" fee in accordance with the Fees and Charges Annexure of Council's current Management Plan.

It is the responsibility of the Consultant/Engineer engaged by the Developer to ensure that the engineering survey supporting the design detail and drawings is of sufficient quality and accuracy to support the design of all infrastructure and land features encompassed by the works.

Designs submitted to Council containing errors or omissions that may have a significant impact on the final design will require resubmission. No further review will be undertaken by Council staff once such an error or omission is identified. e.g. plans submitted without sewer long sections.

Repeated Submission of substandard drawings may necessitate in a meeting between Council and the Developer and the Developers Representative to resolve outstanding issues.

1.5.1 ENGINEERING DRAWINGS

Engineering drawings are to be submitted in, as a complete set in accordance with Table A with a covering letter, by the applicant. One (1) set of approved plans will be returned to the applicant. Additional plan sets will not be returned unless additional plan sets are submitted and requested to be returned. PDF plans are to be exported A1 size true to scale.

Inspection and Test Plans (ITPs), Engineering Checklists, Annexure A – Certification and copies of Insurances must be supplied with the drawings.

Specific requirements to be included on drawings are detailed in checklists in each Part of the Design Minimum Standards to ensure the necessary information is provided

All drawings should be signed by the respective Consultant/Engineer engaged by the Developer.

Additionally, TRC email address shall be copied in on any electronic submissions to Council as per the address: trc@tamworth.nsw.gov.au

Table 1-A Plan Submission Requirements

Type	Revision	Submission Requirements		Notes
		Hard Copy	Electronic	
CCS	Initial Revision submitted to Council	1x A1 Complete Plan Set 1x A3 Complete Plan Set 1x Inspection Test Plan 1x Completed Design Checklist	PDF - Complete Plan Set Associated model files PDF - Pavement Design Report PDF - Line Marking & Signage Plan Safety in Design Report	
	Subsequent Revision(s)	1x A1 Complete Plan Set 1x A3 Complete Plan Set *1x Inspection Test Plan*	PDF - Complete Plan Set Associated model files	Inspection Test Plan only required where resubmission is requested by Council
	Final Revision for Stamping and issue of Construction Certificate	1 x Complete Plan Set for return 1x A1 Complete Plan Set 1x A3 Complete Plan Set 1x Inspection Test Plan	PDF - Complete Plan Set	Size of Plan Set (signed) to be returned to the consultant/developer is at the developer's discretion.
WAE	Initial Revision *(Revision "W1" – Notation "Works As Executed for Council Approval")*	1x A1 Complete Plan Set (marked-up) 1x A3 Complete Plan Set (marked-up) 1x Quality Assurance Documents 1x WAE Checklist *Any Operations and Maintenance Manuals*	PDF - Complete Plan Set (marked-up) PDF - Quality Assurance Documents DWG Associated model files of WAE Stormwater System	Operations and Maintenance Manuals only where applicable
	Subsequent Revision(s) *(Revision "W2", "W3")*	1x A1 Complete Plan Set (marked-up) 1x A3 Complete Plan Set (marked-up) 1x Quality Assurance Documents 1x WAE Checklist	PDF - Complete Plan Set (marked-up) PDF - Quality Assurance Documents DWG	
	Final Revision *(Notation – "Approved Works as Executed")*	1x A1 Complete Plan Set (marked-up) 1x A3 Complete Plan Set (marked-up) 1x Quality Assurance Documents 1x WAE Checklist	PDF - Complete Plan Set (marked-up) PDF - Quality Assurance Documents DWG	

- **Complete Plan Set** – All sheets in plan set regardless of whether the sheet has been revised or marked-up since previous submission
- **Quality Assurance Documents** – Copies of all testing results, completed Inspection Test Plans and Conformance Surveys

1.5.2 SAFETY IN DESIGN REPORTS

A Safety in Design Report prepared in accordance with the Work Health and Safety (WHS) Act 2011 shall be submitted with the initial revision of the design plans and prior to the issue of a Construction Certificate. Under WHS 2011 the Developer's Representative engaged in the preparation of plans and administration of construction works must ensure that all engineering structures are designed without risks to the health and safety of persons. The report should address all 'structures'.

The Safety In Design Report must specify but is not limited to:

- the hazards relating to the design of the structure
- the risks to health and safety to persons who carry out construction work on the structure
- the hazards associated with the design of the particular structure
- the use of the structure
- the maintenance of the structure

The report shall identify the risks and control measures across the whole life including construction.

1.5.3 PERSONS QUALIFIED

Council requires that design plans be prepared to Council's standards by a person, either

A person with a qualification from an accredited program listed as acceptable for Membership of The Institution of Engineers Australia, a person who has been assessed as meeting the Stage 1 Competency Standard as assessed by Engineers Australia or a person with equivalent qualifications and experience in the preparation of plans and specifications for land development.

Council relies upon the professional skill and experience of the person responsible for the preparation of the plans and specifications for the land development. Council requires that the person taking responsibility for the proper design and specification for the land development (or each of them when there is more than one) provide a certificate in the form attached to these Design Minimum Standards (as ANNEXURE A – Certification**)** certifying that all prudent actions have been taken to ensure that the design meets or exceeds current engineering standards appropriate to the development and the site.

1.5.4 CONSTRUCTION SPECIFICATION

The plans prepared to these minimum design standards shall be constructed in accordance to Tamworth Regional Councils Construction Specification.

1.5.5 APPROVAL OF ENGINEERING DRAWINGS AND SPECIFICATION

It is the entire responsibility of the person(s) or company submitting the documents, to ensure that the designs and specification comply with Council's Engineering Design Minimum Standards for Subdivision Developments, Relevant Australian Standards Relevant and Local, State and Federal Government Legislation.

The Council's issue of the Subdivision Works Certificate is conditional on the above basis and does not relieve the developer from rectifying any errors or omissions which become evident during construction.

Developers should be aware that the review of plans and specifications by Council does not extend to verifying site investigations or engineering calculations and design. Professional responsibility for this work rests with the developer and the person preparing the designs and specifications. Council relies upon this work being undertaken by an appropriately skilled and experienced person which must be certified in the manner described in ANNEXURE A – Certification before a Subdivision Works Certificate will be issued.

1.6 Design Departures

Departures from these guidelines will only be granted by the Manager or Director in exceptional circumstances and only after all other avenues to comply with these guidelines have been considered and exhausted. Applications for any departures must be lodged at the time of Development Application (DA) or Construction Certificate for Subdivision (CCS) lodgement. In the event a departure is proposed during construction, application for a departure will be required at that time and determined prior to any departure.

1.6.1 APPLICATION

Application forms are available on Council's website and available as ANNEXURE B – Departure Application Documents in Part 1 of these guidelines. The application must show reasonable grounds for the departure including exploration and assessment of all possible alternatives.

Application needs to be lodged at the same time as the Development Application or CCS.
The submission shall include:

1. Application form Signed in PDF format
2. Signed Checklist completed in PDF format
3. Supporting documentation for assessment of the proposal including assessment of alternative options completed and attached
4. Evidence showing cross discipline checks have been conducted for impacts on other design components including Electrical, Telecommunications, Gas, Water, Sewer, Drainage, Planning, and Transport
5. Any other items deemed necessary to support the application
6. Letter of Outcome in Word Format Pre-Populated with application details

1.7 Release of Subdivision Certificate

1.7.1 NOTIFICATION OF COMPLETION

When the developer or the developer's representative is of the opinion that Completion of Works has been reached and Work as Executed Drawings are submitted, the developer should notify Council in writing and request a final inspection.

Within fourteen (14) days of the receipt of the request, the Council's Representative(s) shall inspect the works and provide a written advice of the results of the final inspection. The developer or the nominated representative must be present for the inspection and assist the Council's Representatives in checking levels, opening manholes etc, as required.

The Subdivision Certificate will not be signed and released by Council until it is satisfied that the following works are completed:

1.7.1.1 DEVELOPMENTS INCLUDING ASPHALT SEALED ROADS

- Water supply, sewer reticulation, kerb and gutter, stormwater drainage and the road construction up to and including the sub-base pavement, primer seal;
- Work as Executed Plans for the work constructed to that point;
- Maintenance Bond and all applicable fees and charges
- A performance bond for the remainder of the work to be completed; and
- A commitment from the Developer to update Work as Executed plans after completion of asphalt sealing works.

1.7.1.2 DEVELOPMENTS NOT INCLUDING ASPHALT SEALED ROADS

- Water supply, sewer reticulation, kerb and gutter, stormwater drainage and the road construction including sealing; and
- Maintenance Bond and all applicable fees and charges

- Work as Executed Plans for all work constructed.

1.7.2 PERFORMANCE BONDS

A Performance Bond may be lodged by the developer for specified outstanding works, subject to agreement to the extent of those works by Council. The Performance Bond must be lodged prior to the release of the Subdivision Certificate and it shall be the greater of $2500 or 140% of the value of the outstanding works.

In any centre across Tamworth Regional Council area where level 3, 4 or 5 water restrictions are imposed, Council will agree to a performance bond for the landscaping of a development in the affected area for the value of 100% of the estimated cost of completing the works. The bond shall be returned in the event the landscaping work is carried out when Level 3, 4 or 5 water restrictions are no longer applicable, or in the event the Developer, of the Developers Representative fails to carry out the landscaping, Council may use the bond to carry out necessary works.

The developer is to provide a detailed costing for the outstanding works accompanied with a timeframe for the completion of the outstanding works not exceeding 12 months from the date of release of the Subdivision Certificate. If works are incomplete in the time nominated, Council may complete works at the developer's cost using the bond. Any unexpended balance will be refunded to the developer at the time the works have been completed.

Performance bonds shall not have an expiry date.

Performance bonds will only be accepted for works within a road reserve or drainage reserve and will not be accepted for essential infrastructure such as water and sewer servicing.

A maintenance bond shall be paid when performance bonded works are completed. Maintenance bonds shall be either:

a. For living landscaping including trees and turf that has been constructed as bonded works, the Maintenance Bond shall be 100% of the cost of these works

b. For all other items for which a performance bond has been applied, a separate maintenance bond shall be lodged as per section 1.7.3

1.7.3 MAINTENANCE BOND

Prior to the issue of a Subdivision Certificate Council will require the lodgement of a Maintenance Bond which is held to cover the cost of any maintenance or defects identified during the maintenance period in relation to the subdivision or development works that are intended to be under Council ownership. The maintenance period commences from the date of issue of the Subdivision Certificate or Occupation Certificate, unless a performance bond for outstanding work is entered into (for example for essential infrastructure such as roads, drainage), in which case the maintenance period shall commence from the date of completion of the outstanding works. In the case where the performance bond is for non-essential infrastructure (for example street trees and footpaths) the maintenance bond shall commence from the date of release of the Subdivision Certificate and the performance bonded works shall have a separate maintenance bond which shall commence from the date of completion of the works. The maintenance period is 12 months, however where infrastructure intended to be public assets is dedicated to Council but staged release of Lots is proposed as part of the Subdivision Certificate process, then the maintenance period will be extended for the period of time that it takes the developer to release at least half of the Lots constructed for each Construction Certificate. The amount of the Bond is calculated as 5% of the total contract price for completion of the work, with a minimum amount of three hundred dollars ($300). Council will not accept Bank Guarantees (for the maintenance bond) that have termination or expiry dates. All lodged bonds shall be unconditional.

Subject to satisfactory performance of the works the maintenance bond shall be released in stages as follows:

- Fifty percent (50%) of the bond held (or 50% of the remaining bond should a portion of the bond money have been utilised to repair defects – see Section 1.7.2) shall be released

after a period of six months. or, In the case of staged Lot release as part of the Subdivision Certificate process, when at least half of the Lots created for each Construction Certificate have been released;

- The balance of the bond remaining shall be released after a further 6 months.
- Where Maintenance Bonds are provided by Bank Guarantee, two (2) separate 2.5% guarantees are to be provided

1.7.3.1 MAINTENANCE OF WORKS

At any time during the Maintenance Period, the relevant Director may direct the developer to rectify any omission or defect in the works which exist at final inspection or becomes apparent prior to the expiration of the Maintenance Period. If defects or omissions are not rectified to the satisfaction of the Director, Council shall be at liberty to rectify same and apply the maintenance bond for payment of the cost thereof.

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

The Performance Bond, as referred to in Section 1.7.2 above, will be released by Council following satisfactory inspection of the outstanding works covered by the bond.

1.8 Works-As-Executed (W.A.E.) Plans

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

The Works-As-Executed plans must be certified by the Registered Surveyor or the Engineer responsible for the preparation of the Works-As-Executed plans:

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 this plan are Works-As-Executed and have been constructed in accordance with the plans and specifications approved by the Council.'

Name: _____

Signature: _____

Capacity: _____

Date: _____

Council relies upon the professional skill and experience of the person responsible for the supervision of the works and ensuring the works are undertaken in accordance with the approved plans and specifications together with these Design Minimum Standards and any other appropriate standards.

Developers should be aware that Council inspections of the site are not a substitute for proper works supervision and Council relies upon the skill, experience and diligence of the person accepting professional responsibility for this work to ensure it is constructed in a proper manner.

1.8.1 GENERAL REQUIREMENTS

General requirements regardless of the format Works as Executed drawings are submitted include;

- All sheets in an approved set of plans (the “Complete Plan Set”) must be submitted
- All plans should substantially be in black and white or greyscale
- There must be a clear delineation of the extent of works, including clear notation of any work that has been constructed in a previous stage or is proposed to be constructed in a future stage
- The lot layout on the WAE plans should be the same as the layout to be included on the subdivision linen
- Where new roads are constructed, the approved street names must be included on the plans, either in a tabular format (referencing the approved street name and the name used on the plans) on a general layout plan or road plan or indicated on each plan
- The revision detail for each sheet (regardless of whether the sheet contains WAE mark-up or not) shall be noted as follows:
    - Initial Submission must be marked as Revision “W1” with the notation “Works as Executed for Council Approval” and dated
    - Subsequent Revisions must be marked as “W#” (where # relates to the number of resubmissions) and dated
    - Final Revision must contain the notation “Approved Works as Executed” and dated
- The location of all Council infrastructure constructed should be included on the plans; this includes but is not limited to conduits, subsoil lines, stub mains and inter-allotment drainage lines.
    - The location of temporary turning heads should be noted

- All changes from the approved design are marked-up in red including:
    - Items constructed (denoted by a tick)
    - Any additional items constructed
    - Any items not constructed (denoted by a strikethrough line and an “X” or cross)
    - Confirmation of any changes to existing infrastructure
- Detention basin capacity is to be confirmed by survey at maximum 200mm depth increments provided in the form of a Volume/ Elevation table. to ensure it conforms to the designed capacity
- Any works bonded under Sections 1.7.2 should be subject to the submission of additional Works-As-Executed documentation in accordance with Section 1.8 and that any release of the bonds is contingent on this documentation being submitted to and approved by Council.
- Any works that are proposed to be bonded and installed at a later time should be clearly marked as such.

1.8.2 ELECTRONIC SUBMISSION REQUIREMENTS

Adobe PDF

- All sheets in an approved set of plans (the “Complete Plan Set”) must be submitted in a single file, in page order
- Each plan must be full-scale (A1)
- Each plan must be an electronic rendition of the submitted hard copy
- Each plan must be legible, particularly if a scanned document
    - Council staff will determine whether acceptability of legible plans on a case-by-case basis

AutoCAD Files

- Must be submitted with each set of the PDF files for Council review;
- Drawing must be an acceptable DWG file version
    - Council can accept up to and including the latest DWG file version;
    - Council must be advised where the DWG has been created in a non-Autodesk product, like Microstation or 12D;
- Drawing must be on MGA (Zone 56) co-ordinates, with AHD datum;
- Drawing must only contain:
    - Final Lot Layout;
    - New and Altered Infrastructure Locations;
    - Location of any existing infrastructure where newly installed infrastructure interfaces
    - Labelling (if appropriate);
    - Layering by Asset Type (Water, Sewer, Stormwater, Roads)
- Each asset must be represented by a single feature (Nodes/Pits can be a block, pipes must be single line. Line types can be used where appropriate).
    - Where pipes connect they must share a common vertex (and where appropriate share that vertex with a node/pit).

Hydraulic Model

- A Hydraulic Model using the Works as Executed survey data shall be submitted as part of the WAE documentation demonstrating the performance of the constructed Stormwater network. The revised hydraulic model should capture as a minimum:
    - Actual basins depth/capacity;
    - Changes in pit locations; and
    - Changes in pipe grades of greater than 10% of the design grade. (For small changes in pipe grades and pit invert/surface levels the design levels may be used.)

1.8.3 QUALITY ASSURANCE PACKAGE

The full Quality Assurance Package must be submitted to Council for review including all testing results, completed Inspection Test Plans and conformance surveys.

Pavement Conformance Survey

Results of the pavement conformance survey must be submitted as follows:

- Results must be produced in a tabular form
- For each constructed road, at each cross section indicated on the design plans at the following locations:
    - Centreline
    - Each side of the road at the lip line or road shoulder
- Subgrade Level
- Finished Surface Level (provided with WAE)
- Conformance Figure being the difference between the pavement design depth and the as-constructed depth (finished surface level minus subgrade level)

Allotment Fill Conformance

- All allotment fill testing results are to be provided to council as part of the quality documentation submitted with the Work as Executed plans.
- Finished levels and depth of fill is to be confirmed on the Work as Executed plans.

1.8.4 SUBMISSION REQUIREMENTS

All Works as Executed submissions must be in accordance with Part 1 - Table A - Plan Submission Requirements

1.8.5 SURVEY / PLAN OF EASEMENTS

A Registered Surveyor is to supply a plan demonstrating that all infrastructure installed are wholly located within their respective easement, reserve or street allocations as per the approved engineering plans and in accordance with the tenure/easement requirements set out in this document.

The plan must:

- Show the finalised lot layout
- Show the location of all constructed infrastructure
- Show the location of all easements, reserves and/or street allocations (existing or proposed) containing infrastructure.
- Demonstrate compliance with Council's tenure/easement requirements, including but not limited to tenure type, width.

I _____ certify that this plan is a true and accurate record of the works certified in Construction Certificate _____ as actually constructed and that all constructed works are located within proposed easement, reserve or street allocations in accordance with the

requirements as set out in Council's Engineering Design Minimum Standards For Subdivisions & Developments.

NAME: _____
SIGNATURE: _____
CAPACITY: _____
REGISTRATION NO: _____
DATE: _____

1.9 Penalties

Penalties will apply for Developers/Consultants in the following instances:

- In the case of Subdivision Construction Certificate plans that are submitted to Council which contain misleading information or false certification in respect compliance with the requirements of these Minimum Standards; and
- Works as Executed drawings are submitted to Council which, at any time after submission are found to not accurately reflect the actual work completed.

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1.10 Miscellaneous

1.10.1 INSURANCE

Contractors/consultants engaged in the preparation of plans and administration of construction works associated with approved developments must hold current certificates of currency of Insurances including, Workers Compensation, Public Liability and Professional Indemnity for Civil Engineering design in accordance with Council's Insurance Policy.

The value of indemnity in each case is details in Council's policy "Developer & Contractor Insurance Requirements" are Public Liability and Professional Indemnity minimum cover.

Council will annually check that the necessary insurance remains current.

1.10.2 ALLOTMENT FILLING

Any proposed allotment filling on residential or commercial subdivisions or developments shall be shown on the drawings, including the location, quantity required and source material. Design surface levels are to be shown on construction plans.

Topsoil (as defined in AS 3798) required to be removed during the works and re-instated following completion is not required to be included in lot filling declarations, provided this fill is less than 150mm thick.

All allotment filling shall be designed, constructed and tested in accordance with Australian Standard AS 3798 – Guidelines for Earthworks for Residential and Commercial Developments.

1.11 ANNEXURE A – Certification

I …… [*Print Name*] of …….. [Print *address*] hereby certify as follows:

1. I am a person qualified in accordance with Clause 1.5.3of the Tamworth Regional Council Engineering Design Minimum Standards for Subdivision Developments.

2. I am aware and accept that Tamworth Regional Council is relying upon my professional skill and experience in designing/supervising the construction of the following works;

    a.

    b.

3. I am aware that the reviews undertaken by Tamworth Regional Council of submitted designs and inspections of the works are limited to regulatory purposes only and the Council relies upon my professional qualifications, skill and experience and my certification for the purpose of confirming that the works have been designed and completed in a competent manner in accordance with the Tamworth Regional Council Engineering Design Minimum Standards for Subdivision and Developments together with all relevant standards and investigations which would be expected to be applied or undertaken by a professional engineer.

4. I hereby expressly authorise Tamworth Regional Council to rely upon this certification to be satisfied of the standard of design and confirm that no further verification or enquiry should be made by Tamworth Regional Council in relation to verifying the quality of construction in relation to those works.

5. I confirm my understanding and accept that the purpose of this certification is firstly to confirm that the works have been designed in a prudent and professional manner and secondly to confirm for the purposes of professional liability that I understand that Council is relying upon my professional skill, experience and diligence to be satisfied that the works have been designed to the standards required by the Engineering Design Minimum Standards for Subdivisions and Developments together with all other relevant standards and investigations which would be expected to be applied or undertaken by a professional engineer and as such I confirm that I have an enforceable duty to the Council to ensure the work has been completed in the manner relied upon by the Council.

Name: _____

Signature: _____

Capacity: _____

Date: _____

1.12 ANNEXURE B – Departure Application Documents

Design Departure Application Form

Subdivision Name	Click here to enter text.			
Location of Work	**Street Address**	Click here to enter text.	**Lot/DP**	Click here to enter text.
Reference	Click here to enter text.			
Departure Subject	Click here to enter text.			
Affected Drawings	Click here to enter text.			
Raised By	Click here to enter text.			
Date Raised				

Departure Request
Click here to enter text.

Designer Commentary
Click here to enter text.

Extent of Impact
Click here to enter text.

Policy Implications
Click here to enter text.

Financial Implications
Click here to enter text.

Other Implications *e.g. Easements, Property Acquisitions*
Click here to enter text.

Community Consultation
Click here to enter text.

Title	Name	Signature	Date
Applicant	Click here to enter text.		

Checklist for Application for Design Departure

Subdivision Name	Click here to enter text.			
Location of Work	**Street Address**	Click here to enter text.	**Lot/DP**	Click here to enter text.
Reference	Click here to enter text.			
Departure Subject	Click here to enter text.			
Affected Drawings	Click here to enter text.			

Application Checklist	Completed
Application form completed and signed in PDF Format	☐
Checklist completed and attached	☐
Supporting documentation for assessment of the proposal ***including*** assessment of alternative options completed and attached	☐
Evidence showing cross discipline checks have been conducted for impacts on other design components including Electrical, Telecommunications, Gas, Water, Sewer, Drainage, Planning, and Transport	☐
Any other items deemed necessary to support the application	☐
Letter of Outcome in Word Format Pre-Populated	☐

Please note that the application will not be assessed unless all appropriate documentation has been provided

Submission Representative Certification			
Title	**Name**	**Signature**	**Date**
Applicant	Click here to enter text.		

Design Departure Report of Outcome

Subdivision Name	Click here to enter text.			
Location of Work	**Street Address**	Click here to enter text.	**Lot/DP**	Click here to enter text.
Reference	Click here to enter text.			
Departure Subject	Click here to enter text.			
Affected Drawings	Click here to enter text.			
Raised By	Click here to enter text.			
Date Raised				

Council Response
Click here to enter text.

Departure Application Result	**Approved** ☐	**Rejected** ☐

Title	Name	Signature	Date
Director/ Manger	Click here to enter text.		
Applicant	Click here to enter text.		

PART 2

MINIMUM STANDARDS

FOR

ROADS

2 MINIMUM STANDARDS FOR ROADS

2.1 Introduction and Objectives

This section of the Minimum Standards outlines the minimum requirements for the design of roads in the Tamworth Regional Council area.

The primary design objective is to facilitate the expansion of the Tamworth Regional Council road network whilst ensuring the following:

- Provision of a safe environment for all road users;
- Development of a network that balances the existing and anticipated future demands of the Council; and
- Design of pavements that meet minimum serviceability standards for the design lifetime with minimal maintenance needs.

The design of roads shall be based on best practise engineering standards and shall meet or exceed the requirements of these Standards as well as relevant sections of Standards and publications referenced herein.

The design of Roads should be undertaken with consideration for the design of other services including those nominated in the sections listed below:

Part 1 General Requirements

Part 3 Minimum Standards for Design of Stormwater Drainage

Part 4 Minimum Standards for Design of Water Reticulation

Part 5 Minimum Standards for Design of Sewerage Reticulation

Part 6 Minimum Standards for Landscaping

References

Part 2 of the Minimum Standards should be read and utilised in combination with the following publications as referenced throughout:

- Austroads - Road Design Guide, Parts 1-7
- Austroads – Design Vehicles & Turning Path Template Guide
- Austroads - Guide to Pavement Technology, Parts 1-9
- AAPA National Asphalt Specification
- AS 1100 – Technical Drawing
- AS 1141 – Methods of Testing Aggregates
- AS 1158 – Australian Standard for Public Lighting
- AS 1289 – Method of Testing Soils for Engineering Purposes
- AS 1379 – Specification and Manufacture of Concrete
- AS 1428 – Design for Access and Mobility
- AS 1742 – Manual for Traffic Control Devices
- AS 2008 – Residual Bitumen For Road Pavements
- AS 2150 – Hot-Mix Asphalt – A Guide to Good Practice
- AS 2758 – Aggregates and Rocks for Engineering Purposes
- AS 2890 – Parking Facilities
- AS 3845 – Road Safety Barrier Systems.

- NSW Streets Opening Conference – Guide to Codes and Practises for Streets Opening
- Tamworth Regional Council Construction Specifications
- Tamworth Regional Council Standard Drawings

2.2 Definitions

All references to the Director should be interpreted as referring to the Regional Services Director or their nominated representative.

All testing to Australian Standards is to be conducted by a NATA accredited testing authority.

A built-up area is considered to be roadside development comprising property accesses at spacing's averaging less than 100m over distances of at least 500m.[1]

A rural area is considered to be a roadside development with an average lot size greater than 4,000m^2.

2.3 Road Construction Certificate Application Documents

The following information shall be submitted in support of an application for a Construction Certificate, and is considered the minimum list of requirements.

2.3.1 DESIGN DRAWINGS

Design drawings shall be submitted to Council for approval. Information to be included in the design drawings is detailed in **APPENDIX A** – Information to be shown on Drawings.

2.3.2 DESIGN CHECKLISTS

Each of the supporting items or documents listed in the checklists in **APPENDIX B** – Checklists shall be completed and submitted with the Drawings. Should any of the items required in any checklist be outstanding or not to a standard acceptable to Council, the Drawings and checklists shall be returned to the *Developer's Representative* for amendment. Council shall only commence review of the design drawings once it is satisfied that all the requirements of the checklists have been met.

2.4 Road Types, Classifications and Design Elements

2.4.1 GENERAL

Roads are generally composed of combinations of some or all of the following key elements:

- Travel lanes;
- Parking lanes;
- Footway reserves;
- Stormwater drainage infrastructure;
- Structural pavement;
- Wearing surface;
- Linemarking and Signage;
- Safety Barrier;
- Street lighting;
- Electricity Distribution; and

[1] *Taken from definitions in AS1742.3*

- Provision of Services.

The inclusion or exclusion of any or all of these elements as well as the specific requirements for each particular road within a subdivision or development shall be determined by Council and will be based on the size, type, location and nature of the subdivision or development, the requirements of local planning instruments such as the Local Environment Plan (LEP), Development Control Plans (DCP), Development Servicing Plans (DSP) and any other policies, specifications and guidelines as required.

For the majority of roads being designed within the TRC area, the combination of design elements will fall within one of the Road Design Standard (RDS) categories as per Table 2-A. Council will assign an RDS to each road within a subdivision or development as a condition of development consent.

Where a standard RDS as per Table 2-A is not appropriate for roads within a particular subdivision or development, Council will determine the requirements for each design element for the roads as a condition of development consent.

Table 2-A - Road Design Standard (RDS) matrix

Design Element	RDS 1	RDS 2	RDS 3	RDS 4	RDS 5
Kerb and Gutter	✓	✓	×	×	×
Formed Footway	✓	✓	×	×	×
Piped Underground Stormwater Drainage	✓	✓	×	×	×
Surface Drainage	×	×	✓	✓	✓
Asphalt Wearing Surface	✓	×	×	×	×
Sprayed Bitumen Wearing Surface	×	✓	✓	✓	×
Unsealed Gravel Wearing Surface	×	×	×	×	✓[1]
Street Lighting	✓	✓	✓	×	×
Above Ground Electricity Distribution	×	×	×	✓	✓
Below Ground Electricity Distribution	✓	✓	✓	×	×

Note 1: Full width ***Sprayed Bitumen Wearing Surface is required*** for a minimum of ***50m*** on approaches to ***intersections with sealed roads and 25m*** on ***approaches to sealed causeways.***

2.4.2 ROAD CLASSIFICATIONS AND FORMATION WIDTHS

Roads are typically categorised according to the function of the road within the entire road network, as well as the nature and volume of traffic expected to utilise the road and is related to the number of lots serviced by each road. Typical design parameters for each classification of road are contained in the road hierarchy shown in Table 2-B.

Each of the roads detailed in Table 2-B can be defined as follows:

- **Arterial**: The highest order roads with the primary function of providing principal links between urban centres or between urban centres and rural regions. Arterial roads shall be developed, or have the capacity to be developed into multi-lane facilities with access control being a desirable feature to enhance traffic flow.
- **Sub-Arterial:** Roads with the main function of connecting arterial roads to centres within a rural area and supplementing the arterial roads in providing for traffic movements from one part of an urban area to another.
- **Collector:** Roads that are intended to carry traffic between the arterial and sub-arterial roads and local and access streets. Collector roads are not expected to carry high traffic

volumes, and are not used for longer distance travel, except at the beginning or end of the journey. Collector roads help to distribute traffic at the neighbourhood level and may provide access to abutting properties. Ideally they should discourage through traffic by not providing continuous through routes between higher order roads.

- **Local and Access:** These are the lowest order roads in tributary road system and consist of local streets and access streets which provide access to residential properties. Their main functions are to provide both property access and residential amenity (resident safety and amenity are dominant design elements). Typically, an access street has only one entry/exit point (such as a cul-de-sac) servicing a maximum of 15 potential dwellings (not based on lots), whilst a local road has more than one entry/exit point or more than 15 dwellings.

A **dwelling** as defined in the Tamworth Regional Council LEP 2010 means a room or suite of rooms occupied or used or so constructed or adapted as to be capable of being occupied or used as a separate domicile.

Generally, arterial and sub-arterial roads form the basis for the major road system, whilst the collectors and the local roads form the basis for the internal road system within the subdivision or development. Local and access roads shall not interact directly with an arterial or sub-arterial road where an alternative is available.

Subdivision and development proposals are to show the proposed hierarchy on the design drawings as well as in the Traffic Impact Study. When preparing the proposed road hierarchy plan for the subdivision or development, consideration shall be given to the function of the road within the entire network, the expected traffic volume and the connection with the adjacent road network.

The road category to be adopted and the formation widths to be used for design purposes will be approved by Council following a detailed analysis of the proposed site, the design traffic and the nature and function of the subdivision or development. The adopted road category and width shall apply to the entire length of the road, and progressive widening or narrowing of a road through intersections or development stages will not be permitted.

When calculating the proposed category or function of a road, the *Developer's Representative* must consider the ultimate number of lots serviced by the road when all potential stages of development and subdivision are complete. Consultation with Council regarding the ultimate function of the road may be necessary.

It is the *Developer's Representative's* responsibility to ensure that road reserve widths are sufficient to accommodate all road and ancillary services and utilities that are required to be located within the reserve and the road reserve may need to be wider than the minimum width detailed in Table 2-B. Consultation with relevant service authorities such as telecommunications and electricity distribution authorities to determine their requirements for the subdivision may be necessary.

Table 2-B - Road Classifications, Formation Widths and Design Traffic

Road Classification	Indicative Design Traffic[2]	RU1	RU4	RU5	R1	R2	R5	B1-B7	IN1, IN3
		Primary Production	**Rural Small Holdings**	**Village**	**General Residential**	**Low Density Residential**	**Large Lot Residential**	**Business**	**Industrial**
Arterial	As determined per pavement design.	30m Road Reserve[1]	30m Road Reserve[1]	30m Road Reserve[1]	34m Road Reserve[1]	34m Road Reserve[1]	30m Road Reserve[1]	32m Road Reserve[1]	32m Road Reserve[1]
		2 x Travel Lanes, 3.5m wide	2 x Travel Lanes, 3.5m wide	2 x Travel Lanes, 3.5m wide	4 x Travel Lanes, 3.5m wide	4 x Travel Lanes, 3.5m wide	2 x Travel Lanes, 3.5m wide	4 x Travel Lanes, 3.5m wide	4 x Travel Lanes, 3.5m wide
		2 x Sealed Shoulder, 2.5m wide	2 x Sealed Shoulder, 1.5m wide	2 x Parking Lanes, 2.5m wide	2 x Parking Lanes, 3.0m wide	2 x Parking Lanes, 3.0m wide	2 x Sealed Shoulder, 1.5m wide	2 x Parking Lanes, 4.0m wide	2 x Parking Lanes, 4.0m wide
Sub-Arterial	As determined per pavement design.	30m Road Reserve[1]	30m Road Reserve[1]	30m Road Reserve[1]	32m Road Reserve[1]	32m Road Reserve[1]	30m Road Reserve[1]	30m Road Reserve[1]	30m Road Reserve[1]
		2 x Travel Lanes, 3.5m wide	2 x Travel Lanes, 3.5m wide	2 x Travel Lanes, 3.5m wide	4 x Travel Lanes, 3.5m wide	4 x Travel Lanes, 3.5m wide	2 x Travel Lanes, 3.5m wide	4 x Travel Lanes; 3.5m wide	4 x Travel Lanes; 3.5m wide
		2 x Sealed Shoulder, 2.0m wide	2 x Sealed Shoulder, 1.5m wide	2 x Sealed Shoulder, 1.5m wide	2 x Parking Lanes, 3.0m wide	2 x Parking Lanes, 3.0m wide	2 x Sealed Shoulder, 1.5m wide	2 x Parking Lanes; 3.0m wide	2 x Parking Lanes; 3.0m wide
Collector	Min 2 x 10^6 ESA	25m Road Reserve[1]	25m Road Reserve[1]	30m Road Reserve[1]	25m Road Reserve[1]	25m Road Reserve[1]	25m Road Reserve[1]	25m Road Reserve[1]	28m Road Reserve[1]
		2 x Travel Lanes, 3.5m wide	2 x Travel Lanes, 3.5m wide	2 x Travel Lanes, 3.5m wide	2 x Travel Lanes; 3.5m wide	2 x Travel Lanes; 3.5m wide	2 x Travel Lanes; 3.5m wide	4 x Travel Lanes; 3.5m wide	2 x Travel Lanes; 3.5m wide
		2 x Sealed Shoulder, 1.5m wide	2 x Sealed Shoulder, 1.0m wide	2 x Sealed Shoulder, 1.0m wide	2 x Parking Lanes, 3.0m wide	2 x Parking Lanes, 3.0m wide	2 x Sealed Shoulder, 1.0m wide	2 x Parking Lanes; 2.0m wide	2 x Parking Lanes; 5.5m wide
Local	Min 3 x 10^5 ESA	20m Road Reserve[1]	20m Road Reserve[1]	30m Road Reserve[1]	20m Road Reserve[1]	20m Road Reserve[1]	25m Road Reserve[1]	25m Road Reserve[1]	25m Road Reserve[1]
		2 x Travel Lanes, 3.5m wide	2 x Travel Lanes; 3.5m wide	2 x Travel Lanes; 3.5m wide	2 x Travel Lanes; 3.5m wide	2 x Travel Lanes; 3.5m wide	2 x Travel Lanes; 3.5m wide	2 x Travel Lanes; 3.5m wide	2 x Travel Lanes; 3.5m wide
		2 x Sealed Shoulder, 1.0m wide	2 x Sealed Shoulder; 0.5m wide	2 x Sealed Shoulder; 0.5m wide	2 x Parking Lanes, 2.0m wide	2 x Parking Lanes, 2.0m wide	2 x Sealed Shoulder, 0.5m wide	2 x Parking Lanes; 5.5m wide[1]	2 x Parking Lanes; 5.5m wide[1]
Access	Min 8 x 10^3 ESA	20m Road Reserve[1]	20m Road Reserve[1]	30m Road Reserve[1]	17m Road Reserve[1]	17m Road Reserve[1]	20m Road Reserve[1]	25m Road Reserve[1]	
		2 x Travel Lanes, 3.0m wide	2 x Travel Lanes, 3.0m wide	2 x Travel Lanes, 3.0m wide	2 x Travel Lanes; 3.0m wide	2 x Travel Lanes; 3.0m wide	2 x Travel Lanes; 3.0m wide	2 x Travel Lanes; 3.5m wide	
		2 x Sealed Shoulder, 0.75m wide	2 x Sealed Shoulder, 0.5m wide	2 x Sealed Shoulder, 0,5m wide	1 x Parking Lane, 2.0m wide	1 x Parking Lane, 2.0m wide	2 x Sealed Shoulder; 0.5m wide	2 x Parking Lanes; 5.5m wide[1]	

Note 1: The Road Reserve width indicated in the table is nominal only and includes a footway width of 4.5m on both sides of the carriageway. The footway width (and as such the Road Reserve width) shall be demonstrated to be adequate subject to the provisions of Clause 2.5.2.4 being met.

Note 2: The Indicative Design Traffic is based on those specified in Austroads Guide to Pavement Design. The Design Traffic to be adopted in the pavement design should be consistent with traffic counts on similar roads within the neighbourhood or development where appropriate.

2.5 Design Parameters

2.5.1 GENERAL

The design of roads shall include the following as a minimum:

- Consideration of the function of the road including the nature and volume of traffic;
- Geometric design, including analysis of existing and proposed levels, gradients and alignments;
- Formation and carriageway cross section and kerb return design;
- Intersection analysis and design;
- Earthworks requirements;
- Pavement design;
- The provision of existing and proposed services, structures and ancillary facilities;
- The provision of vehicle access to each lot;
- Construction management; and
- Any other relevant details.

Sections 2.10 and 2.11 of this document relate to Intersection Design and Pavement Design respectively.

2.5.2 ROAD RESERVES

2.5.2.1 ROAD RESERVE WIDTH

The minimum width of road reserves shall be in accordance Table 2-B.

Road reserve widths must be sufficient to accommodate the road formation, required services and utilities with approved clearances, pedestrian and bicycle access where required, parking, stormwater drainage and bus routes where development is significant.

Should the development design incorporate water sensitive urban design principles the road reserve may need to be wider than that specified in Table 2-B.

2.5.2.2 ROAD RESERVE BOUNDARIES

Road reserve boundaries may be curved, but where they are to be fenced as chords, these should not be less than 10 metres. Where a number of such chords occur adjacent to each other they shall, wherever practical, be equal in length.

2.5.2.3 CARRIAGEWAY WIDTH

The nominal carriageway widths are shown in Table 2-B.

2.5.2.4 FOOTWAY (VERGE) WIDTH

The Footway Reserve is that part of a public road exclusive of the carriageway, and is to be of width prescribed in Table 2-B for each road classification.

The nominal footway width in built-up areas is 4.5m to ensure that all required services and utilities are allocated within their allotted corridor location and width. However, this footway width may be varied where it can be demonstrated that all required services and utilities for the subdivision are provided for within the road reserve with appropriate corridor location and widths, subject to the following minimum conditions:

1. The minimum footway reserve width shall be 2.5m to satisfy the clear zone for non-frangible objects described in Note 2, associated with Table 2-H;
2. Street lighting must be provided on at least one footway reserve. The concrete footpath or shared path should be located on the same Footway reserve as the street lighting;

3. Street trees are to be provided for at the frontage of each lot as per Section 6 Landscaping for lots ≤ 4000m²; and
4. Where a footway width of less than 4.5m is nominated, a plan must be submitted with the Development Application which shows, in sufficient detail, that all services can be accommodated in each footway of each proposed road in the proposed development. Respective service clearances in line with the relevant sections of these Standards are to be maintained for all nominated service allocations.

The width of the Footway in rural areas is dependent on the nature and size of storm water drainage infrastructure, and the allocation for street trees (if required). The Footway must have adequate width so that drainage infrastructure is located wholly within the verge and does not spill onto adjoining properties. The designer shall consider the topography of the upstream and downstream catchments when determining if table drains are required on both sides of the road formation.

Notwithstanding the requirements of Table 2-B, Council may require the inclusion of paved footpaths, cyclepaths or shared paths at any location within a subdivision if warranted by existing or predicted pedestrian and/or bicycle traffic movements.

Notwithstanding the requirements of Table 2-B, the footway reserve of any commercial subdivision or development shall be concrete from the kerb to the property boundary.

Concrete footpaths shall be designed as per TRC Standard Drawing RD006 – Footpath and Shared Paths. Perambulator ramps as per Australian Standard 1428.1 shall be provided at all kerb and gutter crossings where concrete footpaths are constructed.

The service and utility allocation corridors in footways for built-up and rural areas are shown in TRC Standard Drawings G001 and G002 respectively.

The corridor allocations for services and utilities are detailed in Section 2.9.5.1 – Location of Utilities.

2.5.2.5 Footway Cross-Falls

In commercial areas where the footway reserve is to be totally paved with concrete or interlocking pavers from the kerb to the adjacent property boundary, the cross-fall is to be nominally 2% towards the carriageway edge. For areas such as concrete footpaths and paved areas, the cross-fall is to be nominally 2-3%.

In areas where the footway reserve is unpaved or partially paved, cross-fall from kerb to the adjacent property boundary is to be nominally between 2% and 6% towards the carriageway edge.

2.5.2.6 Access Roads (Shareways)

An Access Road or Shareway is defined as 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. Design parameters for Access Ways shall be in accordance with Table 2-B.

The nominal width of Access Roads shall be six metres. Access Roads of less than six metres width shall have one way vehicle movement only. Provisions for vehicle parking/passing must also be provided.

Access Roads dedicated to the public as access from or between roads, or as access to public gardens, recreation space or national parks and the like shall be designed in accordance with the design principles outlined in this document.

2.5.2.7 Pathways, Bicycle Paths and Shared Paths

A Pathway is defined as a public road of width three metres or less, generally designed for the use of pedestrians and/or cyclists as an access from or between roads.

Pathways dedicated to the public or as access to public garden and recreation space shall be cleared and formed, with a concrete path as per Section 2.5.2.4 provided centrally in the reserve unless agreed by TRC representative.

The nominal width for a pathway varies with respect to its anticipated service level; the following widths shall be observed and incorporated into the design.

Table 2-C - Minimum Pathway widths for anticipated service levels

Pathway Demand	Minimum Width (mm)
Low	1200
Medium	1500
High	Full frontage width

Low Demand – Pathway widths with this service level shall be applied where pedestrian traffic is anticipated to be low and is not expected to regularly cater for people with a disability such as development within local road reserves classified as such.

NOTE: Any pathway with a low demand level of service which deviates from an alignment that is greater than 30 degrees will require a splay which shall be designed in accordance with Australian Standard AS1428.1 – Design for access and Mobility.

Medium Demand – Pathway widths with this service level shall be applied in areas where the pathway is expected to regularly cater for people with a disability such as developments adjacent to schools and medical centres or within collector road reserves classified as such.

High Demand – Pathway widths with this service level shall be applied in areas where anticipated pedestrian traffic is high and the pathway is expected to cater for multiple user groups such as developments within the CBD and commercial areas.

All dedicated bicycle paths and shared paths shall have a minimum width of 2500mm and are to be designed in accordance with *Austroads – Guide to Road Design 6A – Pedestrian and Cyclist Paths* and TRC Standard Drawing RD006 – Footpath and Shared Paths.

Generally the maximum permissible longitudinal grade for pathways shall be 15%. Where grades are excessive, pathways shall be designed in accordance with *Australian Standard AS 1428 Design for Access and Mobility.* The maximum permissible longitudinal grade to be used in pathways providing access to public gardens and reserves shall be 8%.

Generally the maximum allowable lateral crossfall for pathways shall be 3%.

The hydraulic capacity of formed pathways must be considered where pathways are to be utilised as overland flow paths.

2.5.3 DESIGN TRAFFIC

The Design Traffic for use in road geometry and pavement thickness calculations shall be determined by analysis of existing traffic movements, through traffic, and an estimate of traffic generated by existing and future development.

For road geometry, road classification and intersection design, the principles outlined in the *Austroads Guide To Traffic Management Parts 1-12* shall be used to estimate the quantity, nature, and distribution of traffic generated by the development.

Additionally, for pavement thickness design calculations, the principles outlined in the *Austroads Guide to the Pavement Technology, Part 2 – Pavement Structural Design, Section 7 – Design Traffic* shall be used to calculate the traffic loading on the pavement.

In all cases the Design Traffic shall be that predicted at the end of the design life of the pavement as per Section 2.11.2 of these Standards and be not less than the indicative minimum in Table 2-B.

The estimation of design traffic shall refer to the Traffic Impact Assessment, completed at the development application stage that quantifies the level of impact the proposed subdivision or development will have on the local traffic environment.

Proprietary software programs may be used to quantify the level of impact on traffic distribution; however, the software must be a recognised industry standard and a comprehensive list of set-up parameters used to obtain results from the software is to be submitted along with the detailed design documentation.

For the purposes of determining the existing traffic volumes of roads that may impact on the proposed development, Council shall make available to the developer, where available, existing traffic count data and any other such information relevant to the development.

For pavement design calculations, consideration shall be given to the impact of construction traffic on the newly constructed pavement. It may be necessary to increase the overall pavement depth to ensure the pavement is of sufficient strength to cater for traffic loads during construction of housing, commercial buildings etc. A staged construction design approach may be adopted to manage the impact of construction traffic.

2.5.4 DESIGN SPEED

The Design Speed to be adopted for the design of new roads shall be the greater of the selected 85th percentile desired speed[2] for the section of road being designed and the prevailing speed limit.

2.5.5 DESIGN VEHICLES

The Austroads Design Vehicles and Turning Path Templates Guide - 2013 are to be used as the basis for design vehicles. Design vehicles are to be designed for the 5 to 15km/h design turning speed. A check shall be performed using an appropriate checking vehicle to demonstrate satisfactory operation of larger vehicles. Design and checking vehicles to be used for Vehicle Turning Movement and Intersection Design calculations are shown in Table 2-D.

Table 2-D - Design & Checking Vehicles for Roads

Road Classification *(as per Section 2.4.2)*	**Design Vehicle**	**Checking Vehicle**
Arterial	As required at minimum: Prime Mover and Semi-Trailer (19m)	As required
Sub-Arterial	As required at minimum: Prime Mover and Semi-Trailer (19m)	As required
Industrial	As required at minimum: Prime Mover and Semi-Trailer (19m)	As required at minimum: B-Double (26m)
Collector	Design Single Unit Truck/Bus (12.5m)	Prime Mover and Semi-Trailer (19m)
Local	Design Single Unit Truck/Bus (12.5m)	Prime Mover and Semi-Trailer (19m)
Access	Design Single Unit Truck/Bus (12.5m)	Prime Mover and Semi-Trailer (19m)

2.6 Geometric Design

2.6.1 GENERAL

Designers of roads shall clearly demonstrate consideration of the following elements as a minimum:

- Smooth, safe, trafficable horizontal and vertical alignments;

[2] A method for determining the desired speed for a road is contained in the *Austroads Guide to Road Design – Part 3: Geometric Design*

- Adequate sight distance with consideration being given to the road classification requirements;
- A safe and efficient speed environment;
- Safe vehicular and pedestrian access to each allotment;
- Provision for utilities and stormwater drainage;
- Access provisions and sight distance from/to each lot;
- Stopping sight distances from all locations;
- The speed environment created by the alignment;
- Provision for stormwater drainage;
- Provision for services and utilities; and
- Hydraulic analysis if the road formation is to be utilised as an overland flow path.

The geometric design of roads is to be based on the principles of the *Austroads Guide to Road Design – Part 3: Geometric Design*, and all publications referenced therein.

2.6.2 SCOPE OF DESIGN

Road horizontal and vertical alignment designs are required to be extended a minimum of 100m beyond the extent of the development where there is a possibility of the road being extended by future development stages. Where new roads intersect with existing roads, the intersection shall be designed in accordance with Section 2.10.

2.6.3 SIGHT DISTANCE

Designers must consider stopping sight distances in the geometric design, and these shall be determined as per the procedure in the *Austroads Guide to Road Design – Part 3: Geometric Design – Section 5 – Stopping Distance*.

Landscaping plans shall be prepared with consideration given to sight distance requirements, as shall any proposal for "Estate Entrance Structures". Design drawings submitted for approval shall show all existing and proposed features in sufficient detail to demonstrate that appropriate sight distances are achieved.

2.6.4 HORIZONTAL ALIGNMENT AND CURVES

The minimum radius of horizontal curves shall be:

Table 2-E - Minimum Radius of Horizontal Curves for Roads

Minimum Deflection Angle	Minimum Radius (m)
75° - 110°	25
60°	33
40°	65
30°	75
20°	100

Where the deflection angle is 90° and travel speed is not an issue, the minimum radius of horizontal curves is to be related to the greater of Table 2-E or the turning requirements of the applicable Design Vehicle as detailed in Table 2-D. For angles not shown in Table 2-E interpolation should be used.

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

2.6.5 VERTICAL ALIGNMENT

Longitudinal Gradients shall be designed to comply with the following absolute limits:

Table 2-F - Absolute Limits for Longitudinal Gradients on Roads

Gradient Type	Value
Maximum permissible grade on an arterial road	8.0%
Minimum permissible grade on an arterial road	1.0%
Maximum permissible grade on all other road categories	16.0%
Maximum distance maximum grade is to be adopted in any one location	150m
Minimum permissible grade on all other road categories	1.0%
Maximum permissible grade adjacent to street intersections, locations of poor visibility, horizontal curves of 15m or less and at cul-de-sacs	10.0%
Maximum grade of turning circles in cul-de-sacs	5.0%

Drainage requirements on steep grades will typically involve the incorporation of special structures and extensive piping of easements. Developers may find it more economical to avoid the use of steep grades to negate the need for the use of such structures.

Gutters or open channel drains are to have a minimum grade of 1% and consideration shall be given to increasing the minimum grade where changes of direction or drainage concentration occur.

Where the grade of open channel drains incorporated into the road formation design exceeds 6%, a concrete lined drain shall be required.

2.6.6 VERTICAL CURVES

Vertical curves shall be provided at all changes in grade and consideration shall be given to the combination of vertical curves with any horizontal curves. Vertical curves are to be designed in accordance with *Austroads Guide to Road Design Part 3*.

2.6.7 SUPER-ELEVATION

Super-elevation of curves is generally not considered necessary in built-up areas; however, if required in rural areas or roads with high design speeds, the design of such curves shall be carried out in accordance with the *Austroads Guide to Road Design – Part 3: Geometric Design, Section 7.7 - Superelevation*.

The maximum super-elevation of a curve in a built-up area shall be 4.0%. The maximum super-elevation of a curve in a rural area shall be 7.0%.

2.6.8 PAVEMENT CROSS-FALL

The nominal cross-fall on all pavements shall be 3.0%.

The maximum cross-fall will generally occur on super-elevated curves and road intersections, and this must be clearly indicated on design drawings.

The relative change in cross-fall of kerb line and centreline is not to exceed 0.5%.

2.6.9 ONE-WAY CROSS-FALL

One-way cross-falls will only be considered where a two-way cross-fall cannot be reasonably achieved due to the topography of the site. The nominal cross-fall for one-way cross-falls shall be 3%. Where the design of the road includes the provision of kerb and gutter as per Table 2-A, Semi-Mountable Kerb shall be installed on the high side of one-way cross-falls.

Consideration shall be given to the hydraulic capacity of the carriageway cross-section in drainage calculations for one-way cross-falls.

2.6.10 CROWN OFF-SETS

In areas of difficult terrain where it is not desirable to have the crown on the centre of the road, the crown may be relocated towards the higher side of the road, provided that the new location is located at the outer edge of the travel lane OR at the interface between travel lanes and parking lanes.

2.6.11 CUL-DE-SACS

The radius of a cul-de-sac bowl shall not be less than 10.0 metres. The provision of stormwater drainage in cul-de-sacs, including the provision of easements or drainage reserves at cul-de-sac heads, shall be given careful consideration to avoid trapped low points.

2.6.12 SPLIT-LEVEL CARRIAGEWAYS

If the topography of a development or subdivision necessitates split level construction of a road, the road reserve shall be sufficiently widened from that detailed in Table 2-B to include the minimum formation width as well as the provision of a median island.

Medians shall consist of a permanently retained batter not steeper than 4(V) in 1(H) and constructed of structural concrete, stone pitch or proprietary keystone blocks. All retaining walls are to be designed by an appropriately qualified structural engineer. The cross-fall of each carriageway is to be one way towards the outer carriageway edge.

Barrier Kerb shall be provided along all median edges to prevent mounting by vehicles.

Consideration shall be given to the warrant for a safety barrier along a median of a split-level carriageway in accordance with Section 2.9.1 of these Standards.

Lengths of split level carriageway exceeding 100m will not be permitted nor may split level carriageways traverse through intersections.

2.6.13 INTERSECTIONS AND ROUNDABOUTS

For the geometric design parameters for intersections and roundabouts, refer to Section 2.10.

2.7 Formation Design

2.7.1 PAVEMENT DESIGN

For the design parameters of pavements, refer to Section 2.11 – Pavement Design.

2.7.2 KERB AND CHANNEL

Where required in Table 2-A or otherwise, kerb and gutter shall be designed to address drainage requirements and to adequately and safely provide both vehicular and pedestrian access to each allotment.

Where it is considered impractical to construct an isolated section of kerb and gutter and road pavement, Council may require the developer to pay a contribution in lieu of construction, based on the estimated full cost of the works calculated by Council.

Kerb and gutter shall be of the type ‘Integral Kerb and Gutter’ for all arterial, sub-arterial and collector roads as detailed in Table 2-B, and type ‘Roll Type Kerb and Gutter’ for local and access roads. All commercial and industrial areas (zoned B1-B7 and IN1-IN3 as shown in Table 2-B) shall have type ‘Integral Kerb and Gutter’.

Notwithstanding the requirements of Table 2-B; where a road carriageway is to be utilised as an overland flow path for stormwater drainage, the kerb and gutter shall be of type ‘Integral Kerb and Gutter’ in accordance with TRC Standard Drawing RD003.

2.7.3 VEGETATION REMOVAL

Road reserves in urban areas shall be cleared of all vegetation for the full width and 0.5 metres past the lot boundaries. Where it is proposed to remove any trees with a trunk diameter greater than 150mm as measured 600mm above natural surface, the location of such trees shall be shown

on the design drawings and Council shall be consulted to determine the environmental significance of the trees.

2.7.4 BATTERS

For rural road design cut and fill batters in road reserves shall not be steeper than 1(V) in 2(H) in cuttings and 1(V) in 3(H) in embankment. If the maximum grade in a cut and fill batter cannot be accommodated within these boundaries, the road reserve shall be widened accordingly. Cut and fill batters in rural areas shall lie wholly within the road reserve, and if necessary the road reserve shall be widened to accommodate the batters.

All formed batters shall be vegetated with topsoil and appropriate grass species. The developer shall provide details of the proposed grass species to be used.

Batters in cuttings shall have concrete or other proprietary lining type catch-drains at the top of the batter incorporated into the stormwater drainage design. The type and location of all batter catch-drains shall be clearly shown on the design drawings.

Where any cutting or filling in a road reserve may undermine or compromise the structural integrity of an existing structure either in the road reserve or on the adjacent land, a structural retaining wall shall be required to retain either the existing structure or the batter.

2.7.5 ROAD EMBANKMENTS

Where road embankments exceed two metres in height as measured vertically from the top of the batter to the toe, the requirement for safety barrier fencing shall be determined in accordance with Section 2.9.1 of these Standards.

Notwithstanding this, safety barrier fencing shall not be used on road boundaries adjacent to residential allotments in built-up areas.

2.7.6 FORMATION ENCROACHMENT INTO LOTS

Where road cut or fill batters cannot be accommodated within the road reserve the batters may extend into proposed lots. The maximum grade of batters within a lot shall be 1(V) in 10(H). Note that footway cross-falls are to be in accordance with Section 2.5.2.5**.**

2.7.7 VEHICULAR CROSSINGS AND ACCESSES

Each allotment shall include provision for vehicular crossings from the carriageway in accordance with Table 2-G. The responsibility for construction of vehicular crossings in roads with kerb and gutter may be assigned to new property owners. In such instances, appropriate measures must be taken to protect the integrity of the kerb and gutter during both subdivision and housing construction.

Table 2-G - Vehicle Crossings

Access Description	Allotment Type	
	Residential	Commercial/ Industrial
Maximum number of crossings per street frontage	2	2
Width of crossing at edge of road	4.5m – 6.0m	6.0m – 9.0m
Minimum distance from crossing to corner allotment boundary	6m	6m
Minimum kerb separation distance between crossings	2m	2m
Minimum separation distance between crossings and common property boundary	0.5m	0.5m

Roads shall be located and designed so that vehicular access can be readily obtained to every allotment of a development, and shall be designed such that the B99 Vehicle as detailed in *Australian Standard 2890.1 – Parking Facilities; Off Street Car Parking* can satisfactorily enter or exit the allotment. Consideration shall be given to access for emergency vehicles and towed vehicles such as caravans, trailers and horse floats for roads in rural areas.

Vehicle accesses shall be designed to cross the footway reserve perpendicular to the longitudinal road alignment.

For roads where 'Integral Kerb and Gutter' is used, concrete laybacks designed in accordance with TRC Standard Drawings RD008 and RD009 shall be provided for all vehicle crossovers. Laybacks shall be designed such that the height at the back of the layback is at a minimum equal to the height of the adjacent kerb and gutter to ensure the drainage characteristics of the kerb and gutter are not compromised. The use of driveway risers shall not be permitted.

Vehicular crossings that cross open channel drains shall include one of the following:

a) A piped culvert, unless the location of the access is at an obvious high point. The minimum width of culverts shall be 4.5 metres. All culverts shall have a headwall at each end of the piped culvert. Refer to TRC Standard Drawing RD010.

b) A concrete causeway in accordance with TRC Standard Drawing RD010. Details of the proposed vehicular crossing are to be provided with design drawings;

c) For access to non-residential lots - A gravel lined drain. Details of the proposed vehicular crossing are to be provided with design drawings;

d) Culverts across open channel drains shall be designed with the following hydraulic capacity:

- The culvert shall be designed in accordance with 3.7.3.7.
- 1 in 5 year ARI (minimum) capacity before property culvert overtops; and
- Requirements of section 3.8 shall be met.

The minimum size for piped culverts is to be 450mm diameter in rural areas and 375mm diameter in rural residential areas. Pipes shall be laid such that the invert of the pipe matches the invert of the adjacent open channel drain.

Vehicle crossings that cross major system overland flow paths shall not be permitted to have a piped culvert and shall have a concrete causeway as per b) above.

Where the wearing surface of the road adjacent to the vehicle crossing is a bitumen seal or is designed to be constructed with a bitumen seal, vehicle crossings shall be sealed with asphalt, concrete or bitumen from the edge of the pavement seal to the property boundary. Suitable scour protection shall also be provided on the batter slopes of vehicle crossings.

Gated accesses in rural areas or areas where the posted speed limit for the road is greater than 80km/h shall have the gate recessed into the property such that no part of the design vehicle (including provision for trailers, floats or caravans) protrudes into the road formation whilst stationary.

The design of vehicle crossings in rural or high speed developments shall have regard to the geometric, spacing and sight distance requirements of Section 2.10 of this document as well as *Austroads Guide to Road Design – Part 4; Intersections and Crossings, Genera*l.

2.7.8 STAGED ROAD CONSTRUCTION

Where roads are constructed in stages of a subdivision, a permanent barricade (minimum D4.5 sign) conforming to *AS1742.3 – Manual for Traffic Control Devices* shall be constructed at the end of the road to warn motorists of the termination of the road and to prevent their passage beyond.

A temporary bitumen sealed cul-de-sac designed in accordance with Section 2.11 shall be designed and constructed at the end of staged road developments. In cases where the design for the stage includes a stub road servicing single corner lots, Council may approve the stub road

without the requirement for a temporary cul-de-sac, provided that it is demonstrated by the developer (either by inclusion of concrete driveways on the CCS plans or by another similar method) that access to the corner lots will be achieved from the primary road at the time of construction.

Temporary cul-de-sacs shall be dedicated as public road reserve or included under a right of way on the plan of subdivision. This Right of Way shall be extinguished when the particular road is extended into the next stage of the development. The Right of Way shall be sized to allow for motorists and garbage trucks to turn around completely within it. Pavements under temporary cul-de-sacs are to be constructed as per the approved pavement design.

Barricades and temporary pavements are to be removed only upon completion of construction of the adjoining stage.

2.8 Local Area Traffic Management - Regulatory Signs

All traffic signs, pavement markings, pedestrian and traffic management devices must be designed and implemented in accordance with the relevent Roads and Maratime Services (RMS) Technical Directions and Guidelines, Austroads Design Guidelines and Australian Standards.

Council shall refer all regulatory traffic related matters and requests for changes to speed zones to the Local Traffic Committee (LTC) prior to exercising its delegated functions under the *Road Transport (Safety & Traffic Management) Act, 1999* and the *Roads Act, 1993.*

Where Local Area Traffic Management (LATM) devices are required as a condition of development consent, these devices shall be designed and installed in accordance with *The Austroads Guide to Traffic Management – Part 8; Local Area Traffic Management*, and *Australian Standard 1742.13 - Local Area Traffic Management*. The type and location of any LATM devices shall be clearly shown on the design drawings.

Traffic control facilities and prescribed traffic control devices may be authorised for use on a road or road related area, whether a public road or on private land, only by the RMS or Councils. In addition, traffic may be regulated for various purposes by means of notices or barriers erected by a roads authority.

Tamworth Regional Local Traffic Committee review and RMS approval is required for all LATM devices. Speed zones and special use areas (shared zone, high pedestrian activity area) must be authorised by the RMS. Contact the RMS and the NSW Centre for Road Safety for details on the requirements.

2.9 Ancillary Facilities

2.9.1 SAFETY BARRIER FENCING

The requirement for the use of safety barrier fencing shall be as per the principles outlined in the *Austroads Guide to Road Design, Part 6 – Roadside Design, Safety and Barriers*.

Barrier fencing shall be designed and installed as per *Australian Standard AS3845 – Road Safety Barrier Systems*.

2.9.2 STREET BLADES

Street blades are to be designed, manufactured and erected in accordance with *Australian Standard 1742.5 - Manual of uniform traffic control devices - Part 5: Street Name and Community Facility Name Signs* and TRC Standard Drawing G003.

All street blades shall be reflectorized as per Clause 2.7 of *AS1742.5*.

The installation of community facilities signs shall not be permitted without the prior approval of the Director.

2.9.3 SIGNPOSTING, LINEMARKING AND GUIDE POSTS

The design, location and installation of signs, line markings and guide posts shall be in accordance with *Australian Standard AS1742 – Manual of Uniform Traffic Control Devices Part 2 – Traffic Control Devices for General Use*. The location of signs, line markings and guide posts shall be shown on a dedicated design plan.

2.9.4 STREET LIGHTING

Where required in Table 2-A or otherwise; street lighting shall be provided on roads and designed in accordance with the Australian Standard for Public Lighting AS 1158.

Street lights shall be designed to maximise energy efficiency. Street lights shall generally be of the following types:

- Nominal 17 Watt LED for all Category P lighting; and 250 Watt High Pressure Sodium for Category V lighting when LED technology is not suitable.

Where practical, street lights should be located adjacent to the property boundary in a staggered or alternating pattern on either side of the road reserve, and designed such that the light is directed towards the centre of the road reserve whilst ensuring that pedestrian facilities such as formed footpaths benefit from the light. The interaction of the street light with street trees should be given careful consideration.

The design of the subdivision or development shall include consideration of the requirements for the provision of street lighting at intersections, pedestrian crossings and other areas of high pedestrian or vehicular traffic.

2.9.5 PROVISION OF UTILITIES

2.9.5.1 LOCATION OF UTILITIES

The provision of utilities within the road reserve shall be as per TRC Standard Drawings G001 and G002. Utilities shall not be installed beneath the floor or batters of open channel drains or other drainage structures.

The minimum corridor widths and footway allocations for utilities and services are as per Table 2-H.

Table 2-H - Utility and Service Corridors and Offsets

Utility or Service	Minimum Corridor Width (mm)	Corridor Offset From (mm)	Corridor Offset To (mm)
Street Lighting	300	Property Boundary	300mm from Property Boundary
Electricity Distribution	900 *Note 2*	300mm from property boundary	1200mm from property boundary
Telecommunications	900 *Note 1*	300mm from property boundary	1200mm from property boundary
Natural Gas	900 *Note 1*	300mm from property boundary	1200mm from property boundary
Telecommunications trunk lines and NBN Co. Infrastructure	600	300mm from property boundary	1200mm from property boundary
Sewer	600	1800mm from property boundary	2400mm from Property boundary
Street Tree	1200 *Note 3*	Edge of street tree to be minimum 3500mm from edge of travel lane *Note 2*	
Water	600 *Note 4*	Centre of water main corridor to be 900mm from face of kerb	
Concrete footpath	1200	600mm from property boundary	1800mm from property boundary

- Note 1: The corridor width for electricity, telecommunications and natural gas is based on the use of shared trenching as per the provisions of the *NSW Streets Opening Conference Guide to Codes and Practises for Streets Opening.* Approval for shared trenching should be sought from the relevant utility providers prior to submission of the design drawings.
- Note 2: The clear zone for non-frangible objects in the road reserve shall be nominal 3500mm from the outside edge of the adjacent travel lane.
- Note 3: The separation distance of any utilities, services or other infrastructure from a street tree shall be no less than 600mm as measured from the centre of the tree.
- Note 4: Water main corridor overlaps street tree corridor by 300mm. Centre of water main corridor to be 900mm from face of kerb.

2.9.5.2 UTILITIES ROAD CROSSINGS

All trenches and conduits under roads shall be installed at a grade of not less than 0.5% and shall be clearly marked on design drawings.

Utility crossings under roads shall be completed prior to construction of the pavement base course layer. Where utilities are to be installed after construction of the pavement is complete, these shall be underbored with minimal disturbance to the pavement.

Where the diameter of the utility conduit is greater than 250mm, open trenching shall be permitted. Re-instatement of the pavement in open trenches shall be as per 2.11 of these Standards. The provision of utilities in shared trenches shall not be permitted unless the prior approval of the relevant utilities authority is obtained.

All road crossings shall be designed perpendicular to the centreline of the road.

2.9.5.3 ELECTRICITY DISTRIBUTION UTILITIES

All electrical power shall be distributed as per the requirements of Table 2-A or DA consent. Consultation with the appropriate electricity distribution authority regarding the provision of electricity distribution shall be required.

Electrical plans shall be submitted to Council for review. Council will approve draft plans prior to final approval by the Electrical Authority. Any revisions to the electrical plans shall be submitted to Council for review prior to construction.

2.9.5.4 ELECTRICITY ROAD CROSSINGS AND TRANSMISSION EASEMENTS

Where proposed roads intersect with existing or proposed electricity transmission easements, consultation with the appropriate electricity distribution authority regarding acceptable minimum ground clearances to the distribution infrastructure within the easement shall be necessary.

If a subdivision is created over an electricity easement, The Electrical Authority may require the provision of vehicular access along the easement.

2.10 Intersections

2.10.1 GENERAL

The design of intersections shall consider the following criteria:

- The efficient movement of traffic through the intersection and distribution of this traffic throughout the development or subdivision;
- The relationship between the intersection type and the horizontal and vertical alignments of the intersecting roads;
- Analysis and treatment of conflict points created by traffic movements through the intersection;
- The safety of motorists, pedestrians and cyclists negotiating the intersection;
- Provision for pedestrian movements;

- The speed environment created by the intersection; and
- The amenity and location of the intersection.

The type of proposed intersections should be selected in accordance with the *Austroads Guide To Traffic Management, Part 6 – Intersections, Interchanges and Crossings* and designed according to the *Austroads Road Design Guide*.

Intersections shall generally comprise of T-junctions or staggered T-junctions. Where T-junctions are considered impractical, four-way intersections or cross-intersections may be proposed; however, these shall be controlled by the most suitable traffic management devices as identified in the Traffic Impact Assessment or other methods, based on warrant.

Where staggered 'T'-junctions are proposed, the distance between the centrelines of the minor roads shall be located a minimum distance of 2 x SSD (Stopping Sight Distance) apart for the adopted Design Speed calculated using a 1.5 second reaction time.

Roads shall not be designed to intersect at an angle less than 70º.

All proposed junctions with classified roads shall have a design reaction time of 2.5 seconds when calculating intersection stopping distances.

Landscaping plans, including any proposed "Estate Entrance Structures", shall be prepared for intersections with consideration given to sight distance requirements, and all landscaping and vegetation shall be designed to require minimum ongoing maintenance.

Design plans shall show all existing and proposed intersection features in sufficient detail to demonstrate that appropriate sight distances are achieved.

2.10.2 DESIGN TRAFFIC

The quantity, nature and distribution of traffic shall be determined as per the requirements of Section 2.6.2 – Design Traffic.

2.10.3 WARRANTS FOR INTERSECTION TREATMENT TYPE

Warrants for the selection and use of intersection treatment types shall be determined using the procedure outlined in *Austroads Guide to Traffic Management, Part 6, Section 2.3.6 - Warrants for BA, AU and CH Turn Treatments* where one or more of the following design criteria are met:

- All arterial and sub-arterial roads;
- The design speed exceeds 80km/h for built-up areas or is equal to or greater than 100km/hour in rural developments;
- The design traffic for either the minor or major road exceeds 1000 AADT; and
- A four-way intersection or cross-intersection is proposed.

For existing intersections, the level of service achieved by the intersection for the design traffic generated by the development or subdivision shall be clearly demonstrated as per the method described in the *Austroads Guide To Traffic Management*.

For new intersections, the intended level of service provided by the proposed intersection treatment type selected shall be clearly demonstrated as per method described in the *Austroads Guide To Traffic Management.*

When considering levels of services provided by intersections, the designers must consider the traffic generated following the ultimate growth of the development or subdivision.

2.10.4 VEHICLE TURNING MOVEMENTS

Notwithstanding the requirements of the *Austroads Road Design Guide Part 4*, vehicle turning movements at intersections are to be designed using the *Austroads Vehicle Turning Templates*.

Sufficient carriageway width shall be provided such that the swept path of a Design Vehicle (as per Table 2-D) making a turning movement is contained wholly within the travelled lane. The design

vehicle must be able to make a turning movement in a single forward motion without the need to use vehicle accesses, driveways, parking lanes or lanes in the opposite direction of travel.

It is also necessary to check the proposed road layout using the next larger design vehicle template to ensure that occasional use by vehicles larger than the chosen design vehicle is viable. In this case, the larger vehicle may be allowed to encroach into other traffic lanes (including the opposing traffic direction if the intersection is unsignalised), and travel over specially designed parts of traffic islands.

2.10.5 ROUNDABOUTS

Where a roundabout is either proposed or required to be constructed as an intersection treatment type, it shall be designed in accordance with the Austroads Guide to Road Design, Part 4B – Intersections and Crossings – Roundabouts.

Where the centre median island of a proposed roundabout is to be landscaped, the type of landscaping proposed shall be shown on the design drawings and included in the landscaping plan, and shall be designed to require minimum maintenance. Any proposed roundabout landscaping shall not interfere with the design sight distances of the roundabout.

2.10.6 SIGNALISED INTERSECTIONS

Where a signalised intersection is either proposed or required to be constructed as an intersection treatment type, it shall be designed in accordance with the Austroads Guide to Road Design, Part 4A – Intersections and Crossings – Unsignalised and Signalised Intersections subject to Local Traffic Committee requirement outlined in Section 2.8 and RMS approval.

2.11 Pavement Design

2.11.1 GENERAL

This Section outlines the minimum requirements for the design of road and carpark pavements.

2.11.2 PAVEMENT DESIGN LIFE

Pavement designs are to be undertaken based on a minimum design life of:

Table 2-I - Pavement Design Life

Type of Pavement	Minimum Design Life
Flexible pavements, either unbound granular or containing one or more modified layers	40 years
Segmental block pavements (pavers)	40 years
Rigid pavements (concrete)	40 years

2.11.3 PAVEMENT DESIGN PROCEDURE

Pavement design criteria is to include but not be limited to the following:

Table 2-J - Pavement Design Criteria

Element	Applicable Section
Projected traffic loadings	2.11.4
Subgrade evaluation	2.11.5
Environmental Factors	2.11.6
Materials	2.12
Construction methods	Specification

A flexible pavement design report shall be prepared by a person with suitable experience in geotechnical investigations or an Engineer, and shall include the following as a minimum:

1. Evaluation and reporting of the subgrade material;
2. Subsoil drainage conditions;
3. Design Parameters used in accordance with these Standards;
4. The calculated nominal layer thicknesses;
5. Details of the materials to be used in the pavement construction; and
6. Wearing surface type and properties.

2.11.4 DESIGN TRAFFIC

The Design Traffic for use in pavement design calculations shall be determined as per Section 2.5.3.

2.11.5 SUBGRADE EVALUATION

Subgrade strength characteristics used in the pavement depth design shall be determined by sampling, testing and reporting in accordance with *AS1289 - Method of Testing Soils for Engineering Purposes.*

Sampling shall be random in accordance with *AS1289.1.4.1*. Additional sampling may be required in the bowls of cul-de-sacs, at intersections and at all locations where existing subgrade conditions change suddenly as directed by the Director.

Subgrade material testing and reporting shall consist of the following:

- California Bearing Ratio (CBR);
- In-situ Dynamic Cone Penetrometer (DCP) and
- Linear Shrinkage of sampled material.

2.11.6 ENVIRONMENTAL FACTORS

The following environmental factors shall be considered during the pavement design process:

- The identification and treatment of ground water;
- Natural drainage including sub-soil drainage;
- The presence of acid sulphate soils;
- The presence of erosion prone soils such as silt, buried landfill and waste dumps;
- The impacts of appropriate preventative or remedial treatments as necessary.

2.11.7 PAVEMENT TICKNESS DESIGN

A compliance survey shall be undertaken at subgrade level to verify the design pavement thickness has been constructed. Three readings will be taken at each chainage marker; one on each side of the road (on the line of the lip of kerb/road shoulder), and one at the centreline. Subgrade levels shall be displayed in tabular format.

The Submission of subgrade conformance levels is to be included as a Hold Point prior to importing of sub base material.

Notwithstanding the above, the compliance survey shall be undertaken by a registered surveyor or a professional civil engineer and a copy of the compliance survey and subgrade level table can be submitted at the same time as the WAE plans (at the developer's risk); however, it is the preference of Council that the compliance survey is submitted separately and prior to the WAE plans. The compliance survey shall demonstrate, as a minimum, that the pavement thickness (as per the pavement design) is achieved.

The nominal pavement design shall be determined using the empirical procedure outlined in the *Austroads Guide to Pavement Technology - Part 2: Pavement Structural Design, Section 8.3.*

Pavements with an asphalt wearing surface 50mm or thicker may have the asphalt thickness included in the overall pavement depth, but shall not have the asphalt thickness included in the depth of base-course material.

2.11.8 PAVEMENT TREATMENT FOR GRANULAR OVERLAY

Where an existing pavement is proposed to be treated with a granular overlay, if the existing pavement has a thin bituminous seal within 300 mm of the finished surface level, the existing seal shall be removed or broken to ensure that water is not trapped in the overlay.

2.12 Materials Selection

2.12.1 PAVEMENT GRANULAR MATERIALS

Details of the materials source and properties proposed for use in the pavement shall be submitted as part of the pavement design report. The following information is required as a minimum:

Table 2-K - Pavement Materials

Property
Material Source
Material Type
Representative CBR Value
Particle Size Distribution
Atterburg Limits

Materials proposed to be used in the pavement shall have the following minimum properties:

Table 2-L - Pavement Materials Limits

Pavement Layer	Property	Required Value
Sub-Base Course	CBR	Minimum 30
	Plasticity Index (PI)	Maximum 12
Base Course	CBR	Minimum 80
	Plasticity Index (PI)	Maximum 6
All layers	Particle Size Distribution	Material is to be classed as "well-graded granular material"

2.12.2 WEARING SURFACE

2.12.2.1 ROADS WITH ASPHALT WEARING SURFACE

Where a road is to have an asphalt wearing surface as Table 2-A, it shall consist of a minimum nominal 30mm layer of AC10 dense graded asphalt.

Asphalt mix designs prepared in accordance with the *AAPA National Asphalt Specification*, including NATA certified test reports of previous applications shall be submitted as part of the pavement design report.

Pavements that are designed with an asphalt wearing surface shall have a cutback bitumen primerseal applied prior to application of the asphalt. The primerseal shall consist of the following:

Table 2-M - Primerseal Design

Element	Type Required	Conformance Standard
Binder	As per pavement design report	AS2157
Aggregate	Nominal 7mm	AS2758.2

The primerseal is to extend full width between kerbs and the bitumen shall be applied to the kerb/pavement interface as well as the lip of kerb. Care should be taken to ensure no bitumen is applied to the face of kerb or channel.

A seal design consisting of the proposed aggregate and binder sources and properties and the application rates for both shall be provided to Council prior to works commencing.

Application of asphalt wearing courses shall only be permitted where it can be clearly demonstrated that all volatile compounds from the primerseal have evaporated.

2.12.2.2 ROADS WITH BITUMEN SEAL

Where a road is to have a sprayed bitumen seal wearing surface as per Table 2-A, the seal shall conform to the following:

Table 2-N - Bitumen Seal Design

Element	Type Required		Conformance Standard
	Industrial or Rural	Urban	
Type Of Seal	Two-Coat Bitumen Seal		N/A
Binder	Cutback Bitumen either C170, C240 or C320		AS1357
Aggregate - 1st Application	Nominal 20mm	Nominal 14mm	AS2758.2
Aggregate – 2nd Application	Nominal 14mm	Nominal 10mm	AS2758.2

A seal design consisting of the proposed aggregate and binder sources and the application rates for both, including the design parameters used to determine these rates, shall be provided to Council. The seal design shall also detail the method of application of the seal, including any proposals to undertake both applications on the same day.

Bitumen sealing shall extend the full width of the carriageway, including shoulders and parking areas.

2.12.2.3 ROADS WITH UNSEALED GRAVEL PAVEMENT

Where a road is to have an unsealed gravel wearing surface as per Table 2-A, the wearing surface shall have the following desirable characteristics:

- Skid resistance;
- Smooth riding characteristics;
- Well-graded with a maximum size of 26mm;
- Cohesive properties;
- Resistance to ravelling and scouring;
- Wet and dry stability;
- Low permeability; and

- Load spreading ability.

The wearing course material used for unsealed roads shall also conform to the following:

Table 2-O - Gravel Wearing Surface Design

Sieve Size (mm)	Percent Passing
55	100
37.5	100
26.5	100
19	90 – 100
2.36	35 – 65
0.425	15 – 50
0.075	10 – 40
Plasticity	Maximum 12

Details of the proposed material to be used in the construction of the wearing surface of unsealed roads shall be provided to Council for approval prior to works commencing.

2.12.2.4 INTERSECTIONS AND ROUNDABOUTS

Consideration shall be given to the selection of the wearing surface for intersections and roundabouts, particularly for high stress environments where the design traffic includes a high percentage of heavy vehicles.

As a minimum, all roundabouts shall be surfaced with a minimum nominal 50mm thick layer of AC14 dense graded asphalt containing a polymer-modified binder. The wearing course for roundabouts shall extend to the commencement of the central splitter islands at each approach. The wearing course for intersections shall extend 30m into each intersection approach.

Mix designs for roundabouts shall be prepared and submitted in accordance with Section 2.12.2 of these Standards.

2.12.3 PAVEMENT CROSS-SECTION

2.12.3.1 ROADS WITH KERB AND GUTTER

The pavement sub-grade and sub-base layers shall be designed to a minimum 500mm behind the invert of kerb see TRC Standard Drawing RD002.

2.12.3.2 ROADS WITHOUT KERB AND GUTTER

All pavement layers shall be designed for the full width of the carriageway, including parking lanes and shoulders.

Where pavements are constructed on formed batters, the pavement layers shall extend the full width of the batter.

2.12.3.3 SUB-SOIL DRAINAGE

Where in-situ natural drainage conditions warrant consideration of the use of sub-soil drainage, the design of such shall be in accordance with the *Austroads Guide to Pavement Technology – Part 10; Subsurface Drainage* and in accordance with TRC Standard Drawing SW010. The type and location of all sub-surface drainage systems shall be clearly shown on the design drawings.

2.13 APPENDIX A – Information to be shown on Drawings – Road Design

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
1)	**General**			
a)	Cover Sheet with Locality Plan and List of Drawings			
b)	Plans prepared in A1 format, drawn at an appropriate scale to provide sufficient detail			
c)	Drawing Scale is shown on drawings as a bar scale on each sheet.			
d)	Scale of Detail Drawings is shown as appropriate at 1:100, 200, 250, 500, 1000, 2000			
e)	Schedule of Symbols			
f)	Benchmark within 100 metres of development site is shown			
g)	North Point shown			
h)	Site topography is shown via contour lines			
i)	Datum reference incl. Benchmark at A.H.D adopted by N.S.W. Dept. of Lands			
j)	Each plan to be numbered with revision no. and revision schedule			
k)	Road names or number			
l)	Drawings to be signed by respective Consultant / Engineer			
m)	Lettering, line work and symbols to conform to AS 1100			
2)	**Road Layout Plans**			
a)	Existing Services and structures are shown			
b)	Lot boundaries and numbers shown			

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
c)	Road Hierarchy, Classification and formation width for each road is shown			
d)	Road centreline chainages, radii, tangent points superelevation critical points and deflection angles shown			
e)	All turning movements have been checked for swept path compliance with design and checking vehicles.			
f)	Critical vehicle turning movements are shown on separate plans, including turning at intersections and cul-de-sacs			
g)	Road reserve widths indicated			
h)	Road formation widths indicated			
i)	Road carriageway widths indicated			
j)	Proposed utilities locations and offsets are shown and tabulated (typical section only)			
k)	Utilities crossings shown			
l)	Vehicular access crossings are clearly shown, are at appropriate locations and details are clearly documented.			
m)	Kerb or open channel drain profiles are clearly nominated			
n)	Radii on kerb returns and kerb lines shown			
o)	Internal intersections to the development are shown in sufficient detail to support proposed design, including proposed kerb radii			
p)	External intersections to the development are shown in sufficient detail to support proposed design, including proposed kerb radii			
q)	Proposed Street Names are nominated			
r)	Footpaths are located on plan at correct offset and dimensions and details are indicated (typical section only)			
s)	Shared paths are clearly shown and dimensions and details are indicated (typical section only)			
t)	Location of signage, safety barriers and line marking is shown			
u)	Topographic contours and intervals are clearly shown			

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
v)	Cut and Fill batters shown			
3)	**Road Longitudinal Sections**			
a)	Longitudinal sections are drawn at scale of 1:500 horizontal and 1:100 vertical			
b)	Centreline long section shows the following at no more than 20 metre intervals and at all intermediate changes of grade;			
i)	Chainages			
ii)	RL of existing surface			
iii)	Design RL of new road			
iv)	Design grades			
v)	Length of vertical curves			
c)	Kerb return long section shows the following at no more than 2 metre intervals and at all intermediate changes of grade;			
i)	Chainages			
ii)	Design RL of kerb invert			
iii)	Design grades			
iv)	Length of vertical curves			
4)	**Road Cross-Sections**			
a)	Cross-sections are drawn at scale of 1:100 natural			
b)	Cross sections show the following at no more than 20 metre intervals and at all intermediate changes of grade or profile;			
i)	Chainages			
ii)	RL of existing surface			

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
iii)	Design RL of new road			
iv)	Drainage infrastructure, with invert levels			
v)	Location of footpaths and Utilities			
vi)	Batter Cut/Fill Gradients – Cross section to extend to min 1.0m past batter toe			
vii)	Pavement cross-falls including any super-elevated curves			
viii)	Pavement details including layer thicknesses and material types (typical section only)			
ix)	Wearing surface details (typical section only)			
x)	Details of Sub-Soil Drainage (if required)			
5)	**Miscellaneous**			
a)	Location and details of any Estate Entry Structures			
b)	Location and details of and Local Area Traffic Management devices			
c)	Location of vegetation to be removed or retained			
d)	Location and details of any batter catch-drains			
e)	Landscaping details for roundabouts			
f)	Details of the type of vegetation to be used on batters			
g)	Details of any retaining structures to be used in batters or split-level carriageways.			

2.14 APPENDIX B – Checklists - Road Design

Item No.	Description	Reference	Developer Confirmation	TRC Confirmation	Comments
1	Have all engineering design condition of the development consent been met, and required documentation submitted				
2	Traffic Study including start-up parameters	2.5.3			
3	Details of Estate Entrance Features	2.6.3			
4	Pavement Design Report	2.11.3			
5	Subgrade Evaluation Report	2.11.5			
6	Details of source and properties of pavement materials	2.12.1			
7	Asphalt Mix Designs	2.12.2.1			
8	Asphalt Mix Designs for Roundabouts	2.12.2.4			
9	Prime Seal Design	2.12.2.1			
10	Bitumen Seal Design	2.12.2.2			
11	Details of material to be used in unsealed gravel pavement	2.12.2.3			
12	Safety in Design Report	1.5.2			

PART 3

MINIMUM STANDARDS

FOR

STORMWATER

DRAINAGE

3 MINIMUM STANDARDS FOR STORMWATER DRAINAGE DESIGN

3.1 Introduction and Objectives

This document outlines Tamworth Regional Council's minimum requirements for stormwater drainage design in developments or subdivisions.

The principle objective is to promote development within the Tamworth Regional Council area whilst ensuring the following:

- The safe and efficient collection and control of all stormwater generated within the subdivision or development;
- The safe and efficient collection and control of all stormwater entering the subdivision or development from up slope catchments;
- Provision of an effective outlet for all collected stormwater from the subdivision or development to a natural watercourse
- Achieving these objectives without detrimentally affecting the general environment, surface and subsurface water quality, groundwater infiltration characteristics and watercourses both upstream and downstream of the subdivision or development.
- Design and construction of a stormwater network that is both feasible to construct and economical to maintain in the long term; and
- Design and construction of a stormwater network that does not place an unnecessary burden on Council's maintenance and operations resources ;

The design of stormwater drainage systems shall be based on best practise engineering standards and shall meet or exceed the requirements of these Standards as well as relevant sections of any publications referenced herein.

This document is in no way a comprehensive design manual and is intended to be read in conjunction with and as a supplement to documents and publications referenced herein, in particular the 2001 Release of *Australian Rainfall and Runoff 1987*.

The design of Stormwater should be undertaken with consideration for the design of other services including those nominated in the sections listed below:

Part 1 General Requirements

Part 2 Minimum Standards for Design of Roads

Part 4 Minimum Standards for Design of Water Reticulation

Part 5 Minimum Standards for Design of Sewerage Reticulation

Part 6 Minimum Standards for Landscaping

3.2 References

This Part should be read and utilised in combination with the following publications as referenced throughout:

- Australian Rainfall and Runoff 1987, 2001 Release (ARR 1987);
- Australian Rainfall and Runoff 2016 (ARR 2016);
- AS 1100 – Technical Drawing;
- CSIRO Publication; 'Urban Stormwater Best Practice Environmental Management Guidelines';
- Australian Standard AS3500.3 – Stormwater Drainage;
- Queensland Urban Drainage Manual (QUDM) - Fourth Edition;

- Soils And Construction - Managing Urban Stormwater (The Blue Book);
- Tamworth Regional Council Construction Specifications; and
- Tamworth Regional Council Standard Drawings.

3.3 Definitions

For the purposes of stormwater drainage design, a built-up area is considered to be an area with average lot size equal to or less than 2,000m^2.

For the purposes of stormwater drainage design, a rural residential area is considered to be an area with average lot size greater than 2,000m² but less than 10ha.

For the purposes of stormwater drainage design, a rural area is considered to be an area which is predominantly undeveloped (<2% of area developed hardstand or structures) with average lot size greater than 10ha.

Trunk Drainage is defined as pipes ≥1200mm or equivalent box culvert and channels with water way area greater than 4.5m² or V.D product greater than 0.4m²/s in the critical duration 100 year ARI event or.

3.4 Stormwater Construction Certificate Application Documents

3.4.1 DESIGN DRAWINGS

Design drawings shall be submitted to Council for approval. Information to be included in the design drawings is detailed in **APPENDIX A** – Information to be Shown on Drawings.

3.4.2 DESIGN CHECKLISTS

Each of the supporting items or documents listed in the checklists in **APPENDIX B** – Checklists shall be completed and submitted with the Drawings. Should any of the items required in any checklist be outstanding or not to a standard acceptable to Council, the Drawings and checklists shall be returned to the developer for amendment. Council shall only commence review of the design drawings once it is satisfied that all the requirements of the checklists have been met.

3.4.3 STORMWATER SERVICING STRATEGY

The stormwater strategy submitted with the application for development consent shall include the following as a minimum:

- Type of minor system proposed (overland/piped underground);
- Location of major system overland flow paths;
- Location of any trunk drainage systems;
- Catchment and sub-catchment boundaries including all upslope contributing catchments, areas and land use types. The catchment and sub catchment areas shall be provided in a tabular form;
- Analysis of topography, including natural drainage paths and watercourses;
- Consideration of flows from upstream developments and catchments, and consideration of the impact of the development on downstream developments and catchments;
- Location and type of any drainage retention or detention structures;
- Simplified calculations to demonstrate & support detention capacities and adequacy of allocated spaces; and
- Location and type of any water quality devices.

Council must be immediately informed of any variations to the Stormwater Servicing Strategy that are identified during the detailed design phase.

For staged developments the stormwater strategy for the full development is to be submitted with the construction certificate plans for each stage.

3.4.4 ARR 2016

Where the *Developer's Representative* chooses to use the procedures outlined in ARR 2016, a report containing the following information shall be provided as a minimum:

- Full calculations in accordance with ARR 2016 including setup parameters used and justification of any assumptions;
- Calculations in accordance with ARR 1987 for comparison; and
- Commentary on all differences between the results from ARR 2016 and ARR 1987.

3.5 Stormwater Drainage Systems - General Design Criteria

Drainage design shall give consideration to the entire catchment area, not just the area included within the subdivision or development. The *Developer's Representatives* shall base the calculated peak flow on the ultimate full potential development of the entire drainage catchment containing both the development site and upstream area for normal flow situations as well as the overland flooding caused by pipe blockages, general flooding and high water levels.

Prior to commencing the detailed design, the *Developer's Representatives* must determine the land zoning of the upstream catchment area contributing to the drainage system within the subdivision or development. Consultation with Council's planning and engineering staff is encouraged in this regard. Consideration and management of flows from all upstream developments and catchments into, and within the development, along with the management of flows through the development shall be detailed. Staged upgrading of drainage systems shall not be permitted.

3.5.1 MINOR/MAJOR SYSTEM DESIGN APPROACH

The Design Engineer shall adopt the 'Minor/Major System' approach as outlined in Section 1.5 in *Book 8* of ARR 1987 for the design of all drainage systems.

3.5.2 DESIGN ELEMENTS

Stormwater drainage infrastructure is generally composed of combinations of some or all of the following design elements:

- Piped inter-allotment drainage;
- Underground minor system consisting of a network of pits and pipes, with kerb and gutter on roadways;
- Overland minor system comprising of table drains, swales and channels
- Underground piped major system;
- Overland major system consisting of open drains and channels;
- Trunk drainage system;
- Drainage retention or detention structures; and
- Water quality devices.

The majority of developments within the TRC area will involve the design of stormwater drainage that falls within one of the Drainage Design Standard (DDS) categories as per Table 3-A, and Council will assign a DDS to each subdivision or development as a condition of development consent.

Table 3-A - Drainage Design Standard (DDS) matrix

Design Element	DDS 1	DDS 2	DDS 3
Kerb and Gutter	✓	✓	×
Piped Underground Minor System	✓	✓	×
Overland Minor System Open Channel (Table Drains)	×	×	✓
Piped Underground Major System	✓	×	×
Overland Major System including roadways	×	✓	✓
Trunk Drainage system;	**As required**	**As required**	**As required**
Drainage retention or detention structures	**As required**	**As required**	**As required**
Water Quality devices	**As required**	**As required**	**As required**

Where a standard DDS as per Table 3-A is not appropriate for drainage within a particular subdivision or development, Council will determine the requirements for each design element for the drainage as a condition of development consent.

3.5.3 PIPED MINOR DRAINAGE SYSTEMS

Where the minor system is to be underground, this typically consists of a pit, pipe and kerb and gutter network with sufficient capacity to capture flows from nominated storm events designed to an Average Recurrence Interval (ARI) or Annual Exceedance Probability (AEP) as shown in Section 3.5.6 and convey them to a natural watercourse. These pipelines prevent stormwater damage to properties and also limit the frequency and quantity of surface water to a level that is acceptable to the community. Pipelines may not follow the natural drainage paths and are usually aligned along property boundaries and the roadway kerb and gutters.

3.5.4 OVERLAND MINOR DRAINAGE SYSTEMS

Where the minor system is to be overland, this typically consists of open channel drains designed parallel to roadways to convey flows generated by Average Recurrence Intervals as prescribed in Section 3.5.6 to a natural watercourse. Where open channels intersect with roadways, culverts under the road shall be designed to connect to table drains or open channels. The major drainage system design will typically dictate, refer to Section 3.5.5.

3.5.5 MAJOR DRAINAGE SYSTEMS

The major system caters for the runoff from storms of higher intensity than for which the minor drainage system has been designed and typically consists of overland flow paths designed to convey flows when the capacity of the minor system is exceeded. The major drainage system shall be designed to convey flow resulting from 100 year ARI storm events to a natural watercourse.

Note that if the major system cannot safely contain the runoff from the design event, the minor system may be upsized to create a combined major/minor system with adequate capacity to convey flow resulting from 100 year ARI storm events.

3.5.6 DESIGN AVERAGE RECURRENCE INTERVALS

For all drainage systems the following average recurrence intervals (ARI) shall be adopted:

3.5.6.1 DESIGN RECURRENCE INTERVALS

Table 3-B – Design Recurrence Intervals

Location	Design Storm ARI	Design Storm AEP	Design Storm EY
All residential areas	5 years		0.2 EY
Rural areas	5 years		0.2 EY
Commercial	10 years	10%	
Industrial	10 years	10%	
Transverse Drainage Structures Minor Road (Access, Local or Collector)	10 year	10%	
Transverse Drainage Structures Major Road (Sub-Arterial or Arterial)	20 year	5%	
Major System	100 year	1%	

3.5.6.2 MAJOR SYSTEM RECURRENCE INTERVAL

The *Developer's Representative* is to ensure that peak 100 year ARI flows have a safe and effective flow path to a natural watercourse or to an established trunk drainage system when the capacity of the minor system is exceeded. Overland flow paths must be clearly shown on the detailed design drawings. The major system design may necessitate design of increased capacity in the minor system so that the combined systems can convey major flows safely.

3.6 Hydrology

3.6.1 TIMES OF CONCENTRATION

Typical applications of the methods used to calculate times of concentration (t_c) are tabulated in Table 3-C. Where proposed developments consist of a combination of urban and rural sub-catchments, it will be necessary to determine the t_c for each sub-catchment separately.

Table 3-C Time of Concentration Calculation Methods

Example Application	Calculation Method	Reference
Pre-developed catchment for detention calculations	PRM	3.6.1.1
Rural catchment with a defined water course.	Bransby Williams	*3.6.1.2*
Rural catchments with significantly varied topography.	Bransby Williams (with Equal Area Slope)	*3.6.1.2*
Rural catchments not described above	Lesser of PRM and Bransby Williams	3.6.1.1 *& 3.6.1.2*
Urban sheet / laminar flow generally from lots to road gutter.	Kinematic Wave Equation	*3.6.1.3*
Roof catchment to road gutter	Recommended Roof Drainage System Times	*QUDM Section 4.6.5*
Urban time from lot to drainage system	Kinematic Wave Equation + Concentrated Flow Travel Time	*3.6.1.3 & 3.6.1.4*

3.6.1.1 PRM – TIME OF CONCENTRATION

Times of Concentration for each pre-developed catchment shall be determined from the formula:

$$t_c = 0.76\ A^{0.38}$$

where t_c is the time of concentration (hours); and

A is the catchment area (km^2).

3.6.1.2 BRANSBY WILLIAMS – TIME OF CONCENTRATION

Times of concentration for each sub-catchment shall be determined by using the Bransby-Williams formula described in *Section 1.3.2 of Book 4 of ARR 1987.*

$$t_c = 58L / (A^{0.1} \times S_e^{0.2})$$

where t_c is the time of concentration (minutes);

L is the mainstream length measured to the catchment divide (km);

A is the catchment area (km^2); and

S_e is the equal area slope of the main stream projected to the catchment divide (m/km).

3.6.1.3 KINEMATIC WAVE EQUATION – TIME OF CONCENTRATION

Times of concentration for each sub-catchment in a built-up area shall be determined using the Kinematic Wave Equation, as detailed in *Technical Note 3 of Book 8 of ARR 1987*;

$$t_c = 6.94\ (L \times n^*)^{0.6} / I^{0.4} S^{0.3}$$

where t_c is the overland flow time (minutes);

L is the flow path length (metres);

n^* is a surface roughness or retardance co-efficient;

I is the rain intensity (mm/hour); and

S is the slope (m/m).

The kinematic Wave Equation is only applicable to laminar / sheet flow. Once flow is concentrated the additional travel time should be calculated using *3.6.1.4.*

- In urban areas the typical sheet flow length will be 20m and the maximum sheet flow length is 50m. In rural residential areas, the typical sheet flow length will be 50m and the maximum sheet flow length is 100m.

The Kinematic Wave Equation is very sensitive to slope and the Retardance Co-efficient (n*); and these should be estimated carefully. Recommended Retardance Co-efficients are listed below;

Table 3-D - Retardance Co-efficients

Land Use	Retardance Co-efficient (n*)
Road/Paved Areas Only	0.01
Normal Residential	0.08
Rural Residential	0.08
Medium Density Residential	0.06
Industrial/Commercial	0.04
Parkland	0.15
Open Space (Natural Bushland)	0.3

Note:

Minimum t_c: 6 minutes

Maximum t_c: 20 minutes

Where t_c is in excess of 14 minutes, it will be necessary to validate the use of such a t_c in the calculations.

3.6.1.4 CONCENTRATED FLOW TRAVEL TIME

Concentrated flow times including kerb & gutter flows shall be calculated using Izzard's equation or QUDM Figure 4.7

3.6.2 METHODOLOGY FOR DETERMINING PRE-DEVELOPED PEAK FLOWS

Peak flow estimation for each pre-developed area shall be determined using the Probabilistic Rational Method described in section 1.4.1 of Book 4 ARR 1987.

$$Q = C\ I\ A / 360$$

where **Q** is the peak pre-developed flow (m^3/s);

C is the run off co-efficient read from Table 3-E to Table 3-H;

I is the rain intensity (mm/hour); and

A is catchment area (ha).

Rainfall intensity for the critical time of concentration and required ARI is read from IFD data for the appropriate IFD zone in **Appendix D**. Runoff Coefficient are read the runoff coefficient $^{10}C_1$ for an ARI of 10 years from Table 3-I.

For ARI's other than 10 years, an appropriate frequency factor FFy is read form Table 3-E to Table 3-H for Tamworth, Barraba, Manilla and Nundle respectively.
The below 500m elevation FF_y values are to be used for all catchments as the default. The above 500m elevation FF_y values are only to be used for catchments where the primary discharge location for the entire catchment is above 500m.

Note that the FFy values used are different to the values in Table 3-J.

The run off co-efficient C_y for the adopted ARI is determined by the formula:

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

***Table 3-E* – Tamworth Frequency Factors**

	Tamwoth Elevation Below 500m		Tamworth Elevation Above 500m	
FF_y	Pre Developed Frequency Factors (FF_y)	C Factor (C10 x FF_y)	Pre Developed Frequency Factors (FF_y)	C Factor (C10 x FF_y)
FF_1	0.38	0.1	0.52	0.13
FF_2	0.54	0.14	0.64	0.17
FF_5	0.78	0.2	0.82	0.21
FF_{10}	1	0.26	1	0.26
FF_{20}	1.26	0.33	1.21	0.31
FF_{50}	1.71	0.44	1.52	0.39
FF_{100}	2.14	0.55	1.78	0.46

Table 3-F - Barraba Frequency Factors

	Barraba Elevation Below 500m		Barraba Elevation Above 500m	
FF_y	Pre Developed Frequency Factors (FF_y)	C Factor (C10 x FF_y)	Pre Developed Frequency Factors (FF_y)	C Factor (C10 x FF_y)
FF_1	0.38	0.14	0.52	0.19
FF_2	0.54	0.2	0.64	0.24
FF_5	0.78	0.29	0.82	0.3
FF_{10}	1	0.37	1	0.37
FF_{20}	1.26	0.47	1.21	0.45
FF_{50}	1.71	0.63	1.52	0.56
FF_{100}	2.14	0.79	1.78	0.66

Table 3-G - Manilla Frequency Factors

	Manilla Elevation Below 500m		Manilla Elevation Above 500m	
FF_y	Pre Developed Frequency Factors (FF_y)	C Factor (C10 x FF_y)	Pre Developed Frequency Factors (FF_y)	C Factor (C10 x FF_y)
FF_1	0.38	0.11	0.52	0.15
FF_2	0.54	0.15	0.64	0.18
FF_5	0.78	0.22	0.82	0.23
FF_{10}	1	0.28	1	0.28
FF_{20}	1.26	0.36	1.21	0.34
FF_{50}	1.71	0.49	1.52	0.43
FF_{100}	2.14	0.61	1.78	0.51

Table 3-H – Nundle Frequency Factors

	Nundle Elevation Below 500m		Nundle Elevation Above 500m	
FF_y	Pre Developed Frequency Factors (FF_y)	C Factor (C10 x FF_y)	Pre Developed Frequency Factors (FF_y)	C Factor (C10 x FF_y)
FF_1	0.38	0.1	0.52	0.14
FF_2	0.54	0.14	0.64	0.17
FF_5	0.78	0.21	0.82	0.22
FF_{10}	1	0.26	1	0.26
FF_{20}	1.26	0.33	1.21	0.32
FF_{50}	1.71	0.45	1.52	0.4
FF_{100}	2.14	0.57	1.78	0.47

3.6.3 METHODOLOGY FOR DETERMINING POST-DEVELOPED PEAK FLOWS

Drainage design shall include a drainage catchment plan showing the total catchment area and sub areas that form the basis of the design including all contributing upslope catchment areas, together with drainage calculation sheets or summaries of computer modelling.

Partial areas shall be taken into account when determining peak flow at sub catchments, particularly in instances where the catchment contains sub areas, such as reserves, that may have a relatively large time of concentration in conjunction with a small co-efficient of runoff. In some instances a partial area design discharge may result in runoff that is less than (or the same as) a discharge that has been calculated at some upstream point. A check of the partial area flows shall be required to determine the peak flow. The peak flow to be adopted for design purposes shall be the largest flow from either full or partial area calculations.
Although the parameters and techniques for Flow Estimation in urban catchments, as set out in these Standards, generally refer to the Rational Method, it may, depending on catchment characteristics, be more appropriate to use a Unit Hydrograph, time area method (ILSAX model see Section 3.6.3.5) or Nonlinear Run-Off Routing Model. The advantages and disadvantages of Unit Hydrographs are explained in detail in ARR 1987. It is the responsibility of the *Developer's Representative* to determine the most appropriate methodology for each application. Various drainage tools, proprietary software and construction methods are available to the *Developer's Representative* to achieve an appropriate design. Regardless of the technique or method used, detailed documentation shall be required to be submitted for approval.

Where computer software is used for hydrological modelling, it shall be a 'recognised industry standard' software program. A comprehensive list of initial and continuing loss rates and set-up parameters used to obtain results from the software is to be submitted along with the detailed input and output documentation.

For catchment area greater than 50 hectares, two recognised runoff estimation methods shall be used to enable comparison or runoff estimates.

Tamworth Regional Council has access to the Watercom Drains software package. Council prefers stormwater calculation to be submitted as a Drains file. Any other industry recognised software may be used but the developer should note that files requiring alternative software will be reviewed by a third party which may extend the time taken to review the design.

3.6.3.1 DESIGN RAINFALL INTENSITIES

Rainfall intensities adopted for design are those issued by the Bureau of Meteorology for the location of the development. Map 1 in **Appendix C** details the location of IFD zones throughout the region. The *Developer's Representative* is to adopt the rainfall intensities for the zone in which the proposed development lies.

The tables in **Appendix C** detail the IFD data for each zone as per Map 1. This data is to be used for all IFD calculations.

3.6.3.2 RUN-OFF CO-EFFICIENTS

Run-off coefficients "C" shall be determined in accordance with *Section 1.5.5 (iii) of Book 8 of ARR 1987*. The following equations apply for each zone in TRC:

$$C_y = F_y \times C_{I0}$$

where:

$$C_{I0} = 0.9 \times f + {}^{10}C_1 \times (1-f)$$

and

$${}^{10}C_1 = 0.1 + (0.7 - 0.1) \times ({}^{10}I_1 - 25)/(70 - 25)$$

These parameters are defined below:

- C_y: Run-off Co-efficient for recurrence interval "y" (years);
- C_{10}: 10 year ARI Run-off Coefficient;
- F_y: Frequency Factor -see Table 3-J; and
- **f**: Fraction Impervious -see Table 3-K.

Rainfall Intensity of a 10 year ARI, 1 hour duration storm for each zone, as per Table 3-I.

Table 3-I - Pervious Area Runoff Co-efficient $^{10}C_1$

Location/Zone	Rainfall Intensity; $^{10}I_1$ (mm/hour)	Pervious Area Runoff Co-efficient; $^{10}C_1$
Tamworth	36.9	0.25827
Barraba	45.3	0.36999
Manilla	38.9	0.28487
Nundle	37.4	0.26492

Where an analysis is to proceed that requires the estimation of Initial and Continuing Loss Rates, a comprehensive list of initial and continuing loss rates shall be provided in accordance with Section 3.6.3.

Past experience suggests that major flooding in the Tamworth Region occurs when the catchment is already saturated and the Loss Rates are negligible.

Table 3-J - Frequency Factors for Run-off Co-efficients

Recurrence Interval	F_y
1	0.80
2	0.85
5	0.95
10	1.00
20	1.05
50	1.15
100	1.20

Table 3-K - Fraction Impervious for Run-off Co-efficients

Land Use	f	Minimum Permissible Lot Size m^2
Residential Lot in Built-Up Area	0.75	600 – 1000
Residential Lot in Built-Up Area including half road	0.80	600 - 1000
Residential Lot in Rural Area	0.50 0.40 0.35 0.35	2000 4000 10000 100000
Residential Lot in Rural Area including half road	0.55	NA
Half Width Road Reserve	0.80	NA
Commercial Areas	0.95	NA
Industrial Areas, Medium Density Residential	0.90	NA
Public Recreation Areas	0.40	NA
Open Space (Natural Bushland)	0.35	NA

A quick reference guide for runoff coefficients is provided in **APPENDIX F.**

3.6.3.3 SUB-AREA DISCHARGE

The discharge for each sub-catchment may be calculated using the Rational Method formula:

$$Q = C\ I\ A\ /\ 360 \qquad (m^3/second)$$

"Hydrological Design Sheet 1" (refer **APPENDIX E**) sets out the preferred format for these calculations. *Technical Note 6 of Book 8* of *ARR 1987* details a worked example for these calculations.

"Hydrological Design Sheet 2" (refer **APPENDIX E**) can then be used to calculate the flows along each reach of the pipe system.

Hydraulic Design Sheets in MS Excel format with visible formulas and calculations shall be submitted with the design documentation.

3.6.3.4 PARTIAL AREA FLOWS

In built-up areas, it is probable that a greater flow rate may be obtained by applying the Rational Method to a lower part of the catchment with a Time of Concentration less than the full area travel time. These partial areas effects commonly occur when large paved areas are directly connected to the pipe inlet, and the sub-catchment discharge is based on a larger pervious area.

Similarly, partial area effects can also occur, where a large open space catchment contributes to an urban catchment, with a Time of Concentration substantially different to the urban catchment.

In areas where this may be critical, such as industrial or high density residential development, a partial area check, based on Times of Concentration of impervious areas directly connected to the pipe system, is necessary.

3.6.3.5 ILSAX PARAMETERS

Where ILSAX models are used to calculate developed flows the parameters shown in Table 3-L shall be used.

Table 3-L ILSAX Parameters

Parameter	Value
Depression Storage – Impervious	2mm
Depression Storage – Supplementary	2mm
Depression Storage – Grassed	8mm
Soil Type	3
Antecedent moisture condition (AMC)	3

3.7 Design of Piped Drainage Systems

Catchment areas to each pit shall be determined from contour information and proposed property boundaries. A site inspection should always be made to verify the contour information and assess the likelihood of any flow path deviations which may occur as a consequence of existing or proposed developments. Changes to flow paths can occur as a result of the construction of fences, earth bunds, retaining walls, buildings etc. after the construction phase of the subdivision. The impact of these changes must be considered at the design stage.

Sub-area discharges can be calculated using the procedures detailed in Section 3.6.3.3 of these Standards. Major system flow paths should be defined at this stage.

3.7.1 DESIGN OF PIT INLETS

3.7.1.1 PIT LOCATIONS

The following criteria govern the location of pits in roadways for the minor system design average recurrence interval:

a) Inlet Pits are to be spaced so that gutter flow width does not exceed 2.5m;

b) Gutter flows should at no point overtop the kerb;

c) Maximum velocity depth product (d.V) to be no greater than 0.4m²/s;

d) Bypass from any pit on grade is not to exceed 15% of the total flow at the pit (Full capture Desirable);

e) Maximum spacing between pits shall not exceed 75m;

f) Where flows in the gutter are equal to or greater than 20 litres per second and/or equal to or greater than 1m in width adjacent to the upstream kerb return tangent point, it will be necessary to intercept these flows with a Kerb Inlet Pit;

g) Inlets are to be provided at the kerb return tangent points; and

h) The location of inlet pits shall not be placed on curves. Inlet pits are not to be placed in line with the normal passage of pedestrians including pedestrian ramps.

Technical Note 4 of Book 8 of ARR 1987 details a method for calculating gutter and road flows.

3.7.1.2 INLET DESIGN

Once the sub-catchment flows are known, pit inlets should be designed in accordance with the charts contained on the following pages. All new inlet pits shall be constructed using welded steel "Weldlok" type or equivalent grates with appropriate skirts.

On grade, percentage capture by grates is mainly dependant on lintel size and the slope of the gutter. TRC Standard Drawing SW001 provides an indication of the percentage capture of pits on grade.

Sag pits shall be designed based on the depth of ponding, up to the top of the kerb. Ponding depths can be calculated using design charts as per TRC Standard Drawing SW002 and Lintel sizes shall be commensurate with inflow requirements. Minimum internal lintel size in a sag should be 2.4m.

Alternatively, inlet capacities can be calculated from first principles using formulas as detailed in *Section 1.5.4(iii), Book 8 of ARR 1987.* If using these formulae, appropriate blocking factors shall be applied.

Curved lintel inlets will not be supported by Council.

3.7.1.1 BLOCKAGE FACTORS

The blockage factors shown in Table 3-M are to be deducted from theoretical pit inlet capacities for inlet pit design.

Table 3-M Blockage Factors for Inlet Pits

Inlet type	Blockage Factor
Sag – Kerb inlet (side entry)	20%
Sag – Grated	50%
Sag – Combination	Kerb inlet – 0% & Grate – 100%
On Grade – Kerb inlet(side entry)	20%
On Grade – Grated	50%
On Grade – Combination	10% (of total capacity)

3.7.2 DRAINAGE PIT DESIGN

3.7.2.1 GENERAL

- Standard pits in accordance with TRC Standard Drawings SW003 to SW009 or approved equivalent precast pits shall 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 150mm;
- Pipe junctions where the deflection angle of the major flow is 90º should be avoided;

- The vertical drop across pits shall be designed on the following basis;
    - Where there is no change in direction or pipe diameter; 50mm invert to invert;
    - Where there is no change in pipe diameter but direction change; 70mm invert to invert;
- Changes in diameter should be graded obvert to obvert;
- Where the depth of the pit exceeds 1.2 metres, step irons shall be provided at 300mm centres in accordance with AS1657; and
- Every endeavour is to be made to maintain flow velocities through pits and excessive drops will not be permitted.

3.7.2.2 INLET PITS

Inlet pits are to be designed in accordance with TRC Standard Drawing SW003-SW006 inclusive.

3.7.2.3 ANGLE PITS AND JUNCTION PITS

Angle and junction pits are to be in accordance with TRC Standard Drawing SW007.

3.7.2.4 FOOTWAY AND FIELD SURFACE INLET PITS

Where footway or field surface inlet pits are required, they are to be in accordance with TRC Standard Drawing SW008.

3.7.2.5 SURCHARGE SURFACE INLET PIT

At the upstream end of drainage pipelines in public reserves, gullies, etc. and in subdivisions involving staged construction an inlet pit with Weldlok or similar surcharge surface inlet pit cover is to be provided in accordance with TRC Standard Drawing SW008.

3.7.2.6 INLET FREEBOARD

A 150mm freeboard shall be allowed for between the peak water level for design events and surface levels at inlets.

3.7.2.7 PIT LOSS FACTORS

Pit loss factors (k) should be calculated using the following formula in accordance with *Section 1.5.7(iv) of Book 8 of ARR 1987.*

$$h_L = Cu.V_o^2 / 2g$$

where;

h_L	is the loss (m);
C_u	is a dimensionless energy loss coefficient;
V_o	is the velocity of flow in the outlet or downstream pipe (m/s); and
g	is the acceleration due to gravity (m/s^2).

Where ‘recognised industry standard’ software is used for the hydraulic design pit losses shall be iterated until the values stabilise.

3.7.2.8 MINIMUM PIT LENGTHS

Table 3-N shows the minimum length of stormwater pits in the direction of flow based on the upstream pipe diameter (Du) and the vertical drop through the pit.

Table 3-N Minimum Pit Lengths

Drop Through Pit	Upstream Pipe Diameter **(Du) < 600mm Min Pit Length (in direction of flow)**	Upstream Pipe Diameter **(Du) ≥ 600mm Min Pit Length (in direction of flow)**
Drop ≤ 0.5 Du	1.0 Du	1.5 Du
0.5 Du < Drop ≤ 1.5 Du	1.5 Du	2.0 Du
1.5 Du < Drop ≤ 2.5 Du	2.0 Du	2.0 Du
2.5 Du < Drop	2.0 Du	3.0 Du

Where Du is the diameter of the upstream pipe.

3.7.3 PIPELINE DESIGN

3.7.3.1 GENERAL

The Hydraulic Grade Line (HGL) method shall be used for pipeline design. *Technical Note 9 of Book 8 of* ARR 1987 details the recommended procedures for Hydraulic Grade Line calculations. The "Hydraulic Design Sheet" (see **APPENDIX E**) shall be used for calculating the HGL and shall be submitted in MS Excel format along with the design drawings.

The initial pipe sizing shall be performed on a reach by reach basis and final HGL checking of the system should then be performed from the system outlet working upstream. The water level results of the HGL analysis shall be plotted on the pipeline longitudinal sections in the design drawings.

The following points details the minimum requirements for pipeline design:

a) All pipelines constructed shall be rubber ring jointed type;

b) Pipelines in roadways shall have a minimum diameter of 375mm in urban areas and 450mm in rural areas;

c) Pipelines should cross roads at right angles to the road centreline;

d) Pipelines should have adequate inspection manholes spaced no greater than 75m for each drainage pipeline. Where the pipeline diameter exceeds 1200mm, this distance may be increased to 100 metres;

e) For single cell pipe systems, a downstream pipe of smaller diameter than the upstream pipe will not be permitted;

f) The minimum grade of all pipelines shall be 1.0% to encourage self-cleaning under low flow velocities. Flow velocities should be limited to a minimum of 0.6 m/s for self-cleaning purposes;

g) The inlet and outlet drains to pipelines should be carefully designed so as to avoid either scouring or silting velocities during storm flows, and adequate scour protection is to be provided at the outlet of all stormwater lines. Details of proposed scour protection to pipe outlets shall be shown on the design drawings;

h) All pipe inlets and outlets shall be designed with appropriate inlet/outlet structures;

i) Curved pipelines will not be permitted where the diameter of the pipeline is less than 900mm. Where curved pipelines are permitted and have prior approval by TRC, they are to be constructed using rubber ring jointed reinforced concrete pipes and installed strictly in accordance with the Manufacturer's recommended radii; and

j) Pipelines shall be designed under and parallel to the road kerb and gutter. Additional pits will be required to negotiate curved alignments. The maximum distance from the pipeline centreline to the radius of the kerb and gutter face shall be 1.5m.

3.7.3.2 RECOMMENDED PIPE FRICTION CO-EFFICIENTS

Table 3-O below details the recommended pipe friction co-efficients to be used in HGL calculations;

Table 3-O - Pipe Friction Co-efficient

Pipe Material	Mannings "n"	Colebrook-White "k"
Steel Reinforced Concrete Pipe (SRCP)	0.012	0.6
Fibre Reinforced Concrete Pipe (FRCP)	0.011	0.3
UPVC Pipe (UPVC)	0.010	0.015

3.7.3.3 TAILWATER LEVELS

The tailwater to be adopted will depend on the outflow conditions. Where determination of a tailwater level is in doubt the *Developer's Representative* shall consult with Council prior to proceeding with the design to confirm the value, generally:

- for free outfalls, the pipe obvert may be adopted;
- for discharge into receiving waters, tailwater equivalent to the design ARI flood level may be adopted;
- for discharge into existing systems where the hydraulic grade levels are unknown, a tailwater 150mm below the natural surface/invert of kerb may be adopted; and
- for discharge into a point designed to surcharge, a tailwater level equivalent to the height of the surcharge may be adopted.

3.7.3.4 HEADWALLS AND OUTLET STRUCTURES

Concrete headwalls shall be installed on all culverts and pipe outlets and shall not protrude above the level of the road shoulder.

3.7.3.5 CONCRETE BULKHEADS

Concrete bulkheads shall be required for all drainage pipelines with grades exceeding 6%, at intervals not exceeding 15 metres. Bulkheads are to be in accordance with TRC Standard Drawing SW014.

3.7.3.6 SUB-SOIL DRAINAGE

Sub-soil drains may be required in certain locations, particularly as intercepting drains behind kerb (including traffic island and roundabout kerb) and for drainage of the flexible pavement, and these shall be designed as per the requirements of the *Austroads Guide to Pavement Technology – Part 10; Sub-Soil Drainage*. Sub-soil drainage lines should be graded to suitable outlets such as stormwater pits.

For rural residential style roads, the subgrade shall be boxed out to the table drain to allow for pavement drainage. Subsoil drainage shall be installed in all other cases in accordance with TRC Standard Drawing SW010.

3.7.3.7 CULVERT DESIGN

Road culverts should be designed in accordance with culvert hydraulics theory. That is, the culvert capacity is determined by the flow conditions, depending on whether inlet control or outlet control governs.

Recommended design procedures are contained in *Section 3 of the Concrete Pipe Association of Australia's publication: "Hydraulics of Precast Concrete Conduits Hydraulic Design Manual".* A preferred format for culvert design calculations is provided in **APPENDIX E** and shall be submitted in MS Excel format along with the design documentation.

The combined capacity of the road culverts piped flow and any flows traversing the vehicular crossing roadway shall be designed to cater for the 100 year ARI. The above road capacity in addition to the culverts capacity must have a maximum safe depth of flow of 200mm above the finished surface level of the roadway. The velocity depth product (d.V) shall not exceed 0.4m²/s. Pipe capacity shall be in accordance with Table 3-B. Where culverts cross a public road, guide posts shall be installed either side of culverts on both sides of the road.

Vehicle crossings shall be designed in accordance with Section 2.7.7.

3.8 Design of Overland Drainage Systems

Catchment areas to each overland drainage line shall be determined from contour information and proposed property boundaries. A site inspection should always be made to verify the contour information and assess the likelihood of any flow path deviations which may occur as a consequence of existing or proposed developments. Changes to flow paths can occur as a result of the construction of fences, earth bunds, retaining walls, buildings etc. after the construction phase of the subdivision. The impact of these changes must be considered at the design stage.

Sub-area discharges can be calculated using the procedures detailed in Section 3.6.3.3 of these Standards. Major system flow paths should be defined at this stage.

Design of open channel drains shall be in accordance with *Section 1.6.4 of Book 8 of Australian Rainfall & Runoff,* having regard to vehicle crossover and access requirements in Part 2 of these Standards. Open channel drains in overland minor systems shall have a minimum floor width of 2.0m and batter slopes not exceeding 1(V) in 5(H) to allow for maintenance and mowing, provided the HGL of the drain is below the bottom of all pavement layers in the adjacent pavement.

3.8.1 HYDRAULIC DESIGN – MAJOR SYSTEM FLOWS

The capacity of roadways to convey the major system flows shall be calculated using the procedure outlined in *Technical Note 4 of Book 8 of ARR 1987.*

The hydraulic design of major system open channels shall be in accordance with *Section 1.6.4 of Book 8 of ARR 1987*.

These flows shall follow a designated flow path, which typically shall be:

- A road if the catchment area is sufficiently small. Where the roadway is to be used as a major overland flow path the following criteria needs to be met:
    - Maximum flow depth to be top of kerb or 200mm above top of kerb where the footway can cater for the depth of overland flow and where it is demonstrated that it will not cause any flooding issues to adjacent lots;
    - Maximum velocity depth product (d.V) to be no greater than 0.4m²/s
- A defined drainage reserve or open channel generally following natural drainage contours where it is impractical or unsafe for a road to carry the excess flows;
- A piped underground system designed in accordance with Section 3.7 where it is impractical or unsafe for the major flows to follow overland flowpaths;
- Open channel drains for rural residential layouts; and
- The *Developer's Representative* shall demonstrate that there is no impact to private property or Council infrastructure downstream if discharging to a natural watercourse (blue line on topographical map) unless flows have been reduced to pre-developed flows.

3.8.2 OPEN CHANNEL DESIGN

Open channels include overland minor system flowpaths and overland major system flowpaths for example table drains, formed concrete lined channels, turf lined swale drains etc. Open channels shall be designed in accordance with *Section 1.6.4 of Book 8 of Australian Rainfall & Runoff* and the following.

3.8.2.1 FLOW VELOCITIES

Maximum flow velocities in turf-lined channels shall be 2 m/s for a minimum 100 year ARI flow. Designs shall be based on sub-critical flow with a Froude Number no greater than 0.8.
Maximum flow velocities in excess of 2m/s for a 100 year ARI shall be provided with suitable protection in accordance with the Office of Environment and Heritage *Managing urban stormwater: soils and construction - Volume 1, 4th Edition* "Blue Book"

3.8.2.2 SCOUR PROTECTION

Scour protection shall be designed at all inlet/outlet points of open channels, and at any point in the channel where there is a significant change in flow conditions or there is the potential for scouring. Details of proposed scour protections shall be nominated on the plans and be in accordance with the "Blue Book" and be approved by Council.

Adjacent piped systems should connect to the low flow piped system as a continuation of the side lines pipe diameter. The connection point should be a surcharge pit capable of surcharging the side lines total discharge. No surcharge points should occur in the channel batters higher than the 100 year ARI Top Water Level.

3.8.2.3 STABILISING

The floors of all open channels including the walls of batters 0.5m above floor level shall be designed with turf of an appropriate species subject to Section 3.8.2.2. The remainder of internal and external batters of open channels shall be provided with topsoil and seeded with appropriate grass species, or shall be designed with a geotextile material with a minimum life expectancy of two (2) years.

The details and specification for fixing of geotextile are to be submitted with the design documentation.

Details of the proposed grass species to be used shall be included in the design drawings.

3.8.2.4 BATTER SLOPES AND LONGITUDINAL GRADES

Batter slopes of grassed open channels shall be maximum 1(V) in 5(H). The minimum longitudinal grade of open channels shall be 1.0% and the maximum longitudinal grade shall be such that the maximum flow velocity is not exceeded.

3.8.2.5 ROAD CROSSINGS

Where open channel drains intersect with roadways, culverts shall be designed to convey flows under the roadway. Culverts shall be designed in accordance with Section 3.7.3.7.

3.8.2.6 CURVATURE

The centreline curves of open channels shall have a radius not less than twice the minimum width at the top of design flow with a minimum radius of 30 metres.

3.8.2.7 HYDRAULIC DESIGN OPEN CHANNELS

Open channels shall be designed using backwater calculations in the format as per **APPENDIX E.** The Velocity Depth product (d.V) shall not exceed 0.4m²/s.

Recommended Manning's Roughness Co-efficients "n" for Open Channels are given in Table 3-P below.

Table 3-P - Mannings Values for Open Channels

Surface Type	Mannings "n"
Concrete Lining	0.013
Grass	0.035
Earth (Clear)	0.02
Rock Lined	Refer to QUDM table 9.3.3

3.8.2.8 TRUNK DRAINAGE CHANNEL DESIGN

Trunk drainage channels Velocity x Depth product (d.V) shall not exceed 1.0m²/s for the critical duration 100 year ARI event. A freeboard allowing flows up to 25% greater than the peak design top water level is to be incorporated into the channel design. Trunk drainage channels shall have exclusion fencing (as defined in QUDM Section 12.4 Safety fencing) to prevent causal access. Concrete or other approved material shall line the base and walls of trunk drainage channels to the level of the design event plus freeboard.

3.9 Inter-Allotment Drainage Systems

Inter-allotment drainage is considered necessary in urban development's where roof water and surface water cannot be discharged directly to the street gutter. Inter-allotment drainage systems are intended to collect both roof water and surface water.

Inter-allotment drainage lines shall be designed with an ARI of 10 years over the entire lot area, with a fraction impervious area as per Table 3-K, and in accordance with the *Building Code of Australia or Australian Standard AS3500,* whichever is applicable.

The minimum size pipe is to be 225mm diameter. The design is to include manholes at intervals of not more than 75 metres. Consideration will be given to the installation of a 150mm diameter pipe where only one (1) lot is to be served.

A freeboard allowance of 150mm above the peak water level shall be adopted for inter-allotment pits

Inter-allotment drainage lines are to be located within an easement 1.5 metres wide, granted in favour of the properties served by that line, and should be located in the higher rather than the lower property.

Under no circumstances should minor or major system drainage, piped or otherwise, discharge into an inter-allotment drainage line. Similarly, only stormwaters that are captured from roofs and the surfaces of private properties are to be captured and discharged into inter-allotment drainage lines. Stormwater from roads, parks, reserves or other public places shall not be discharged into inter-allotment drainage lines.

Each lot served by an inter-allotment drainage line shall be provided with at least one grated inlet structure to permit the inlet of surface water. At the most suitable point in each lot, which will correspond with the lowest surface level along the line of the inter-allotment drainage, an inlet structure is to be brought to surface level with a pit and exposed grate. From the wall of the pit a 150mm junction is to be left for the connection of roof water. The connection by the plumber of roof water to this point is to be supervised by Council's Building Inspector.

Inter-allotment drainage pits are to be in accordance with TRC Standard Drawing SW009.

3.10 Stormwater Detention and Retention

3.10.1 DEFINITIONS

- *Stormwater Detention* is defined as the process of temporarily holding and/or controlled release of stormwater through the use of a hydraulic storage system;
- *Stormwater Retention* is defined as the reduction in flow volume by long-term storage or discharge to an alternative outlet such as evaporation or infiltration*;*
- A *Large Subdivision and Development* is defined as a development consisting of greater than 5 potential dwellings or units.
- A *Small Development* is defined as a development consisting of less than or equal to 5 potential dwellings or units and a predeveloped lot size less than 2000m²; and
- *Dwelling* is defined in the Tamworth Regional Council LEP 2010.

In subdivisions or developments larger than single allotments, stormwater detention or retention typically involves the construction of detention/retention basins to retard flows and control outfall.

In small developments, stormwater retention or detention typically involves the design of on-site detention structures and systems.

3.10.2 GENERAL DESIGN REQUIREMENTS AND CONSIDERATIONS

Stormwater detention or retention is to be considered where post-developed flows discharging from the development exceed the pre-developed flows as calculated by the method described in section 3.6.2, or where the capacity of the existing downstream stormwater drainage system will be exceeded by the addition of any flows from the proposed development.

Stormwater detention or retention is only to be considered as a preferred design option where it can be demonstrated that there are no other practical solutions to capture and control stormwater flows, or where there is a demonstrated environmental benefit with their use. The *Developer's Representative* shall provide details of all other design strategies explored prior to the selection of stormwater detention or retention as the preferred design option.

Where it is intended to utilise stormwater retention/detention structures, details of such shall be included in the Stormwater Servicing Strategy, including details of the requirements for a suitable stormwater retention/detention system and details that demonstrate that the system can be integrated into the development and the surrounding environment. Where retention structures are proposed, the Servicing Strategy shall include a water usage plan, details of any top-up water supplies, and capacity modelling data.

Detailed design and documentation of retention/detention systems are to be prepared by the *Developer's Representative*. A detailed hydrological and hydraulic analysis is required for all detention/retention systems and shall be submitted in MS Excel Format along with the detailed design documentation.

Where computer software is used for hydrological modelling, it shall be a 'recognised industry standard' software program. A comprehensive list of set-up parameters used to obtain results from the software is to be submitted along with the detailed input and output documentation.

Land that has been identified for stormwater retention/detention basins to be maintained by Council, whether existing or proposed, must be shown on a Plan of Subdivision as a Drainage Reserve and vested to the Council as operational land.

In circumstances where detention basins are not to be maintained by Council and are located within land that is common property, a covenant as per Section 88B of the Conveyancing Act 1919 (as amended) shall be placed on each benefiting allotment to ensure the performance of the structure is not compromised by any act, or failure to act, by the body corporate.

Detention basins should be designed to drain completely and shall be constructed so that the area can be used for passive recreation or active recreation or other uses such as carparks as approved by Council.

Retention/detention basin areas shall not be used in calculations for public open space requirements.

When a retention/detention basin is required for any development, the basin and any overland flow paths shall be constructed as part of stage one works. Where it can be demonstrated to Council that a retention/detention basin is not required as part of the first stage works; plans, computations, and relevant approvals must be provided to confirm the alternate method of outfall and/or storage capacity.

3.10.3 STORMWATER RETENTION/DETENTION IN LARGE SUBDIVISIONS AND DEVELOPMENTS

3.10.3.1 OBJECTIVES

The objectives to be achieved through the design of stormwater retention/detention are as follows:

- To protect property and infrastructure from flooding occurring from a nominated rainfall event by the provision of retention/detention basins;

- To limit, as much as possible, the number of retention/detention basins servicing an area to reduce Council's future maintenance expenditure;
- To protect Council's existing stormwater drainage assets from exceeding their design capacity and overloading as a result of new developments, which increase the amount of stormwater runoff being generated from a particular property;
- To protect the public from risk of injury or death;
- To standardise the type and operation of structures, basins and outfalls associated with retention/detention; and
- To design aesthetically pleasing drainage structures having regard to the area that they will be located in.

3.10.3.2 RISK ANALYSIS

A risk assessment report included with the Safety In Design Report is to be prepared by the *Developer's Representative* for all retention/detention systems to assess the likelihood and consequence of structural failure of the system. The risk assessment should be undertaken in accordance with the principles detailed in *Australian Standard AS4360.* The risks associated with these structures shall be assessed over the entire life of the structure and not just the design. Refer to Section 1.5.2. The Safety in Design Report shall be written to meet the requirements of the Work Health Safety Regulation 2011.

The *Developer's Representative* shall be responsible for deciding on the action required in response to the risk assessment report and its recommendations; however, consultation with Council is encouraged if recommendations are complicated, require community involvement, or have significant ongoing maintenance issues.

A copy of the risk assessment report, with recommendations and associated works, shall be provided to Council with the detailed design documentation.

3.10.3.3 LOCATION

Retention/detention basins shall not be located in areas zoned Flood Liable Land.

Council's preference is for off-stream retention/detention basins. Retention/detention basins shall not be located "on-stream" in the flow path of natural drainage courses or designated overland flow paths unless approval is granted from the Office of Environment and Heritage (OEH) and application and subsequent approval is granted by Council. Council is not obliged to approve on-stream systems if OEH approval has been granted. The location of retention/detention basins shall have regard to:

- The physical dimensions required for storage volume including the flattest possible batters, access to the basin bed, and maintenance of batters and edges;
- Pre-developed catchments;
- Existing developed catchments;
- Existing drainage including piped, swale drains, or flow paths;
- Existing and proposed drainage easements;
- Ground water depth and seasonal fluctuations;
- Subsoil characteristics;
- Location and point of discharge;
- Soil type and seepage rate;
- Land uses and zoning;
- Effect of overland flows external to the catchment;
- Potential risk or effect on people, fauna and flora;

- Amenity of the area;
- Benefiting landholder issues;
- Provision of a suitable discharge method by gravity only;
- Maintenance issues and all weather access;
- Water quality;
- The location of overland flows into the basin and the treatment(s) to minimise erosion;
- Inlet velocity and the need to install energy dissipation structures; and
- Flood level information or historical flood data.

Approval of the proposed location of any retention/detentions structures will only be subject to Council being satisfied that each of the above criteria has been satisfactorily addressed.

3.10.3.4 DESIGN CRITERIA

All retention/detention structures are to be designed utilising:

- Hydrographs produced by an acceptable method of unit graph theory or mathematical modelling; and
- Flood routing through the structure.

Retention/detention structures shall be designed to maintain the existing undeveloped discharges for the range of storm durations and frequencies from 1 year ARI events up to and including 100 year ARI events.

The methods described in Section 3.6.3 of these Standards may be used to calculate peak flows.

Retention/detention structures with downstream established areas and no clear and safe overland flow paths shall be designed for the peak 100 year ARI storm with consideration of the sensitivity of the design given to 200 year ARI events.

The peak storm duration with retention/detention structures is to be confirmed by the *Developer's Representative.* The critical duration is likely to be longer than without retention/detention. A graph showing the range of peak flood levels in the structure and peak discharges from the structure are to be provided for all storm events examined. Consideration must be given to areas downstream to ensure that changes in timing of peak flows at the confluence of downstream reaches is not adversely impacted by construction of the structure.

A sensitivity analysis must be undertaken for a range of variables (catchment roughness, link lags etc.) to determine how sensitive the design is to minor changes in these variables.

Rainwater tanks either installed or intended to be installed as part of the development shall not be used in retention/detention basin design calculations. The volume of storage in pits and pipes in the minor system is also to be ignored.

3.10.3.5 FREEBOARD

Basin freeboard shall be considered by the *Developer's Representative* as a minimum and the following conditions need to be met:

- Minimum freeboard above the 100 year ARI critical duration top water level shall be 500mm for earth structures and 300mm for concrete structures;
- The lowest kerb inlet level in the basin catchment area shall be higher than the 100 year ARI critical duration top water level;
- If the top water level in the structure resulting from the minor storm event is higher than the invert of the lowest inlet pipe to the basin tail water conditions shall be considered; and
- Overland flow path for a major storm shall be designed such that the minor system contribution to flow is ignored, i.e. inlet pipe is blocked.

3.10.3.6 SPILLWAYS

Spillway design must be of sufficient capacity to safely convey a minimum 100 year ARI peak basin inflow without failure of the embankment. The design of the spillway should not consider any low level outlet discharge in the calculations i.e. spillway calculations shall include a blocking factor of the low level outlet structure(s) of 100%. Spillway structures are to be designed as a concrete lip (minimum 2m width) with erosion protection measures. Scour protection of the spillway embankment is to be provided in accordance with the predicted velocities with rock protection mattress to be provided as a minimum.

Consideration shall also be given to the sensitivity of the design for 200 year ARI events where significant impact to downstream infrastructure or potential loss of lives exists.

The spillway design for on-line basins shall consider the cumulative effect of the 1 in 100 year inflows from all upstream basins.

Where a spillway is proposed to discharge to a road reserve and is located within 50m of the road reserve the low level basin outlet shall be designed such that only flows greater than the 100 year ARI are directed over the spillway.

3.10.3.7 OVERFLOW SYSTEMS

All overflows are to be directed away from buildings, adjoining properties and associated infrastructure. The depth of overland flow shall be designed so that it is no higher than 300mm below the lowest floor level of any dwelling impacted by the overflow.

Overflow flow paths must be shown as major system flow paths on the detailed design drawings.

3.10.3.8 RETENTION/DETENTION STRUCTURE DEPTH

The depth of excavations for retention/detention structures shall be limited such that loss or infiltration to the demonstrated water table level will not occur.

The maximum depth of retention/detention systems shall be such that they are not required to meet the requirements described by ANCOLD.

Retention/detention structures may require an impervious lining or other treatment to prevent the ingress of groundwater. Groundwater may not be extracted and used.

Any structure that penetrates the demonstrated groundwater zone such as footings and drainage shall be appropriately treated to prevent possible damage caused by contact with ground water.

The depth of all retention/detention structures for which the public have access to will be determined having regard to the safety of persons who may fall into or enter the structure during times of operation.

3.10.3.9 BATTER SLOPES IN EARTHEN BASINS

Desirable batters for detention basins shall be 1 in 6 for both cut and fill situations.

Council will accept batter slopes up to 1(V) in 4(H).

Maintenance and Management Plans shall be prepared for all detention basins and submitted to Council for approval.

For all submitted detention/retention basin designs, a Safety in Design Report will need to accompany the submission. The Safety in Design Report is a mandatory requirement under Regulations 294-296 of the Work Health and Safety Regulation (2017), and the intent of the report is to identify all hazards and risks associated with the design of a structure (including design for safe construction, design for safe use and design for safe maintenance - as per Section 4 of the Safe Design of Structures Code of Practice), and to identify risk control measures that have been considered and/or put in place.

Council will not undertake a review of detention/retention basin designs without a Safety in Design Report. All basin designs will also need to address scour control; particularly at the inlet point, and the discharge point.

Minimum crossfall for floors is to be 1.0% graded to the outlet point of the structure.

3.10.3.10 GEOTECHNICAL PROPERTIES

Due consideration must be given to the geotechnical aspects of retention/detention structure design, and a full Geotechnical report prepared by a suitably qualified and experienced Geotechnical Engineer is to be submitted with the detailed design documentation.

3.10.3.11 INLET STRUCTURES

Any inlet pipe to a basin shall be fitted with a headwall and an approved structure that will allow debris escape whilst impeding the entry of persons. Access requirements in accordance with 3.10.3.13 shall be followed.

All inlet headwalls shall be fitted with an approved post and rail barrier to prevent falls and to identify the location of headwalls and wingwalls.

3.10.3.12 LOW LEVEL OUTLET STRUCTURES

Culvert outlets from retention/detention structures are to be rubber ring jointed with no lifting holes. Cut-off walls and seepage collars are to be provided as necessary. Pipe and culvert bedding are to be specified to minimise permeability.

Outlet structures must take into account upstream catchment land uses in consideration of potential blocking. Outlets must be designed with debris and scour control devices and energy dissipation structures.

Outlets are to be minimum 375mm RCP with orifice plate(s) installed at the outlet pit to meet peak flow design requirements.

3.10.3.13 ACCESS REQUIREMENTS

All weather access is to be provided to the retention/detention basin and any associated structures to enable maintenance to be carried out. The access should be provided in such a manner that there is no need to reverse a maintenance vehicle at any time. The access should be provided so that maintenance of any portion of the basin and its associated works can be safely carried out. A 3.0 metre width reserve shall be required around the perimeter of all retention/detention basins.

3.10.3.14 FENCING AND SECURITY

Retention basins shall generally be fenced off and made safe against casual entrance. Where batter slopes of detention basins are steeper than the current standard for publicly accessible areas, they shall also be fenced to prevent casual entrance.

3.10.3.15 LANDSCAPING

The floors of all retention/detentions structures and walls of batters 0.5m above floor level shall be appropriately stabilised to prevent erosion and scouring of the drain (in both the short and long term) with turf of an appropriate species. Refer to Section 3.8.2.3. The remainder of internal and external batters of retardation/detention structures shall be provided with topsoil and seeded with appropriate grass species.

A fully detailed landscape plan for all retention/detention basins shall be submitted as part of the landscaping plans required in Part 6 – Landscaping of these Standards.

3.10.3.16 SIGNAGE

Approved signage shall be provided at all retention/detention basins indicating the depth of water and slope of batters. Signs are to be erected such that two signs and one depth indicator are visible from any one point of the basin embankment at any time.

3.10.3.17 MAINTENANCE

Access covers and grates are to be designed so as to enable access for maintenance and cleaning. Any large pipe inlets into the basin shall be grated in a satisfactory manner to prevent entry to the stormwater drain. The grates shall be designed so that they can easily be maintained and so that they will not cause blockages during storm events.

Pits, pipes, screens etc. that require regular cleaning and maintenance shall be readily accessible with all openings of suitable geometry to allow for cleaning and removal of debris and silt accumulations.

3.10.3.18 BASIN CONSTRUCTION AND TESTING REQUIREMENTS

Earth fill requirements

Material	Criteria

Basin Construction:

Basin Testing Requirements:

3.10.4 ON-SITE DETENTION SYSTEMS IN SMALL DEVELOPMENTS

3.10.4.1 OBJECTIVES

On-site detention (OSD) will only be considered for small developments as defined in Section 3.10.1.

The objectives of OSD systems are as follows:

- The capacity of existing drainage infrastructure shall not be exceeded as a result of developments which increase the volume and rate of stormwater runoff beyond the capacities originally designed for;
- The likely cumulative impact of similar developments shall not adversely impact on the capacity of the existing drainage system;
- That OSD systems are able to be effectively maintained by landowners and provide a cost-effective method of meeting the other requirements of this section;
- Provide a simplified method for designers, builders and owners to determine Council's requirements for on-site detention in relation to volume of detention and permissible rate of discharge to Council's drainage system; and
- That OSD systems meet necessary WHS guidelines.

3.10.4.2 GENERAL

On-site detention systems may be required in the following types of small development:

- Any development on an existing lot where post-developed flows exceed existing flows;
- Any development where the capacity of the drainage network downstream of the development will be exceeded by post-developed flows from the development;

- Any development where generated stormwater flows could adversely impact on private property irrespective of the capacity of the downstream drainage network; and
- Any areas identified by Council as drainage problem areas.

On site detention tank systems shall also meet the following requirements:

- The orifice for the detention tank must be readily accessible via detachable plumbing fittings. The orifice outlet diameter shall be clearly indicated on the detention tank signage plate;
- All roof water plumbing including tank connections shall cater for the ARI 20 year, to AS 3500. All roof water and detention tank stormwater calculations shall be considered over the range of 1 in 2 year to 1 in 100 year ARI. Stormwater calculations in the range greater than 1 in 20 year to 1 in 100 year ARI shall consider the roof water system to be at the 1 in 20 year ARI standard;
- An 88B instrument (or similar) shall be provided for the dedicated detention tank for each unit or dwelling;
- All roof water shall be directed to the proposed (Basix) water storage tank. Any roof area that is not directed to the Basix tank, shall be connected to the dedicated detention tank;
- All stormwater overflow from the (Basix) water storage tanks are to be connected to a proposed dedicated detention tank for each unit; and
- On the dedicated detention tank to be provided, signage installed on the tank to clearly indicate the detention tank purpose, refer to Section 3.10.4.6.

Where an OSD system is required for a development, the entire development area is to be considered in OSD calculations. All stormwater runoff, including any bypass should be included in the OSD calculations. Rainwater tanks shall not be included in detention volume calculations. Detention tanks must be dedicated tanks separate to rainwater tanks.

3.10.4.3 Design Criteria

OSD systems shall be designed to maintain the existing undeveloped discharges for all storm durations and frequencies in the range from the 2 year ARI up to and including the 100 year ARI events.

The methods described in Section 3.6.3 of these Standards may be used to calculate peak flows.

The design documentation must clearly describe the proposed storage system and location. The developer shall provide computations in that demonstrate the volume of detention required and the permissible rate of discharge.

3.10.4.4 Overflow

A suitable overflow system must be provided to cater for storm events greater than the design storm and to cater for a blockage in the system. All overflows are to be directed away from buildings, adjoining properties and associated infrastructure and must drain to the legal point of discharge. The overflow system shall be designed to cater for all storms up to and including a 100 year ARI storm event.

The depth of overland flow shall be designed so that it is no higher than 300mm below the lowest floor level of any dwelling impacted by the overflow.

3.10.4.5 Discharge Control Point

Orifice plates shall be designed to be corrosion resistant stainless steel. The outlet is to be protected by a screening device to avoid blocking.

3.10.4.6 Signage

Each OSD system is to be marked by a plate in a prominent position which identifies the OSD system and that it is an offence to reduce the volume of the structure or interfere with the orifice plate that controls the outflow.

The detention tank plate should include the following:

- This is an onsite dedicated detention tank required by Tamworth Regional Council;
- It is an offence to reduce the volume of the detention tank or to interfere with the orifice that controls outflows;
- The detention tank orifice diameter is xx mm; and
- This Plate Must Not Be Removed.

3.10.4.7 Underground (OSD) and Access Requirements

All underground storage tanks shall have suitable access for maintenance and comply with the Occupational Health and Safety Act 2000 and Confined Spaces requirements.

All underground storage tanks shall comply with the Public Health Act 1991.

Access to underground storage tanks must be secured with a grate or cover and fastened to prevent unauthorised access. Access points are not to be concreted, paved, built over or otherwise obstructed.

Access openings must be a minimum:

- 600 mm by 600 mm for storages up to 600 mm deep; or
- 900 mm by 900 mm for storages greater than 600 mm deep.

The floor of underground storages must be graded so that the storage empties under gravity and water does not pool in the tank.

Underground storage tanks may face corrosion and acidic attack. The storage tank type must be resistant to the environment in which it is placed. This applies to both above and below ground installation.

Underground storage tanks must not be installed over or within 1.0m of a water main, sewer main, on-site wastewater system or on-site wastewater disposal field.

Underground storage tanks should not be installed within 1.0m of the drip line of trees. A root barrier shall be installed if underground storage tanks are located adjacent to trees.

Where OSD facilities are located under driveways and parking areas, consideration must be given to the finished surface levels and vehicular access requirements.

OSD storage shall not be installed into the groundwater zone unless detailed computations are provided and approved by council.

3.10.4.8 Above Ground OSD systems:

Above ground OSD may comprise of one or a combination of the following:

- Driveways and carpark areas;
- Tanks of varying configurations;
- Excavated earthen storages;
- Grassed or landscaped areas; or
- OSD system with a Primary (lower) Orifice Outlet and a Secondary High Early Discharge (HED) Outlet.

Above ground tank systems must be separated from BASIX rainwater tanks. Combined rainwater tanks with built in detention offset will not be permitted.

3.10.4.9 Paved Surfaces

- Water ponding depth is to be limited to a depth of 150 mm in areas where vehicles are parked and 180 mm in areas where vehicles are not parked;

- The storage area shall be totally impermeable; and
- Where the surface may be used for traffic or pedestrian movements, flows from minor events up to the peak 5 year ARI event are to be stored underground.

3.10.4.10 LANDSCAPED AREAS

- OSD systems shall not extend across lot boundaries;
- OSD shall meet the following requirements:
    - Water depth shall be no deeper than 1200 mm;
    - Water depth greater than 500 mm shall be fenced with child-proof fencing;
    - A maximum batter slope of 1 in 6 or alternatively a terraced slope system so that the maximum terraced depth is no greater than 300 mm; and
    - Council may consider alternative designs to the above requirements, however public safety shall be addressed and child-proof fencing may be required.
- The floor of the OSD area shall not pond water;
- The bunded wall of the OSD area must be impervious; and
- Where vegetated the storage capacity shall be increased by 20% to allow for vegetation growth.

3.10.4.11 MAINTENANCE OF ON-SITE DETENTION SYSTEMS

Where an OSD system is required the landowner shall be required to maintain these to the satisfaction of Council. A plan of required maintenance procedures and practices for OSD systems shall be supplied with the design documentation.

3.10.5 BASIN WALL CONSTRUCTION REQUIREMENTS

Earth fill material requirements are shown below in Table 3-Q.

Table 3-Q Basin Wall Material Requirements

Material type	Material not to be used directly in basin wall construction
Clays	• Materials with clay (less than 2 microns)content less than 15% • Hard clay lumps which will not readily absorb the required moisture content • Materials with Emerson Class Number of 1 or 2 • Material that have a permeability coefficient of more than 10^{-8}m/s • Materials that are prone to piping and surface erosion • Materials that contain rubbish, roots or organic material • Materials contaminated through past site usage • Materials with plasticity index of less than 10
Material containing large particles after compaction	• Material, stones or rock fragments with dimensions greater than 75mm
Over wet materials	• Over wet materials
Demolition rubble	• Demolition rubble

3.10.5.1 FOUNDATION PREPARATION FOR BASIN WALL CONSTRUCTION:

Scarify the stripped and prepared surfaces as indicated in preparation for pre-rolling. Should the cleared foundation area be dry and cracked prior to scarifying, thoroughly water the area and ensure that compaction of the scarified material complies with the Construction requirements. Pre-roll the foundation with one (1) pass of a padfoot roller immediately after scarification / watering and immediately prior to placement of fill materials.

3.10.5.2 BASIN WALL CONSTRUCTION:

Prior to compaction of the layers, condition all material by breaking fill up into fragments less than 75mm size, laying out in layers of uniform loose thickness, and bringing up to an appropriate water content by aeration and drying or wetting. Spread and compact fill in layers not exceeding 150mm thickness prior to compaction. All layers of fill placed in the works must be uniformly compacted over the full area and depth of the layer to achieve the acceptable compaction specified before the next layer is commenced. Compact fill using a padfoot roller. In confined places or where a padfoot roller may damage adjacent structures hand operated tamping equipment is to be used.

A minimum topsoil cover of 100mm should be applied to batters. A gravel crest layer of minimum 100mm should also be reinstated on the levee crest. The final embankment is to be reconstructed to that of the level pre-works.

3.10.5.3 BASIN TESTING REQUIREMENTS:

- Moisture Content - Maintain moisture content of the fill at the time of placing and compacting within +2% to -1 % of Optimum Moisture Content (OMC) when the particular material is subjected to the Standard Compaction Test (AS1289.5.1.1).
- Fill Density - Compact each layer until the dry density ratio is in excess of 98% of the maximum dry density as determined by the standard compaction test (AS1289.5.3.1).

The density and moisture content of the compacted fill shall be monitored using the Nuclear Densometer Method or Compaction Control Test - Rapid Method given in RTA Test Method T162.

3.10.6 CONTROL TEST FREQUENCY SHALL BE ONE TEST PER 100M3.PRESCRIBED DAMS

Council will expect the Design Engineer to prepare a risk assessment report for all drainage structures, including basins and associated structures. The risk assessment should be undertaken in accordance with the principles of AS/NZS 31000, 2009 Risk Management. Additionally, if the detention basin poses a high risk (in terms of potential risk/threat to downstream property/community) when assessed using the Australian National Committee on Large Dams (ANCOLD) guidelines then Council will expect that the structure will be designed, and the construction to be supervised and approved, by a qualified engineer with specific expertise in the field. The Design Engineer will be responsible for deciding on the action required in response to the risk assessment report and its recommendations, but should consult with Council if the recommendations are complicated, require community involvement, or may involve significant ongoing maintenance issues. Council will expect the Design Engineer to include a copy of the risk assessment report, with recommendations and associated works, when submitting the detailed design documentation for review and approval.

3.11 Drainage Corridor Tenure

Where inter-allotment stormwater drainage, piped or otherwise, is designed to discharge onto land other than an existing drainage easement, drainage reserve, public road or other legal point of discharge or public place as approved by the Director, it shall be the responsibility of the developer to obtain a drainage easement through such land, sufficient in dimension to convey the drainage to an easement, natural watercourse or public place, and to transfer easement rights thereover to each upstream beneficiary of the inter-allotment drainage line. Tamworth Regional Council is not to be named as a beneficiary of easements for the purposes of inter-allotment drainage.

Where minor system stormwater drainage, piped or otherwise, is designed to discharge onto land other than an existing drainage easement, drainage reserve, public road or other legal point of

discharge, it shall be the responsibility of the developer to obtain a drainage easement through such land, sufficient in dimension to convey the drainage to an easement, natural watercourse or public place, and to transfer easement rights thereover to Council.

Where major system stormwater drainage, piped or otherwise, is designed to discharge onto land other than a roadway, an existing drainage reserve or other public place, the land shall be dedicated as a drainage reserve, sufficient in dimension to convey the drainage to a natural watercourse or other public place, and to transfer ownership thereover to Council.

Where it is intended to create drainage easements or drainage reserves in a subdivision or development, a notation shall appear on the engineering drawings and subdivision plan creating the easement or easements pursuant to Section 88B of the Conveyancing Act, 1919 as amended.

Where a drainage easement to the benefits of Council lies within a development that does not involve the opening of a new road, the developer shall transfer to Council any drainage easement provided in the subdivision and execute a transfer and grant of easement in favour of Council pursuant to Section 88B of the Conveyancing Act, 1919 as amended.

Where stormwater is designed to discharge into a public park, an open grassed channel shall be provided to meet the minor/major design requirements of these Standards.

The Subdivision certificate will not be released until the above requirements have been complied with, and all fees and contributions have been paid.

Where diversion banks are required they shall be protected by a Restriction of the Use Of Land that cannot be modified without the permission of Council.

3.11.1 WIDTH OF EASEMENTS AND RESERVES

Table 3-R - Corridor Width and Type

Type of Drainage	Width	Corridor Type
Inter-allotment Drainage	1.5 metres	Easement identifying lots benefiting
Piped Drainage (Greater of)	Width of trench plus twice the depth of trench	Easement benefiting Council or Drainage reserve
	3.0 metres	
Open Channels	1m plus top width of 1.25 times 100 year ARI design flow.	Easement benefiting Council, Road Reserve or Drainage reserve
Trunk Drainage Pipes (Greater of)	Width of trench plus twice the depth of trench	Easement benefiting Council or Drainage reserve
	3.0 metres	
Trunk Drainage Channels	1m plus top width of 100 year ARI design flow with 500mm freeboard	Easement benefiting Council or Drainage reserve

For each proposed drainage corridor Council will determine whether it shall be a drainage reserve or easement on a case by case basis.

3.12 APPENDIX A – Information to be Shown on Drawings – Stormwater Drainage

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
1)	**General**			
a)	Cover Sheet with Locality Plan and List of Drawings			
b)	Plans prepared in A1 format at a scale of 1:500			
c)	Drawing Scale is shown on drawings as a bar scale			
d)	Scale of Detail Drawings is shown as appropriate			
e)	Schedule of Symbols			
f)	Benchmark within 100 metres of development site is shown			
g)	North Point shown			
h)	Site topography is shown via contour lines			
2)	**Drainage Layout Plans**			
a)	Catchment area plan including sub-catchments and areas is submitted			
b)	Existing services and drainage structures are shown			
c)	Lot boundaries and numbers shown			
d)	Pipeline or table drains are numbered			
e)	Pipeline or table drain centreline chainages are shown			
f)	Pipeline diameters or table drain cross-sections are shown			
g)	Kerb or table drain profiles are clearly nominated			
h)	Location of pits shown			
i)	Type and size of pits clearly indicated			
j)	Location and dimensions of any proposed easements or drainage reserves is shown			
k)	Location of major system overland flow path shown			
l)	Natural drainage paths are shown			
m)	Location of natural watercourse to be drained to is identified			

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
n)	Location of any retention, detention or water quality devices is shown			
3)	**Drainage Longitudinal Sections**			
a)	Longitudinal sections are drawn at scale of 1:500 horizontal and 1:100 vertical			
b)	Longitudinal section shows the following;			
i)	Chainages			
ii)	RL of existing surface at each inlet structure, outlet structure, pit and/or change of grade			
iii)	Design RL of all inlet and outlet structures; pit, pipe and table drain inverts, pit inlets and all changes of grade			
iv)	Design grades including length of each gradient			
v)	Pipe diameters and classes and/or table drain capacities is shown.			
vi)	Hydraulic Grade Line Analysis results as per AR&R			
vii)	Location of existing and proposed services and utilities			
4)	**Open Channel Drainage Cross-Sections**			
a)	Cross-sections are drawn at scale of 1:100 natural			
b)	Cross sections show the following at no more than 20 metre intervals and at all intermediate changes of grade or profile;			
i)	Chainages			
ii)	RL of existing surface			
iii)	Design RL of open channel invert and top of batters			
iv)	Batter slopes of open channels are shown			
v)	Section profiles of all open channels is shown			
vi)	Details of low-flow pipes and/or lined inverts is shown			
vii)	Details of Sub-Soil Drainage (if required)			
c)	Sections of pits including details of access covers and access provisions is shown			

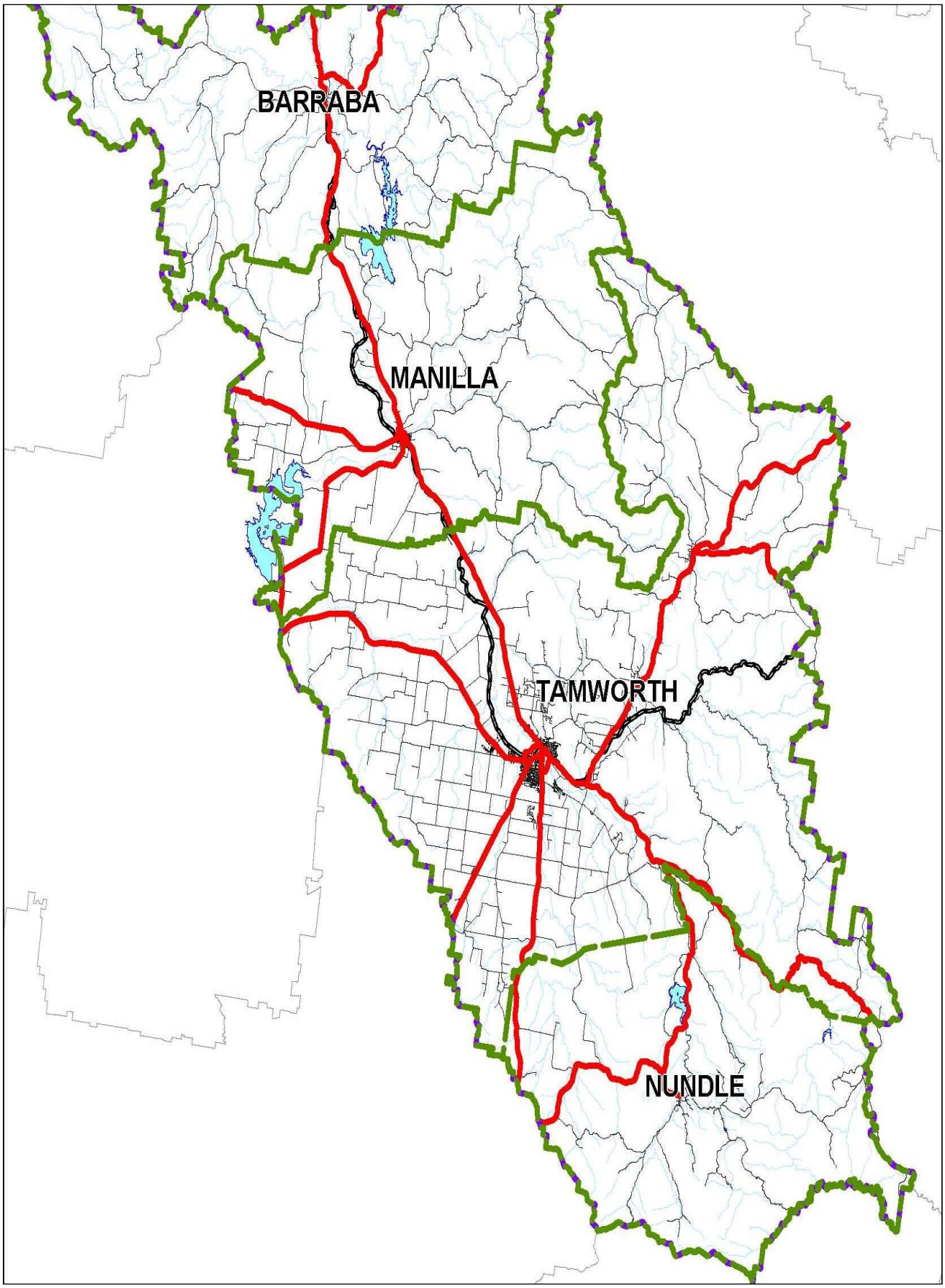
Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
d)	Scour protection details shown			
5)	**Miscellaneous**			
a)	Location and details of any Water Quality devices is shown			
b)	Location and details of any batter catch-drains			
c)	Details of the type of vegetation to be used on batters			
d)	Scour protection to all outlet structures is shown			
6)	**Basins**			
a)	Contours shown			
b)	Grades of batters			
c)	Depth indicated with spot levels			
d)	Basin elevation / volume relationship at 100mm intervals			
e)	Surface area tabulated (where applicable)			
f)	Crest width			
g)	Low level outlet details			
h)	Scour protection			
i)	Signage – depth markers, warning signs,			
j)	Safety in design report			
k)	Batter slopes, depth and typical section of any retention/detention structures is shown			
l)	Spillway Capacity – Q100			

3.13 APPENDIX B – Checklists - Stormwater Drainage

Item No.	Description	Reference	Developer Confirmation	TRC Confirmation	Comments
1	Stormwater Servicing Strategy including catchment areas and flow paths	3.5.2			
2	Hydrological Modelling, including details of start-up parameters used in computer modelling	3.7.1			
3	Hydrological Design Sheets used for sub-area discharge calculations	3.7.4			
4	Hydraulic Design Sheet used for calculating Major System flows	3.8			
5	V x D <= 0.4	3.9.1.1			
6	Width of flow in gutters between pits does not exceed 2.5m	3.9.1.1			
7	Volume of flow in K&G does not exceed 20l/s and/or width of flow does not exceed 1m at upstream tangent points of curves/kerb returns	3.9.1			
8	Required vertical drops across pits have been achieved;	3.9.2			
9	Tailwater levels have been included and the effects have been accounted for	3.9.3.3			
10	Bypass from any pit on grade does not exceed 15% of the total flow at the pit	3.9.1.1			
11	Hydraulic Design Sheet used for pipeline design and HGL analysis	3.9.3			
12	Culvert Design Calculations	3.9.3.7			
13	Details of modelling or calculations used for Trunk Drainage System Design	3.14			
14	Details of geofabric used for slope stabilisation	3.15.1.4			
15	Hydrological/hydraulic assessment and design of retention/detention structures	3.16.3			
16	Risk Analysis for retention/detention structures	3.16.3.2			

17	Geotechnical Report for proposed retention/detention structures	3.16.3.9			
18	Landscape plan for retention/detention structures	3.16.3.14			
19	Details of proposed OSD systems	3.16.4			
20	Hydrological/hydraulic assessment and design of OSD systems	3.16.4.3			
21	Maintenance Plan for OSD systems	3.16.4.11			
22	All pipe sizes in the model correspond with pipe sizes in your plan set				
23	Safety in Design Report	1.5.2			

3.14 APPENDIX C - Map 1; Design IFD Zones – Stormwater Drainage



3.15 APPENDIX D – IFD Data for each IFD Zone – Stormwater Drainage

Rainfall Intensity Frequency Duration data for; Tamworth NSW
Geographic Location: 31.0833 Deg. South 150.9333 Deg. East
AUSIFD Version 2.0 1-Feb 2010

Duration	1 Year ARI (mm/hour)	2 Year ARI (mm/hour)	5 Year ARI (mm/hour)	10 Year ARI (mm/hour)	20 Year ARI (mm/hour)	50 Year ARI (mm/hour)	100 Year ARI (mm/hour)
5 minutes	69	90	115	132	154	184	208
5.5 minutes	67	87	111	127	148	177	200
6 minutes	65	84	108	123	143	171	193
6.5 minutes	63	82	104	119	138	165	187
7 minutes	61	79	101	115	134	160	181
7.5 minutes	60	77	98	112	130	156	176
8 minutes	58	75	96	109	127	151	171
8.5 minutes	57	73	93	106	123	147	166
9 minutes	55	72	91	103	120	143	162
9.5 minutes	54	70	89	101	117	140	158
10 minutes	53	68	87	99	115	137	154
11 minutes	51	66	83	94	110	130	147
12 minutes	49	63	80	91	105	125	141
13 minutes	47.3	61	77	87	101	120	135
14 minutes	45.7	59	74	84	97	116	130
15 minutes	44.3	57	72	81	94	112	126
16 minutes	42.9	55	70	79	91	108	121
17 minutes	41.7	54	68	76	88	105	118
18 minutes	40.6	52	66	74	86	101	114
19 minutes	39.5	51	64	72	83	98	111
20 minutes	38.5	49.5	62	70	81	96	107
21 minutes	37.6	48.3	61	68	79	93	105
22 minutes	36.7	47.2	59	67	77	91	102
23 minutes	35.9	46.1	58	65	75	89	99
24 minutes	35.1	45.1	56	63	73	86	97
25 minutes	34.4	44.2	55	62	72	84	95
26 minutes	33.7	43.2	54	61	70	83	92
27 minutes	33.1	42.4	53	59	68	81	90
28 minutes	32.4	41.6	52	58	67	79	89
29 minutes	31.8	40.8	51	57	66	77	87
30 minutes	31.3	40.1	49.9	56	64	76	85
32 minutes	30.2	38.7	48.1	54	62	73	82
34 minutes	29.2	37.4	46.5	52	60	70	79
36 minutes	28.3	36.3	45	50	58	68	76
38 minutes	27.5	35.2	43.6	48.8	56	66	74
40 minutes	26.7	34.2	42.3	47.3	54	64	71
45 minutes	25	32	39.5	44.1	51	59	66
50 minutes	23.6	30.1	37.1	41.4	47.3	55	62
55 minutes	22.3	28.5	35	39	44.6	52	58
60 minutes	21.2	27.1	33.2	37	42.2	49.3	55
75 minutes	18.3	23.4	28.7	31.9	36.4	42.6	47.4
90 minutes	16.2	20.7	25.4	28.2	32.3	37.7	41.9
105 minutes	14.6	18.6	22.9	25.4	29.1	34	37.8
120 minutes	13.4	17	20.9	23.2	26.5	31	34.5
135 minutes	12.3	15.7	19.3	21.4	24.5	28.6	31.8
150 minutes	11.5	14.6	17.9	19.9	22.8	26.6	29.6
165 minutes	10.7	13.7	16.8	18.7	21.3	24.9	27.7
180 minutes	10.1	12.9	15.8	17.6	20.1	23.5	26.1
195 minutes	9.58	12.2	15	16.6	19	22.2	24.7
210 minutes	9.1	11.6	14.2	15.8	18.1	21.1	23.5
225 minutes	8.68	11.1	13.6	15.1	17.2	20.1	22.4
240 minutes	8.3	10.6	13	14.4	16.5	19.3	21.4
270 minutes	7.66	9.75	12	13.3	15.2	17.8	19.8
5 hours	7.12	9.07	11.1	12.4	14.1	16.5	18.4
6 hours	6.28	8	9.82	10.9	12.5	14.6	16.2
7 hours	5.65	7.2	8.83	9.82	11.2	13.1	14.6
8 hours	5.16	6.57	8.06	8.96	10.2	12	13.3
9 hours	4.76	6.06	7.43	8.27	9.44	11	12.3
10 hours	4.43	5.64	6.92	7.69	8.79	10.3	11.4
11 hours	4.15	5.28	6.48	7.21	8.23	9.61	10.7
12 hours	3.91	4.98	6.11	6.79	7.75	9.06	10.1
14 hours	3.51	4.47	5.51	6.14	7.02	8.22	9.16
16 hours	3.19	4.07	5.03	5.62	6.44	7.55	8.43
18 hours	2.93	3.75	4.65	5.2	5.97	7.01	7.83
20 hours	2.72	3.48	4.33	4.85	5.57	6.55	7.33
22 hours	2.54	3.26	4.06	4.55	5.23	6.16	6.9
24 hours	2.39	3.06	3.82	4.29	4.94	5.83	6.53
30 hours	2.03	2.61	3.27	3.69	4.26	5.04	5.66
36 hours	1.77	2.28	2.88	3.25	3.76	4.46	5.02
42 hours	1.57	2.03	2.57	2.91	3.38	4.01	4.52
48 hours	1.42	1.83	2.33	2.64	3.07	3.66	4.13
54 hours	1.29	1.67	2.13	2.42	2.82	3.36	3.8
60 hours	1.18	1.53	1.96	2.23	2.6	3.11	3.52
66 hours	1.09	1.42	1.82	2.07	2.42	2.9	3.28
72 hours	1.01	1.31	1.69	1.93	2.26	2.71	3.07

Rainfall Intensity Frequency Duration data for; Barraba NSW
Geographic Location: 30.3833 Deg. South 150.6167 Deg. East

AUSIFD Version 2.0 24-Feb 2010

Duration	1 Year ARI (mm/hour)	2 Year ARI (mm/hour)	5 Year ARI (mm/hour)	10 Year ARI (mm/hour)	20 Year ARI (mm/hour)	50 Year ARI (mm/hour)	100 Year ARI (mm/hour)
5 minutes	74	97	129	150	178	217	250
5.5 minutes	71	94	125	145	172	210	241
6 minutes	69	91	121	140	166	203	234
6.5 minutes	67	88	117	136	162	197	227
7 minutes	65	86	114	132	157	192	220
7.5 minutes	64	84	111	129	153	187	214
8 minutes	62	81	108	125	149	182	209
8.5 minutes	60	79	105	122	145	177	204
9 minutes	59	78	103	120	142	173	199
9.5 minutes	58	76	101	117	139	169	194
10 minutes	56	74	98	114	136	166	190
11 minutes	54	71	94	110	130	159	182
12 minutes	52	69	91	106	125	153	176
13 minutes	50	66	88	102	121	147	169
14 minutes	48.6	64	85	98	117	142	164
15 minutes	47.1	62	82	95	113	138	158
16 minutes	45.7	60	79	92	110	134	153
17 minutes	44.4	58	77	90	106	130	149
18 minutes	43.2	57	75	87	103	126	145
19 minutes	42	55	73	85	101	123	141
20 minutes	41	54	71	83	98	120	137
21 minutes	40	53	70	81	96	117	134
22 minutes	39.1	51	68	79	93	114	131
23 minutes	38.2	50	66	77	91	112	128
24 minutes	37.4	49	65	75	89	109	125
25 minutes	36.6	48	64	74	87	107	123
26 minutes	35.8	47	62	72	86	105	120
27 minutes	35.1	46.1	61	71	84	103	118
28 minutes	34.5	45.2	60	69	82	101	115
29 minutes	33.8	44.4	59	68	81	99	113
30 minutes	33.2	43.6	58	67	79	97	111
32 minutes	32.1	42.1	56	65	77	94	107
34 minutes	31	40.8	54	63	74	90	104
36 minutes	30.1	39.5	52	61	72	88	101
38 minutes	29.2	38.3	51	59	70	85	98
40 minutes	28.4	37.2	49.3	57	68	83	95
45 minutes	26.6	34.9	46.1	53	63	77	89
50 minutes	25	32.8	43.4	50	60	73	83
55 minutes	23.7	31.1	41.1	47.6	56	69	79
60 minutes	22.5	29.5	39	45.3	54	65	75
75 minutes	19.5	25.5	33.5	38.8	45.9	56	64
90 minutes	17.2	22.5	29.6	34.2	40.3	49	56
105 minutes	15.5	20.3	26.6	30.6	36.1	43.8	50
120 minutes	14.2	18.5	24.2	27.9	32.8	39.7	45.3
135 minutes	13.1	17.1	22.3	25.6	30.1	36.5	41.6
150 minutes	12.2	15.9	20.7	23.8	27.9	33.7	38.4
165 minutes	11.4	14.9	19.3	22.2	26.1	31.5	35.8
180 minutes	10.8	14	18.2	20.8	24.5	29.5	33.6
195 minutes	10.2	13.3	17.2	19.7	23.1	27.8	31.6
210 minutes	9.7	12.6	16.3	18.7	21.9	26.3	29.9
225 minutes	9.25	12	15.5	17.8	20.8	25	28.4
240 minutes	8.85	11.5	14.8	16.9	19.8	23.8	27.1
270 minutes	8.17	10.6	13.6	15.6	18.2	21.9	24.8
5 hours	7.6	9.85	12.6	14.4	16.9	20.2	22.9
6 hours	6.71	8.69	11.1	12.7	14.8	17.7	20
7 hours	6.04	7.81	9.97	11.3	13.2	15.8	17.9
8 hours	5.52	7.13	9.07	10.3	12	14.3	16.2
9 hours	5.09	6.57	8.35	9.47	11	13.1	14.8
10 hours	4.74	6.12	7.75	8.78	10.2	12.1	13.7
11 hours	4.44	5.73	7.25	8.2	9.52	11.3	12.8
12 hours	4.19	5.4	6.82	7.71	8.94	10.6	12
14 hours	3.74	4.83	6.11	6.92	8.03	9.56	10.8
16 hours	3.4	4.38	5.56	6.31	7.33	8.73	9.85
18 hours	3.12	4.03	5.12	5.81	6.75	8.05	9.09
20 hours	2.88	3.73	4.75	5.39	6.27	7.49	8.46
22 hours	2.69	3.48	4.43	5.04	5.87	7.01	7.93
24 hours	2.52	3.26	4.16	4.74	5.52	6.6	7.46
30 hours	2.13	2.76	3.54	4.03	4.7	5.64	6.39
36 hours	1.85	2.4	3.09	3.52	4.12	4.94	5.61
42 hours	1.64	2.13	2.75	3.14	3.67	4.41	5.01
48 hours	1.47	1.92	2.47	2.83	3.31	3.99	4.53
54 hours	1.34	1.74	2.25	2.58	3.02	3.64	4.14
60 hours	1.22	1.59	2.06	2.37	2.78	3.35	3.81
66 hours	1.13	1.47	1.91	2.19	2.57	3.1	3.53

Rainfall Intensity Frequency Duration data for; Manilla NSW
Geographic Location: 30.75 Deg. South 150.7167 Deg. East

AUSIFD Version 2.0 24-Feb 2010

Duration	1 Year ARI (mm/hour)	2 Year ARI (mm/hour)	5 Year ARI (mm/hour)	10 Year ARI (mm/hour)	20 Year ARI (mm/hour)	50 Year ARI (mm/hour)	100 Year ARI (mm/hour)
5 minutes	68	89	117	135	160	195	223
5.5 minutes	65	86	113	130	154	188	215
6 minutes	63	83	109	126	149	181	207
6.5 minutes	62	81	106	122	144	176	201
7 minutes	60	78	103	119	140	170	195
7.5 minutes	58	76	100	115	136	165	189
8 minutes	57	74	97	112	133	161	184
8.5 minutes	55	72	95	109	129	157	179
9 minutes	54	71	93	107	126	153	175
9.5 minutes	53	69	90	104	123	149	170
10 minutes	52	68	88	102	120	146	166
11 minutes	49.6	65	85	98	115	139	159
12 minutes	47.8	62	81	94	111	134	153
13 minutes	46.1	60	78	90	106	129	147
14 minutes	44.5	58	76	87	103	124	142
15 minutes	43.1	56	73	84	99	120	137
16 minutes	41.8	55	71	82	96	116	132
17 minutes	40.6	53	69	79	93	113	128
18 minutes	39.5	51	67	77	90	109	124
19 minutes	38.5	50	65	75	88	106	121
20 minutes	37.5	48.9	63	73	86	103	118
21 minutes	36.6	47.7	62	71	83	101	115
22 minutes	35.7	46.5	60	69	81	98	112
23 minutes	34.9	45.5	59	68	79	96	109
24 minutes	34.2	44.5	58	66	78	94	106
25 minutes	33.5	43.5	56	65	76	91	104
26 minutes	32.8	42.7	55	63	74	89	102
27 minutes	32.1	41.8	54	62	73	88	100
28 minutes	31.5	41	53	61	71	86	98
29 minutes	30.9	40.2	52	60	70	84	96
30 minutes	30.4	39.5	51	58	68	82	94
32 minutes	29.3	38.1	49.2	56	66	79	90
34 minutes	28.4	36.9	47.6	54	64	77	87
36 minutes	27.5	35.7	46.1	53	62	74	84
38 minutes	26.7	34.7	44.7	51	60	72	82
40 minutes	26	33.7	43.4	49.6	58	70	79
45 minutes	24.3	31.5	40.5	46.2	54	65	74
50 minutes	22.9	29.7	38.1	43.4	51	61	69
55 minutes	21.6	28.1	36	41	47.8	57	65
60 minutes	20.6	26.7	34.1	38.9	45.4	54	62
75 minutes	17.7	22.9	29.3	33.4	38.9	46.6	53
90 minutes	15.6	20.2	25.8	29.4	34.2	41	46.4
105 minutes	14	18.2	23.2	26.4	30.7	36.7	41.5
120 minutes	12.8	16.5	21.1	24	27.9	33.4	37.8
135 minutes	11.8	15.2	19.4	22.1	25.7	30.7	34.7
150 minutes	10.9	14.1	18	20.5	23.8	28.4	32.2
165 minutes	10.2	13.2	16.8	19.1	22.2	26.6	30
180 minutes	9.61	12.4	15.8	18	20.9	24.9	28.2
195 minutes	9.08	11.7	14.9	17	19.7	23.5	26.6
210 minutes	8.61	11.1	14.2	16.1	18.7	22.3	25.2
225 minutes	8.2	10.6	13.5	15.3	17.8	21.2	24
240 minutes	7.84	10.1	12.9	14.6	17	20.3	22.9
270 minutes	7.21	9.31	11.8	13.4	15.6	18.6	21
5 hours	6.69	8.64	11	12.4	14.5	17.2	19.5
6 hours	5.89	7.6	9.64	10.9	12.7	15.1	17.1
7 hours	5.28	6.81	8.64	9.79	11.4	13.5	15.3
8 hours	4.81	6.2	7.85	8.9	10.3	12.3	13.9
9 hours	4.42	5.71	7.22	8.18	9.49	11.3	12.7
10 hours	4.11	5.3	6.7	7.59	8.8	10.5	11.8
11 hours	3.84	4.95	6.27	7.09	8.22	9.78	11
12 hours	3.61	4.66	5.89	6.66	7.73	9.19	10.4
14 hours	3.27	4.21	5.31	6	6.95	8.26	9.3
16 hours	2.99	3.85	4.85	5.48	6.34	7.52	8.47
18 hours	2.77	3.56	4.48	5.05	5.84	6.93	7.79
20 hours	2.58	3.32	4.17	4.7	5.43	6.43	7.23
22 hours	2.42	3.11	3.9	4.4	5.08	6.01	6.76
24 hours	2.29	2.94	3.68	4.14	4.78	5.65	6.35
30 hours	1.97	2.52	3.15	3.54	4.08	4.82	5.4
36 hours	1.73	2.22	2.76	3.1	3.57	4.21	4.72
42 hours	1.55	1.99	2.47	2.77	3.18	3.75	4.2
48 hours	1.41	1.8	2.24	2.5	2.88	3.38	3.79
54 hours	1.29	1.65	2.04	2.28	2.62	3.08	3.45
60 hours	1.19	1.52	1.88	2.1	2.41	2.83	3.16
66 hours	1.11	1.41	1.74	1.95	2.23	2.62	2.92
72 hours	1.03	1.32	1.62	1.81	2.07	2.43	2.71

Rainfall Intensity Frequency Duration data for; Nundle NSW
Geographic Location: 31.4667 Deg. South 151.1333 Deg. East

AUSIFD Version 2.0 24-Feb 2010

Duration	1 Year ARI (mm/hour)	2 Year ARI (mm/hour)	5 Year ARI (mm/hour)	10 Year ARI (mm/hour)	20 Year ARI (mm/hour)	50 Year ARI (mm/hour)	100 Year ARI (mm/hour)
5 minutes	68	89	115	132	155	186	212
5.5 minutes	66	86	111	127	149	179	204
6 minutes	64	83	107	123	144	173	197
6.5 minutes	62	81	104	119	140	168	190
7 minutes	60	78	101	116	135	163	184
7.5 minutes	59	76	98	112	131	158	179
8 minutes	57	74	96	109	128	153	174
8.5 minutes	56	72	93	107	125	149	169
9 minutes	55	71	91	104	121	146	165
9.5 minutes	53	69	89	102	119	142	161
10 minutes	52	68	87	99	116	139	157
11 minutes	50	65	83	95	111	133	150
12 minutes	48.2	62	80	91	106	127	144
13 minutes	46.5	60	77	88	102	122	138
14 minutes	45	58	74	85	99	118	133
15 minutes	43.6	56	72	82	95	114	128
16 minutes	42.2	55	70	79	92	110	124
17 minutes	41	53	68	77	89	106	120
18 minutes	39.9	52	66	75	87	103	117
19 minutes	38.9	50	64	72	84	100	113
20 minutes	37.9	48.9	62	71	82	98	110
21 minutes	37	47.8	61	69	80	95	107
22 minutes	36.1	46.6	59	67	78	93	104
23 minutes	35.3	45.6	58	65	76	90	102
24 minutes	34.6	44.6	57	64	74	88	99
25 minutes	33.9	43.6	55	63	72	86	97
26 minutes	33.2	42.7	54	61	71	84	95
27 minutes	32.5	41.9	53	60	69	82	93
28 minutes	31.9	41.1	52	59	68	81	91
29 minutes	31.3	40.3	51	58	67	79	89
30 minutes	30.8	39.6	50	56	65	78	87
32 minutes	29.7	38.2	48.2	54	63	75	84
34 minutes	28.8	37	46.6	53	61	72	81
36 minutes	27.9	35.8	45.1	51	59	70	78
38 minutes	27.1	34.8	43.7	49.2	57	67	76
40 minutes	26.3	33.8	42.4	47.8	55	65	73
45 minutes	24.6	31.6	39.6	44.5	51	61	68
50 minutes	23.2	29.7	37.2	41.8	48.2	57	64
55 minutes	22	28.1	35.1	39.4	45.4	53	60
60 minutes	20.9	26.7	33.3	37.4	43	51	57
75 minutes	18.3	23.4	29.2	32.8	37.8	44.5	49.9
90 minutes	16.4	21	26.2	29.5	34	40.1	44.9
105 minutes	14.9	19.1	23.9	26.9	31	36.6	41
120 minutes	13.7	17.6	22.1	24.8	28.6	33.8	37.9
135 minutes	12.7	16.4	20.5	23.1	26.7	31.6	35.4
150 minutes	11.9	15.3	19.3	21.7	25.1	29.6	33.3
165 minutes	11.2	14.4	18.2	20.5	23.7	28	31.4
180 minutes	10.6	13.7	17.2	19.4	22.5	26.6	29.9
195 minutes	10.1	13	16.4	18.5	21.4	25.3	28.5
210 minutes	9.66	12.4	15.7	17.7	20.5	24.3	27.3
225 minutes	9.26	11.9	15	17	19.6	23.3	26.2
240 minutes	8.89	11.4	14.4	16.3	18.9	22.4	25.2
270 minutes	8.26	10.6	13.4	15.2	17.6	20.9	23.5
5 hours	7.73	9.96	12.6	14.2	16.5	19.6	22.1
6 hours	6.9	8.9	11.3	12.8	14.8	17.6	19.8
7 hours	6.27	8.09	10.3	11.6	13.5	16	18.1
8 hours	5.77	7.44	9.46	10.7	12.4	14.8	16.7
9 hours	5.36	6.92	8.8	9.99	11.6	13.8	15.6
10 hours	5.02	6.49	8.26	9.37	10.9	13	14.6
11 hours	4.73	6.11	7.79	8.85	10.3	12.3	13.8
12 hours	4.48	5.79	7.39	8.4	9.76	11.6	13.1
14 hours	4.03	5.22	6.65	7.56	8.79	10.5	11.8
16 hours	3.68	4.76	6.07	6.9	8.03	9.58	10.8
18 hours	3.4	4.39	5.6	6.37	7.41	8.84	9.98
20 hours	3.16	4.08	5.21	5.92	6.89	8.22	9.28
22 hours	2.96	3.82	4.88	5.54	6.45	7.7	8.69
24 hours	2.78	3.6	4.59	5.22	6.07	7.25	8.18
30 hours	2.38	3.07	3.92	4.46	5.19	6.19	7
36 hours	2.08	2.69	3.44	3.91	4.55	5.43	6.14
42 hours	1.86	2.4	3.07	3.49	4.06	4.85	5.48
48 hours	1.68	2.17	2.78	3.16	3.68	4.39	4.96
54 hours	1.53	1.98	2.54	2.88	3.36	4.01	4.53
60 hours	1.41	1.82	2.33	2.65	3.09	3.69	4.17
66 hours	1.31	1.69	2.16	2.46	2.86	3.41	3.86
72 hours	1.21	1.57	2.01	2.28	2.66	3.18	3.59

3.16 APPENDIX E – Hydrological Design Sheet – Stormwater Drainage

Hydrological Design Sheet 2										
Project ID:								Prepared By:		
Reference:								Date:		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Pipe	Full - Area				Partial - Area				Adopted Flow-Rate (Litres/sec) Greater of [5] & [9])	Remarks
	Time (T_c) (mins)	Intensity (I) (mm/hour)	∑C*A (ha)	Q=CIA/0.36 [(3)x(4)/0.36] (litres/sec)	Time (T_c) (mins)	Intensity (I) (mm/hour)	∑C*A (ha)	Q=CIA/0.36 [(7)x(8)/0.36] (litres/sec)		

Hydrological Design Sheet 3																			
Project ID:								Prepared By:											
Reference:								Date:											
(1)	(2)	(3)	(4)	(5)		(6)	(7)	(8)	(9)	(10)		(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Location	Land Use Type	Flow Times						Intensity (I) (mm/hour)	Runoff Co-efficient (C)	Area (A) (ha)	Area (A) (km^2)	CA (ha) [(9)x(10)]	∑ CA (ha)	Q=CIA/0.36 [(8)x(12)/0.36]	Cumulative Pit Capacities (l/sec)	Downstream Pipe Capacity (l/sec)	Road Flow-rate; [13] lesser of [14] & [15] (l/sec)	Road Capacity Check	Remarks
		Flow Length (m)	Slope (S) (m/m)	n*	$t.I^{0.4}$	Time (T) (mins)	Total Time (min)												

Hydraulic Design Sheet

Project ID:		Prepared By:		
Reference:		Date:		

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
																Upstream Invert Levels (m AHD)				Downstream Inverts (m AHD)			
Pipe	Length (L) (m)	Design Flow Rate (Q) (l/sec)	Trial Pipe Diameter (m)	Full Pipe Velocity (V) (m/sec)	$V^2/2g$ (m)	U/S Surface Level (m AHD)	U/S Pit Water Level Limit* (m)	Pit Pressure Change Co-efficient k_u or k_w	$k \cdot V^2/2g$ (m) [9] x [6]	HGL at U/S Pit (m) [8] - [10]	HGL Slope S_f (m/m)	Pipe Friction Loss $S_f \cdot L$ [12] x [2]	HGL at D/S Pit (m) [11] - [13]	D/S Pit Surface Level (m AHD)	D/S Pit Water Level Limit** (m)	Hydraulic [11] - [4]	Cover [7] - Cover	U/S Pipe [23] - drop	Adopted; Lowest of [17], [18] & [19]	Hydraulic [11] - [4]	Cover [7] - Cover	Adopted; Lowest of [21] & [22]	Remarks

Hydraulic Checking Sheet													
Project ID:								Prepared By:					
Reference:								Date:					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Pipe	Length (L) (m)	Design Flow Rate (Q) (l/sec)	Pipe Diameter (m)	Full Pipe Velocity (V) (m/sec)	$V^2/2g$ (m)	D/S HGL Level (m AHD)	Pipe Friction Loss $S_f . L$ (m)	HGL just below U/S Pit (m) [7] + [8]	Obvert Level at Upper End of Pipe (m)	Pit Pressure Change Co-efficient k_U or k_W	$k . V^2/2g$ (m) [11] x [6]	Adopted U/S Pit HGL (or water) Level* (m)	U/S Surface Level (m AHD)

3.17 APPENDIX F - Quick Reference Table for Runoff Co-efficients

TAMWORTH - QUICK REFERENCE TABLE FOR RUNOFF CO-EFFICIENTS							
Fraction Impervious (f)	C1	C2	C5	C10	C20	C50	C100
0	0.21	0.22	0.25	0.26	0.27	0.30	0.31
0.05	0.23	0.25	0.28	0.29	0.30	0.33	0.35
0.1	0.26	0.27	0.31	0.32	0.34	0.37	0.39
0.15	0.28	0.30	0.34	0.35	0.37	0.41	0.43
0.2	0.31	0.33	0.37	0.39	0.41	0.44	0.46
0.25	0.33	0.36	0.40	0.42	0.44	0.48	0.50
0.3	0.36	0.38	0.43	0.45	0.47	0.52	0.54
0.35	0.39	0.41	0.46	0.48	0.51	0.56	0.58
0.4	0.41	0.44	0.49	0.51	0.54	0.59	0.62
0.45	0.44	0.46	0.52	0.55	0.57	0.63	0.66
0.5	0.46	0.49	0.55	0.58	0.61	0.67	0.69
0.55	0.49	0.52	0.58	0.61	0.64	0.70	0.73
0.6	0.51	0.55	0.61	0.64	0.68	0.74	0.77
0.65	0.54	0.57	0.64	0.68	0.71	0.78	0.81
0.7	0.57	0.60	0.67	0.71	0.74	0.81	0.85
0.75	0.59	0.63	0.70	0.74	0.78	0.85	0.89
0.8	0.62	0.66	0.73	0.77	0.81	0.89	0.93
0.85	0.64	0.68	0.76	0.80	0.84	0.92	0.96
0.9	0.67	0.71	0.79	0.84	0.88	0.96	1.00
0.95	0.69	0.74	0.82	0.87	0.91	1.00	1.00
1	0.72	0.77	0.86	0.90	0.95	1.00	1.00
BARRABA – QUICK REFERENCE TABLE FOR RUNOFF CO-EFFICIENTS							
Fraction Impervious (f)	C1	C2	C5	C10	C20	C50	C100
0	0.30	0.31	0.35	0.37	0.39	0.43	0.44
0.05	0.32	0.34	0.38	0.40	0.42	0.46	0.48
0.1	0.34	0.36	0.40	0.42	0.44	0.49	0.51
0.15	0.36	0.38	0.43	0.45	0.47	0.52	0.54
0.2	0.38	0.40	0.45	0.48	0.50	0.55	0.57
0.25	0.40	0.43	0.48	0.50	0.53	0.58	0.60
0.3	0.42	0.45	0.50	0.53	0.56	0.61	0.63
0.35	0.44	0.47	0.53	0.56	0.58	0.64	0.67
0.4	0.47	0.49	0.55	0.58	0.61	0.67	0.70
0.45	0.49	0.52	0.58	0.61	0.64	0.70	0.73
0.5	0.51	0.54	0.60	0.63	0.67	0.73	0.76
0.55	0.53	0.56	0.63	0.66	0.69	0.76	0.79
0.6	0.55	0.58	0.65	0.69	0.72	0.79	0.83
0.65	0.57	0.61	0.68	0.71	0.75	0.82	0.86
0.7	0.59	0.63	0.70	0.74	0.78	0.85	0.89

0.75	0.61	0.65	0.73	0.77	0.81	0.88	0.92
0.8	0.64	0.67	0.75	0.79	0.83	0.91	0.95
0.85	0.66	0.70	0.78	0.82	0.86	0.94	0.98
0.9	0.68	0.72	0.80	0.85	0.89	0.97	1.00
0.95	0.70	0.74	0.83	0.87	0.92	1.00	1.00
1	0.72	0.77	0.86	0.90	0.95	1.00	1.00
MANILLA - QUICK REFERENCE TABLE FOR RUNOFF CO-EFFICIENTS							
Fraction Impervious (f)	C1	C2	C5	C10	C20	C50	C100
0	0.23	0.24	0.27	0.28	0.30	0.33	0.34
0.05	0.25	0.27	0.30	0.32	0.33	0.36	0.38
0.1	0.28	0.29	0.33	0.35	0.36	0.40	0.42
0.15	0.30	0.32	0.36	0.38	0.40	0.43	0.45
0.2	0.33	0.35	0.39	0.41	0.43	0.47	0.49
0.25	0.35	0.37	0.42	0.44	0.46	0.50	0.53
0.3	0.38	0.40	0.45	0.47	0.49	0.54	0.56
0.35	0.40	0.43	0.48	0.50	0.53	0.58	0.60
0.4	0.42	0.45	0.50	0.53	0.56	0.61	0.64
0.45	0.45	0.48	0.53	0.56	0.59	0.65	0.67
0.5	0.47	0.50	0.56	0.59	0.62	0.68	0.71
0.55	0.50	0.53	0.59	0.62	0.65	0.72	0.75
0.6	0.52	0.56	0.62	0.65	0.69	0.75	0.78
0.65	0.55	0.58	0.65	0.68	0.72	0.79	0.82
0.7	0.57	0.61	0.68	0.72	0.75	0.82	0.86
0.75	0.60	0.63	0.71	0.75	0.78	0.86	0.90
0.8	0.62	0.66	0.74	0.78	0.82	0.89	0.93
0.85	0.65	0.69	0.77	0.81	0.85	0.93	0.97
0.9	0.67	0.71	0.80	0.84	0.88	0.96	1.00
0.95	0.70	0.74	0.83	0.87	0.91	1.00	1.00
1	0.72	0.77	0.86	0.90	0.95	1.00	1.00
NUNDLE - QUICK REFERENCE TABLE FOR RUNOFF CO-EFFICIENTS							
Fraction Impervious (f)	C1	C2	C5	C10	C20	C50	C100
0	0.21	0.23	0.25	0.26	0.28	0.30	0.32
0.05	0.24	0.25	0.28	0.30	0.31	0.34	0.36
0.1	0.26	0.28	0.31	0.33	0.34	0.38	0.39
0.15	0.29	0.31	0.34	0.36	0.38	0.41	0.43
0.2	0.31	0.33	0.37	0.39	0.41	0.45	0.47
0.25	0.34	0.36	0.40	0.42	0.44	0.49	0.51
0.3	0.36	0.39	0.43	0.46	0.48	0.52	0.55
0.35	0.39	0.41	0.46	0.49	0.51	0.56	0.58
0.4	0.42	0.44	0.49	0.52	0.54	0.60	0.62
0.45	0.44	0.47	0.52	0.55	0.58	0.63	0.66

0.5	0.47	0.50	0.55	0.58	0.61	0.67	0.70
0.55	0.49	0.52	0.58	0.61	0.64	0.71	0.74
0.6	0.52	0.55	0.61	0.65	0.68	0.74	0.78
0.65	0.54	0.58	0.64	0.68	0.71	0.78	0.81
0.7	0.57	0.60	0.67	0.71	0.74	0.82	0.85
0.75	0.59	0.63	0.70	0.74	0.78	0.85	0.89
0.8	0.62	0.66	0.73	0.77	0.81	0.89	0.93
0.85	0.64	0.68	0.76	0.80	0.84	0.93	0.97
0.9	0.67	0.71	0.79	0.84	0.88	0.96	1.00
0.95	0.69	0.74	0.82	0.87	0.91	1.00	1.00
1	0.72	0.77	0.86	0.90	0.95	1.00	1.00

PART 4

MINIMUM STANDARDS

FOR

WATER

RETICULATION

DESIGN

4 MINIMUM STANDARDS FOR WATER RETICULATION DESIGN

4.1 Introduction

This document outlines Tamworth Regional Council's recommended practice for design and construction of water reticulation.

It is in no way a comprehensive "Design Manual" and it is intended to be read in conjunction with documents referenced in Section 4.2.

The design for Water Reticulation should be made with consideration for other services. Guidance for Roads, Stormwater, Sewerage Reticulation and Landscaping can be found in the sections of this document as follows.

Part 1 General Requirements

Part 2 Minimum Standards for roads

Part 3 Minimum Standards for Stormwater Drainage Design

Part 5 Minimum Standards for Sewerage Reticulation Design

Part 6 Design Minimum Standards for landscaping

4.2 References

This section of the Design Minimum Standards should be read and utilised in combination with the following publications as referenced throughout;

- NSW Public Works Department
- AS/NZS 2280 Ductile Iron Pipes and Fittings
- AS/NZS 4087 Metallic Flanges for Waterwork Purposes
- AS 1432 Copper Pipes for Plumbing, Gas fitting and Drainage Applications
- National Construction Code - Volume 3 Plumbing Code of Australia
- National Construction Code - Volumes 1 & 2 Building Code of Australia
- AS/NZS 2544 Grey Iron Pressure Fittings
- AS/NZS 3500 Plumbing and drainage suite
- AS/NZS 2648 Underground marking tape Non-detectable tape
- AS 1100 Technical drawing Engineering survey and engineering survey design drawing

4.3 Classification of Mains and Areas for Water Supply

For each City, town and village within Tamworth Regional Council area provided with reticulated water, Council has adopted areas that are defined as water reticulation areas. These areas are those where

- Treated water is/must be supplied at full mains pressure;
- Fire fighting is to be supplied via the reticulation through the provision of hydrants.

Outside of those areas if treated water is to be supplied by Council, those areas will be classified as trickle flow areas. Broadly these areas are those where

  - Treated water is/must be supplied at a maximum flow rate to each connection of 0.06 l/sec
  - Fire fighting is provided by on site storage at each property and not the reticulation.

Trunk and Distribution mains are those pipelines which transfer water to reservoirs, link reservoirs or areas of demand, or distribute water to or through areas of development. These pipelines are of

strategic importance to the operation of the reticulation system irrespective of size. Individual service connections will not be permitted to Trunk Mains.

4.4 General Requirements Regardless Of Area

4.4.1 DESIGN

Any development application that involves changes or extension to Councils existing, or construction of new water infrastructure must be accompanied by documentation that complies with the requirements detailed in the following sections including plans and calculations at the time of submission.

4.4.2 SERVICING STRATEGY

All design elements submitted must comply with the Servicing Strategy approved by Council as part of the conditions of development consent issued for the subject development, as appropriate.

Changes to the approved Servicing Strategy must be approved by the Director prior to the submission of plans and associated documentation.

4.4.3 FUTURE DEMANDS

Water supply components are to be sized to cater for proposed future development. Council's current reticulation analyses will be used as a guide in assessing size requirements.

In certain cases where Developers are requested by Council to construct infrastructure that caters for future demand as well as their own development, Council will reimburse the difference in cost between constructing the larger components and the size required to supply the development. For further details in relation to development within reticulation areas please refer to Council's policy:- Water and Sewer Reimbursement of Developers for Construction of Water and Sewer Infrastructure Within Reticulation Areas and for development elsewhere refer to Council's policy:- Water Sewer Reimbursement of Developers for Construction of Water and Sewer Infrastructure Outside Reticulation Areas.

4.4.4 PLANS AND CALCULATIONS

The Checklist – Water Reticulation Design in **APPENDIX A** shall be completed and submitted with the Drawings. Should any of the items included in the checklist be outstanding or not to a standard acceptable to Council, the Drawings shall be returned to the developer for amendment. Council shall only commence review of the design drawings once it is satisfied that all the requirements of the checklist have been met.

Design drawings and calculations shall be submitted to Council for approval. Information to be included in the design drawings is detailed in **APPENDIX B** – Information to be shown on Water Reticulation Drawings. The completed checklist will be submitted with the Drawings.

4.4.5 STRUCTURES

Detailed engineering drawings are required for any structures such as reservoirs, pumping stations and PRV pits proposed for construction in conjunction with water supply works.

4.4.6 LOCATIONS AND COVER

Water mains are to be located on the footway in accordance with the footway allocations referred to in Part 1 of these Design Minimum Standards and shall extend to the extremity of the development.

Cover to pipelines will be in accordance with the manufacturer's instructions; however minimum cover required is 500mm in footways and driveways and 600mm under road carriageways. The depths may need to be increased on larger diameter mains to accommodate larger fittings.

The Director may give approval for infrastructure to be located in areas other than road reserves provided an easement is created. The developer should transfer to Council any water easements provided in the subdivision and execute a transfer and grant of easement in favour of Council pursuant to Section 88B of the Conveyancing Act 1919, as amended. The minimum width of water easement should be 3.0m.

The Director may require water mains to be located on both sides of the road in commercial/industrial areas, in areas likely to have high or medium density housing, at the boundaries between pressure zones and on highly trafficked roads.

Water mains are to be provided for the full extent of the development to facilitate the systematic and orderly expansion of Council's infrastructure

4.4.7 MAINS IN CUL-DE-SACS

Where the cul-de-sac incorporates a pathway to an adjacent street or ends in a park, the water main is to extend through the pathway or park so that a dead-end is not created in the main.

Where a pathway or park is not provided, the main is to be returned at the end of the cul-de-sac to form a loop main which should conform to the following criteria:

1. The loop is to be totally on the footway, apart from the one road crossing required to reconnect with the main;
2. The loop is to incorporate a minimum of 3 separate service tapping's, each separated by at least one block frontage;
3. A hydrant is to be provided within the loop approximately equidistant from loop back point; and
4. The loop is to cross the road perpendicular and at the start of the neck at the Cul-de-sac.
5. Changes in direction of the main shall be achieved through the installation of deflection fittings and by deflections at pipe collars within the manufacturer's guidelines.

4.4.8 HYDRANT, FLUSHING POINT AND STOP VALVE CHAMBERS

Around each valve, hydrant and flushing point, a chamber of the type shown in the TRC Standard Drawings for Water 1300 Series - Fittings will be provided.

Unless otherwise specified, each valve chamber should be covered by a cast iron surface box cast into a concrete block as shown on the TRC Standard Drawings for Water 1300 Series - Fittings however other covers will be considered. Concrete blocks shall be used in roadways.

4.4.9 EXISTING STOP VALVES AND HYDRANTS

Where the subdivision is utilising existing water mains, the level of hydrant and stop valve surface boxes should be adjusted to suit new surface levels.

4.4.10 DETECTOR TAPE

A metal detectable tape complying with Australian Standard AS/NZS 2648 shall be laid with water mains constructed from material other than Ductile Iron Cement Lined in accordance with the manufacturer's specifications. At a minimum such tape shall be continuous and electrically bonded to metallic components including services and standpipes.

4.4.11 TAPPING BANDS

Approved tapping bands are to be used for all service connections. Tapping bands including hard stop design will be required when using non DICL pipe material. Thin brass type tapping bands without rubber backing will not be permitted. Readytap connectors or equivalent are acceptable.

4.4.12 WATER METER INSTALLATION

Council requires that all lots, including areas set aside for recreation, be provided with a water meter in a location as detailed in the TRC Standard Drawings for Water 1150 Series - Service Details. The Developer to pay applicable fees and lodge developer water meter payment form prior to the subdivision release.

Council will supply and install water meters once the applicable fees and charges have been paid and upon registration of the subdivision and following receipt of a request for water meter connection from the property owner.

4.4.13 SHARED TRENCHING

4.4.13.1 FOOTWAYS

Shared trenching will not be permitted.

4.4.13.2 ROAD CROSSINGS

All road crossings are to be provided at right angles to the road centreline at the point of crossing.

Shared trenches will be permitted between utilities provided the minimum separation between utilities, not in conduits, is 300mm both in the horizontal or vertical direction.

Shared trenches will be permitted between utilities provided the minimum separation between the outside of the conduits containing the utilities is 150mm in the horizontal or vertical direction.

Fill between the conduits shall be as detailed in the TRC Standard Drawings for Water 1200 Series - Trench/ Embedment.

4.4.14 PIPE/FITTINGS CONNECTION

Connection of pipes will be in accordance with the manufacturer's instructions.

4.4.15 PRESSURE REDUCING VALVES

Where Pressure Reducing Valves (PRV's) are required they shall be of a type and design approved by the Director.

Pits to house PRV's will be constructed from concrete, or other suitable material, and be of a size that allows a clear work area of at least 600 mm in all directions around the PRV. A drain shall be located in the bottom of the pit which drains to adjacent water course or drainage structure. Dismantling joints will be provided on the upstream and downstream side of the valve and the pit will have lockable removable covers.

4.4.16 OPENING OF VALVES

The developer is required to establish that all valves and service connections are fully open, following construction as appropriate.

4.4.17 THRUST BLOCKS

Valves, flexible jointed bends, tees, dead ends, and other points in the pipeline where there are unbalanced forces should be adequately restrained to withstand the forces resulting from the internal pressure when the pipeline is in use by packing between the fitting and the side of the trench with concrete as detailed in the TRC Standard Drawings for Water 1200 Series - Trench/ Embedment.

Stop valves on mains of 150mm diameter or greater are to be fixed to a thrust block.

The Developer shall be responsible for any failure of the pipeline that may be due to inadequate restraint in accordance with in the TRC Standard Drawings for Water 1200 Series - Trench/ Embedment.

4.5 Water Reticulation Areas

4.5.1 MINIMUM REQUIREMENTS

Council requires that all allotments, including areas set aside for recreation, be provided with a reticulated water supply sufficient for both domestic and fire fighting purposes.

4.5.2 WATER DEMAND

The design water demands should be calculated in accordance with New South Wales Public Works Department Standards.

4.5.3 SYSTEM COMPONENTS

The water supply system components should be designed generally in accordance with New South Wales Public Works Department standards and Council requirements as detailed in these Minimum Standards.

4.5.4 SERVICE RESERVOIRS

Minimum capacity is one days supply at future peak day demand.

4.5.5 STATIC HEAD

Recommended minimum static head required at the meter location for each lot, when the service reservoir is one third depleted, refer to Part 4 Table A.

Table 4-A - Recommended Minimum static head requirements

Location	Recommended Minimum Static Head (Metres)
Attunga	20
Barraba	20
Bendemeer	20
Manilla	20
Moonbi/Kootingal	28
Nundle	20
Tamworth	28

The main is to be capable of delivering peak instantaneous demand to each lot, while maintaining a minimum head of 12m throughout the system with the service reservoir assumed to be two thirds depleted.

4.5.6 PIPE SIZE

Minimum acceptable pipe size is 100mm diameter for residential areas and 150mm diameter for commercial and industrial areas. 100mm dead end mains are to be limited to 150m in length and should serve no more than 40 residential dwellings.

100mm mains over 2,000m long are not permitted.

4.5.7 MAINS AND FITTINGS

4.5.7.1 MATERIALS

All mains must be constructed from material which is compatible with Ductile Iron fittings.

Council may direct that any water mains should be constructed from PN35 Ductile Iron Cement Lined, spigot and socket, rubber ringed jointed pipe manufactured in accordance with AS/NZS 2280. This will usually only apply to those designated as trunk or distribution mains which service adjacent development.

All cast or ductile iron fittings should be cement or epoxy lined and conform to AS/NZS 2280. Stop valves and scour valves are to be anti-clockwise closing (ACC) and resilient seated, with stop valves to have a minimum pressure rating of PN16.

For flanged pipe the pipe barrel is to be manufactured to AS/NZS 2280 flanged class.

Flanged fittings should be cement or epoxy lined and conform to AS/NZS 4087 and AS/NZS 2280 with a minimum pressure rating of PN16 or PN35 depending on the application.

Where it is proposed to use pipe material other than PN35 Ductile Iron the Developer will be required to show that the material proposed conforms as follows:

- Pipe is suitable to meet pressure requirements at the proposed location;
- Has the minimum required pressure rating of PN16, SDR 37;
- Is compatible with Ductile Iron fittings;
- Fatigue and/or cyclical load testing indicates the material will meet a minimum 50 year design life;
- Will not be adversely effected, in terms of shape and strength by construction loading;
- Installation method to manufacturers instruction for minimum 50 year design life; and
- Complies with all relevant Australian Standards.

4.5.7.2 HYDRANTS AND VALVES

Fire hydrants along each water main are to be provided at a maximum of 75 metre spacing's in residential areas and at maximum spacing's of 160 metres in rural residential areas and at all dead-ends.

A hydrant or air valve is to be provided at all high points and a hydrant or scour valve at all low points.

Air valves are to be installed with an air isolation valve to allow maintenance of the air valve without shutting down the main.

Scour valves are to be discharged to a stormwater drainage pit or an adjacent water course or stormwater facility when drainage pits are not available.

Stop valves are required at all pipeline intersections and branches so that each section of line can be isolated separately, by closing a maximum of three (3) valves.

Where kerb and gutter is constructed adjacent to the main the locations of stop valves and hydrants should be delineated by formed kerb impressions. Lettering should be 80mm high, 80mm wide and 10mm thick placed on top of kerb.
Where no kerb and gutter is available the locations of stop valves and hydrants should be delineated by galvanized steel marker posts and indicator plates erected on the footway, at the property line, perpendicular to the location of the valve or hydrant.
The TRC Standard Drawings for Water 1300 Series Fittings provides details regarding posts and indicators.

Raised Pavement Markers "reflective" blue in colour shall be fixed to the centreline of the road perpendicular to the location of hydrants.

All maincocks, hydrants, stop valves, scour valves and air valves are to be located on the footway, unless approved otherwise.

Hydrants and Valves are not to be located in table drains.

Hydrants and Valve covers are to open in the direction of the main.

4.5.7.3 KERB IMPRESSIONS

Lettering for respective infrastructure to be as follows;

SV – Stop valves, scour valves

H – Hydrants

W – Water mains, water service

In addition the following kerb impressions should also be made to indicate the location of relative infrastructure.

S – Sewer main

G – Gas

T – Telecommunications

E - Electrical

Kerb Impressions are to be installed as per the TRC Standard Drawings for Water 1300 Series Fittings

4.5.7.4 TRENCH STOPS/DRAINAGE

Trench Stops or concrete bulkheads are required for grades of 10 % or steeper. Spacing requirements are detailed in Part 4 Table B.

Table 4-B - Trench Stops Spacing

Type	Grade (%)	Horizontal Spacing (m)
Trench Stop	10	10x Depth to Invert
Concrete Bulkhead for all water mains at grades of 15% or greater	15	6x Depth to Invert
	20	5x Depth to Invert
	25	4x Depth to Invert
	33	3x Depth to Invert
	50	2x Depth to Invert

Adequate trench drainage is required to prevent trench scouring and subsidence due to high permeability of the bedding and trench fill.

4.5.8 SERVICE CONNECTIONS

4.5.8.1 MATERIALS

Water services should be of single service drawn copper pipe, manufactured in accordance with AS 1432.

Services are to be a minimum of 20mm nominal diameter with 1.4mm wall thickness.

Fittings at joints, branches and bends are to be brass or copper capillary fittings or of a type approved by the Director. Ball valves and elbows are to be of brass and of a type approved by the Director. Flared fittings will be acceptable.

4.5.8.2 LOCATION

Water services are to be laid at right angles to the road centreline and parallel to the radius on curves and in cul-de-sac ends.

The services are to have a minimum cover of 500mm under carriageways and 300mm in footway reserves.
The service is to terminate inside each lot in accordance with TRC Standard Drawings for Water 1150 Series - Service Details. The minimum distance between two (2) adjacent tapping bands is 600mm.

All maincocks are to be located in the footway.

In Industrial/Commercial areas services under carriageways should be laid in approved conduit pipes. The minimum conduit pipe shall be 100mm. PN 9, uPVC pipe is required as a conduit.

In residential areas services under carriageways should be laid in approved conduit pipes. The minimum conduit pipe shall be 50mm. PN9, uPVC pipe is required as a conduit.

Conduits may be laid for future proposed services, however the service is not to be connected to the water main.

Fire service to be contained within lot served.

4.5.8.3 NOMINAL SIZE OF WATER SERVICE

The minimum size of a water service in both residential and industrial commercial areas is 20 mm.

For areas set aside for recreation, a 32mm service with a 20mm meter is to be provided.

However fire fighting requirements and other considerations may warrant a larger service size. The Developer is responsible for nominating the correct size water service.

The size of service required shall be determined in accordance with the National Construction Code – Volume 3 Plumbing Code of Australia and AS/NZS 3500 to ensure adequate flow and pressure is provided to each property.

The size of water services serving multiple dwellings, flats or units will vary as detailed the table below.

Part 4 - Table A – Minimum Size of Water Service

Class of Building	No. of dwellings	Service Size (mm)	Maximum Length (m)
Class 1 Single Dwelling House	1	20	30
	1	25	130
Class 1&2 Excluding Single Dwelling House	1	20	100
	2	25	100
	3-5	32	100
	6-10	40	100
	11-16	50	100

Notes: Classes are defined in the National Construction Code of Australia Volume One

Limitations of Method:

1. *Total length as measured from the water main to the last branch offtake is not to exceed the total length as stated above.*
2. *Height of the highest fixture above the water main is not to exceed 4m, where the minimum mains pressure is 15m (150 Kpa).*

4.6 Trickle Flow Areas

4.6.1 MINIMUM REQUIREMENTS

Council requires that all proposed residential allotments be provided with a reticulated water supply sufficient for domestic supply and in accordance with the appropriate water demand.

4.6.2 WATER DEMAND

The design water demands are to be calculated in accordance with New South Wales Public Works Department Standards except that the demand for each residential allotment is a maximum of 0.06 Litres/sec

Flow reduction devices shall be fitted to each service to limit flow to 0.06 Litres/sec.

4.6.3 SYSTEM COMPONENTS

The water supply system components should be designed in accordance with New South Wales Public Works Department standards and Council's requirements as stated in these Minimum Standards.

4.6.4 SERVICE RESERVOIRS

Minimum capacity is one days supply at future peak day demand.

4.6.5 HEAD

The main is to be capable of delivering 0.06 Litre/sec demand to each lot, while maintaining a positive head throughout the system with the service reservoir assumed to be two thirds depleted.

4.6.6 PIPE SIZE

Mains are to be sized to meet the required demand of this and/or proposed future developments Future Demands

Minimum nominal internal diameter of all pipes shall be 50 mm

Council's current reticulation analyses will be used as a guide in assessing size requirements.

4.6.7 PIPELINES IN TRICKLE FLOW AREAS

4.6.7.1 MAINS AND FITTINGS - MATERIALS

All mains of diameter 100mm or greater must be constructed from material which is compatible with Ductile Iron fittings.

Council may direct that water mains shall be constructed from PN35 Ductile Iron Cement Lined, spigot and socket, rubber ringed jointed pipe manufactured in accordance with *AS*/NZS *2280.* This will usually only apply to those designated as distribution mains which service adjacent development.

All cast or ductile iron fittings should be cement or epoxy lined and conform to *AS*/NZS *2544 and AS*/NZS *2280 respectively.* Stop valves and scour valves are to be anti-clockwise closing (ACC) and resilient seated.

Where it is proposed to use pipe material other than Ductile Iron the Developer will be required to show that the material proposed conforms as follows:

- Is compatible with Ductile Iron fittings;
- Fatigue and/or cyclical load testing indicates the material will met a 50 year design life;
- Will not be adversely effected, in terms of shape and strength by construction loading; and
- Complies with all relevant Australian Standards.

4.6.7.2 FLUSHING POINTS, HYDRANTS AND VALVES

Flushing points are to be provided at dead-ends. Air valves, complete with isolation valves, are to be provided at all high points in the main.

A hydrant or air valve is to be provided at all high points and a hydrant or scour valve at all low points.

Air valves are to be installed with an air isolation valve to allow maintenance of the air valve without shutting down the main.

Scour valves are to discharged to an adjacent water course or drainage structure.

Stop valves are required at all pipeline intersections and branches so that each section of line can be isolated separately, by closing a maximum of three (3) valves.

Stop valves and flushing points should be delineated by the installation of galvanized steel marker posts and indicator plates erected on the footway, at the property line, perpendicular to the location of the valve or hydrant. the TRC Standard Drawings for Water 1300 Series - Fittings provides details regarding posts and indicators.

All maincocks, flushing points, stop valves, scour valves and air valves are to be located on the footway, unless approved otherwise.

4.6.7.3 SERVICE CONNECTIONS – MATERIALS

Water services should be of single service drawn copper pipe, manufactured in accordance with AS 1432.

Services are to be a minimum of 20mm nominal diameter with 1.4mm wall thickness.

Fittings at joints, branches and bends are to be brass or copper capillary fittings. Ballvalves and elbows are to be of brass and of a type approved by the Director. Flared fittings will be acceptable.

4.6.7.4 SERVICE CONNECTIONS – LOCATIONS

Water services are to be laid at right angles to the road centreline and parallel to the radius on curves and in cul-de-sac ends.

The services are to have a minimum cover of 500mm under carriageways and 300mm in footway reserves.

The service is to terminate inside each lot in accordance with the TRC Standard Drawings for Water 1150 Series - Service Details. The minimum distance between two (2) adjacent tapping bands is 600mm.

All maincocks are to be located in the footway.

In residential areas services under carriageways should be laid in approved conduit pipes. The minimum conduit pipe shall be 50mm. PN 9, uPVC pipe is required as a conduit.

4.7 APPENDIX A – Checklists – Water Reticulation Design

Item No.	Description	Reference	Developer Confirmation	TRC Confirmation	Comments
1	Water Servicing Strategy	4.5.2			
2	Future Demands	4.5.3			
3	Water Reticulation Areas	4.6			
4	Trickle Flow Areas	4.7			
5	Design Departure Application and Approval Documentation	1.6			

4.8 APPENDIX B – Information to be shown on Water Reticulation Drawings

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
1	**General**			
1a	Cover Sheet with Locality Plan, List of Drawings and DA number			
1b	Plans prepared in A1 format at a scale of 1:500			
1c	Drawing Scale is shown on drawings as a bar scale			
1d	Scale of Detail Drawings is shown as appropriate			
1e	Schedule of Symbols			
1f	Benchmark within 100 metres of development site is shown			
1g	North Point shown			
1h	Site topography is shown via contour lines			
1i	Datum reference incl. Benchmark at A.H.D adopted by N.S.W. Dept. of Lands			
1j	Each plan to be numbered with revision no. and revision schedule			
1k	Road names or number			
1l	Drawings to be signed by respective Consultant / Engineer			
1m	Lettering, line work and symbols to conform to AS 1100			
1n	Water mains to be shown on road cross sections			
2	**Water Layout Plans**			
2a	Existing water mains and services are shown			
2b	Lot boundaries and numbers shown			
2c	Pipelines are numbered			
2d	Pipeline centreline chainages are shown			
2e	Pipeline diameters are shown			
2f	Terminations at Cul-de Sac's through pathways, reserves or loop shown			
2g	Location and size of water services shown			
2h	Type and class of pipe work and fittings clearly indicated			

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
2i	Location of hydrants, stop valves especially at intersections, scour valves, air valves and other fittings to be shown			
2j	Alignment of mains and services in accordance with respective footway allocations for urban and rural residential			
2k	Location of proposed easements reserves etc. incl. downstream if required			
2l	Location of all drainage lines, sewer lines and other utility lines crossing the mains to be shown			
2m	Limit of construction to be shown including staging			
2n	Mains to be extended to the full length of the subdivision			
2o	Service connection to each block			
2p	A hydrant is to be located at dead ends			
2q	Hydrant spacing to be as per Minimum Standards			
2r	Thrust blocks to be indicated where required			
2s	Water services at right angles to road centreline and parallel to the radius on curves and in Cul-de-Sac ends			
2t	Metal detectable tape to be shown when non metallic pipe is proposed			
3	**Water Longitudinal Sections**			
3a	Sections are drawn at scale of 1:500 horizontal and 1:100 vertical			
3b	Levels to be shown at 20m chainage intervals, high and low points and pipe junctions			
3c	Chainages as per layout plan			
3d	RL of existing surface, design surface and pipe invert at each location of 3b above and at major variations in natural surface such as roads, gullies etc.			
3e	Location of hydrants, stop valves, scour valves, air valves and other fittings			
3f	Design grades including extent of each gradient			
3g	Pipe diameters and material type and class to be shown			
3h	Air valves or hydrants at high points			
3i	Scour valves at low points			
3j	Location and size of existing and proposed services and utilities crossing the main complete with invert levels			

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
3k	Sections to be taken along intersecting roads for a sufficient distance to allow connection design			
3l	Trench stops shown as required on steep grades			
3m	All new water services to be shown			
3n	Mains satisfy cover requirements			
5	**Miscellaneous**			
5a	Show differing water supply zones if applicable			
5b	Design is satisfactory for future extension			
5c	Pipe sizes conform to current strategies for future development			
5d	Detailed engineering drawings are required for any structures such as reservoirs and pumping stations proposed for construction in conjunction with water supply works			
5e	All allotments including areas set aside for recreation to be provided with a reticulated water supply sufficient for both domestic and fire fighting purposes except where trickle flow has been determined			
5f	Engineering plans and subdivision plans agree			
5g	Engineering conditions of consent included in design plans			
5h	Water service sizes determined in accordance with National Construction Code – Volume 3 Plumbing Code of Australia and AS/NZS 3500			
5i	Mains to be designed to satisfy minimum cover requirements			
5k	Minimum pipe size is 100mm diameter for residential and 150mm diameter for commercial and industrial areas.			
5l	All details conform to Standard Drawings including water services, connection details, Hydrant and Stop Valve design, Thrust blocks and Trench design			

PART 5

MINIMUM STANDARDS FOR

SEWERAGE

RETICULATION

DESIGN

5 MINIMUM STANDARDS FOR SEWERAGE RETICULATION DESIGN

5.1 Introduction

This document outlines Tamworth Regional Council's recommended practice for design of sewerage reticulation. It is in no way a comprehensive "Design Manual" and it is intended to be read in conjunction with and as a supplement to, relevant government department publications.

The other parts of the Engineering Design Minimum Standards for Subdivisions and Developments are as follows:

Part 1 General Requirements

Part 2 Minimum Standards for roads

Part 3 Minimum Standards for Stormwater Drainage Design

Part 4 Minimum Standards for Water Reticulation Design

Part 6 Design Minimum Standards for landscaping

5.2 References

This section of the Minimum Design Standards should be read and utilised in combination with the following publications as referenced throughout;

- NSW Public Works Department
- National Construction Code - Volume 3 Plumbing Code of Australia
- National Construction Code - Volumes 1 & 2 Building Code of Australia
- AS/NZS 3500 Plumbing and drainage suite
- AS/NZS 2648 Underground marking tape Non-detectable tape
- AS 1100 Technical drawing Engineering survey and engineering survey design drawing
- AS/NZS 1260 uPVC SN8
- AS 1741 Vitrified Clay
- AS/NZS 5065 Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
- AS/NZS 3000 – Electrical Installations – Wiring Rules

5.3 Gravity, Pump Out or Low Pressure

Councils preferred method of providing sewerage services to individual properties is via gravity sewer connected into Council's existing reticulation.

Individual connections in both residential and industrial/commercial areas that cannot be connected to the existing reticulation via gravity can be connected to the existing reticulation via a pump out system, but only after it has been demonstrated that the provision of gravity sewer is not possible. Certain conditions including responsibility for various components of the system may apply.

The provision of sewer services using low pressure sewer is presently only approved for the Forest Hills area in Tamworth. Plans showing the boundaries of the catchments to be serviced by low pressure sewer are available from Council. Certain conditions apply as detailed in these Minimum Standards.

5.4 General Requirements

The design of sewers is controlled by the application of design and construction minimum standards as detailed below.

The minimum standards apply to the design of sewer in industrial or residential areas including medium density development.

5.4.1 DESIGN

Any development application that involves changes to or extension of Councils existing, or the construction of new sewer infrastructure must be accompanied by documentation that complies with the requirements detailed in the following sections including plans and calculations at the time of submission.

5.4.2 SERVICING STRATEGY

All design elements submitted must comply with the Servicing Strategy approved by Council as part of the conditions of development consent issued for the subject development, as appropriate.

Changes to the approved Servicing Strategy must be approved by the Director prior to the submission of plans and associated documentation.

5.4.3 FUTURE LOADING

Reticulation components are to be sized to cater for proposed future development. Council's current reticulation analyses will be used as a guide in assessing size requirements.

In certain cases where Developers are requested by Council to construct infrastructure that caters for future loading as well as their own development, Council will reimburse the difference in cost between constructing the larger components and the size required to service the development. For further details please refer to Council's policy:- Reimbursement of Developers for Construction of Water and Sewer Infrastructure.

5.4.4 PLANS AND CALCULATIONS

The Checklist – Sewer Design in **APPENDIX A** shall be completed and submitted with the Drawings. Should any of the items included in the checklist be outstanding or not to a standard acceptable to Council, the Drawings shall be returned to the developer for amendment. Council shall only commence review of the design drawings once it is satisfied that all the requirements of the checklist have been met.

Design drawings and calculations shall be submitted to Council for approval. Information to be included in the design drawings is detailed in **APPENDIX B** – Information to be shown on Sewer Reticulation Drawings. The completed Checklist shall be submitted with the Drawings.

5.4.5 EXCAVATING OR BUILDING ADJACENT TO OR OVER EXISTING SEWER MAINS

Council has adopted a policy entitled Sewer- *Excavating, Filling or Building Adjacent to or Over Existing Sewer Mains* which provides details of circumstances when building, filling or excavating adjacent to or over existing sewers will or will not be approved and the minimum requirements if work is approved.

The policy can be viewed on Council's website.

5.5 Gravity Sewer

5.5.1 LOCATIONS AND COVER

Sewers should be located wherever possible as follows:

a) on public road reserves

- within the footway allocation as detailed in the General Requirements Section of these Minimum Standards.

b) on private property

- adjacent to and parallel to a property boundary.

Where sewer mains are located within lots adjacent to storm water drainage lines, the sewer should be laid with a minimum 0.5m separation between the outside of the sewer and the outside of the stormwater pipe in the horizontal direction.

Sewer mains shall extend to the extremity of the development where potential exists for future developments.

Minimum cover required to mains and junctions is 750 millimetres in road carriageways and 450 millimetres elsewhere.

Where sewers of different diameters intersect or join, the maximum depth of the smaller pipe is to be such that the pipe obverts are at the same level.

5.5.2 MATERIALS

Reticulation pipelines and fittings may be of any of the following materials manufactured in accordance with the relevant Standards,

uPVC SN8, -	AS/NZS 1260
Vitrified Clay -	AS 1741
Twin – walled corrugated Polypropylene –	AS/NZS 5065

All pipes shall be rubber ring jointed.

PVC pipes are to be maximum 3 metres in length.

5.5.3 JUNCTIONS

Where depth to the invert of the main exceeds 1.5 metres, sewer junctions are to be raised on a vertical shaft so that depth to invert is not greater than 1.5 metres.

Construction of the vertical shaft is not to be undertaken in cases where it would preclude gravity sewer servicing of the entire lot.

5.5.4 SIDELINES

Junctions exceeding 10 metres in length are considered to be a side line and require an access chamber where they enter the main. When the sewer main is outside the property boundary the service should be perpendicular to the sewer mains as shown in the TRC Standard Drawings for Sewer 1100 Series - Property Connections.

5.5.5 MARKING OF JUNCTIONS AND SIDELINES

The position of each riser, junction or end of a sideline should be clearly marked by the Contractor on completion of backfilling and shall be no further than 1m from the front and side boundaries when the main is located within the road reserve or neighbouring lot and no further than 1m from the side boundary and the centreline of the main where the main is traversing the lot.

A red survey peg should be used to indicate the location of sewer junctions. The peg should be tied to an underground identification tape, connected to the sewer junction. The contractor should adjust the levels of pegs where necessary to conform to final surface level at the time of notification of completion.

As an alternative to providing a red survey peg, the vertical riser can be constructed. The sewer riser is to be marked red, solvent capped, protected from vandalism and easily identifiable for future internal drainage connection.

The position of each riser, junction or end of sideline, dimensioned relative to at least 2 adjacent property boundaries must be shown on Works As Executed drawings to allow location at future date. Distance to junctions from downstream manhole also to be indicated.

5.5.6 ACCESS CHAMBERS

Sewer access chambers are required at all changes of grade, deflections, line intersections and at all dead-ends exceeding 10 metres in length.

The bases for access chambers may be either cast-in-situ or precast whilst chambers are to be precast. The developer is required to submit detailed drawings of proposed access structures for approval.

Step Irons to be installed in accordance with TRC Standard Drawings for Sewer 1300 Series - Maintenance Holes.

Sewer access chambers should not be located in road carriageways.

An internal manhole drop between inlet and outlet is required as follows:

Table 5-A - Internal Manhole Drop

Deflection Angle	Drop (mm)
0°to 45°	30
46° to 90°	50
91° to 135°	100

Deflections greater than 135° are not permitted.

Maximum spacing for access chambers should be as follows:

Table 5-B - Spacing for Access Chambers

Pipe Size(mm)	Access Chambers Spacing (m)
150	80
225	100
300	120
375 and above	150

5.5.7 EXISTING ACCESS CHAMBERS AND SERVICES

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

5.5.8 SOFFIT REQUIREMENT

Council has adopted the NSW Code of Practice for House Drains, which stipulates a minimum height differential between the soffit of the receiving sewer and the lowest fixture of the house drain connecting to that point.

The height difference is 1,200 mm which may be reduced to 900 mm where:

- The number of properties upstream is 10 or less, or
- The grade of the sewer downstream is steeper than 3.3%; and the overlay gully is installed immediately upstream of the inspection shaft or boundary trap.

In the situations where it can be demonstrated that this soffit cannot be satisfied or an alternative is not possible (ie. set minimum floor level) consideration may be given to the installation of a reflux valve in the house drain on the house side of the junction.

5.5.9 SEWER EASEMENTS

Easements are required over Council's sewer mains crossing private property. It is the responsibility of the developer to obtain sewer easements from any other land if required. (The Subdivision Certificate will not be released until the above requirements have been complied with).

The developer should transfer to Council any sewer easements provided in the subdivision and execute a transfer and grant of easement in favour of Council pursuant to Section 88B of the Conveyancing Act 1919, as amended.

The minimum width of sewer easement should be 3.0m, this width may need to be increased depending upon depth of main, size of main, shared trench with other services.

Where shared trench with stormwater, sewer should be located nearest a lot being served where practical.

5.5.10 DESIGN CRITERIA

All lots are to be provided with a sewer junction, so placed that the whole of the lot can be gravity sewered.

A 150 millimetre diameter sewer junction is to be provided within each lot. 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 millimetres of cover laid at a grade of 1 in 60.

5.5.10.1 DESIGN FLOWS

The design flows should be calculated in accordance with the New South Wales Public Works Department Standards.

5.5.10.2 DESIGN OF SYSTEM COMPONENTS

The sewerage system components should be designed generally in accordance with Public Works Department standards.

5.5.10.3 MAXIMUM AND MINIMUM ALLOWABLE LOADINGS - RETICULATION MAINS

The minimum size for gravity sewer mains is 150 millimetre diameter

Gravity reticulation mains capacity should be greater than or equal to P.W.W.F. and grading sufficient to achieve self-cleansing velocity at Peak Dry Weather Flow (P.D.W.F.)

Part 5 Table B gives maximum and minimum allowable loadings for various diameter pipes.

The maximum acceptable grade for any sewer is 1 in 10, whilst the minimum acceptable grades are detailed in Part 5 Table B.

5.5.10.4 VALUES FOR ROUGHNESS

The values of roughness to be used in the design of gravity sewers are detailed Table 5-C - Value of Roughness

Table 5-C - Value of Roughness

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

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

Table 5-D – Maximum and Minimum allowable loadings

GRADING TABLE - GRAVITY SEWERS
150 - 600mm Nominal Size Pipelines

Pipe Diameter (mm)	150			225			300			375		450		525		600			Pipe Diameter (mm)
Grade 1 in	Tenements			Tenements			Tenements			Tenements		Tenements		Tenements		Tenements			Grade 1 in
	K	Min. 1.5	Min. 3.0	Max 0.6	Min. 1.5	Min. 3.0	Max 0.6	Min. 1.5	Min. 3.0	Max 0.6	Min. 3.0	Max. 0.6	Min. 3.0	Max. 0.6	Min. 3.0	Max. 0.6	Min. 3.0	Max. 0.6	K	
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	41	35	475	49	41	1053	49	1941	58	3188						160
180	48	41	143	52	45	446	61	52	989	61	1825	71	3000						180
200	65	56	135	66	57	422	76	65	936	75	1727	86	2839	98	4313				200
220	89	77	128	83	71	401	92	79	890	90	1642	103	2703	116	4104				220
250	204	176	119	113	97	374	120	105	832	117	1536	131	2527	146	3840	163	5511		250
300				186	161	339	184	159	755	172	1395	188	2296	207	3492	227	5013		300
350				324	283	312	269	234	695	242	1287	259	2118	281	3222	305	4627		350
400							389	340	648	332	1199	347	1975	370	3006	396	4316		400
450							577	507	608	448	1120	585	1855	475	2826	504	4060		450
500							1175	1039	575	602	1066	747	1757	600	2674	628	3843		500
550										819	1013	953	1670	748	2544	773	3656		550
600		Normal Flattest grade be adopted in reticulation design ------								1191	967	1226	1596	926	2430	940	3494		600
650												1630	1531	1138	2331	1134	3351		650
700												2829	1471	1400	2242	1362	3222		700
750													1420	1732	2162	1628	3109		750
800		Absolute limiting grade for pipeline designed to be cleaned by gravity flows ———												2186	2089	1948	3006		800
850														2925	2024	2341	2926		850
900																2850	2825		900
1000																5668	2673		1000

5.6 Rising Mains

Velocity in the rising main should not exceed 3.0 metres per second and be a minimum of 0.7 metres per second.

5.6.1 MATERIALS

All rising mains must be constructed from material which is compatible with Ductile Iron fittings.

Council may direct that any rising main should be constructed from PN35 Ductile Iron Cement Lined, spigot and socket, rubber ringed jointed pipe manufactured in accordance with AS/NZS 2280.

All cast or ductile iron fittings should be cement or epoxy lined and conform to AS/NZS 2544 and AS/NZS 2280 respectively. Stop valves and scour valves are to be anti-clockwise closing (ACC) and resilient seated, with stop valves to have a minimum pressure rating of Class 16.

Where it is proposed to use pipe material other than Ductile Iron the Developer will be required to show that the material proposed conforms as follows:

- Pipe is suitable to meet pressure requirements at the proposed location;
- Has the required minimum required pressure rating of PN16, SDR 37;
- Is compatible with Ductile Iron fittings;
- Fatigue and/or cyclical load testing indicates the material will meet a minimum 50 year design life;
- Will not be adversely effected, in terms of shape and strength by construction loading;
- Installation method to manufacturers instruction for minimum 50 year design life; and
- Complies with a relevant Australian Standard.

5.6.2 VALVES, FITTINGS AND VENTS

Each pump discharge line is to be provided with a reflux valve and stop valve, the stop valve is to be positioned upstream from the reflux valve.

An approved air valve is required at high points in the main.

A scour valve and line is required to enable the rising main to be completely drained of sewage.

The receiving manhole is to be vented.

The developer is required to submit detailed drawings of rising mains and receiving access chambers for approval.

5.6.3 PUMPING STATIONS

Wet well capacity is to be sufficient for the total ultimate Peak Wet Weather Flow (P.W.W .F.).

Pumps are to be sized for a maximum 10 starts per hour and provide a self cleansing velocity of 0.6 metres per second in the rising main.

Minimum volume from top water level to bottom water level is to be the volume pumped in 90 seconds.

The combined detention time in the wet well and rising main should not exceed 4 hours. Full stand-by pump capacity is required.

All incoming lines to a pump station are to be fitted with a knife type isolation valve at the end of the incoming line.

5.7 Low Pressure Sewer

The Forest Hills area of Hills Plain in Tamworth has been designated as being serviced by Low Pressure Sewer. Maps showing the catchment to be served by low pressure sewer can be reviewed at Council's Water & Waste Directorate Office 468 to 472 Peel Street Tamworth. The following issues are relevant.

5.7.1 GENERAL

Council has prepared a master plan for the installation of low pressure sewer in the Forest Hills area. Developers will be required to comply with the master plan unless the Director approves a change.

Council has an existing Agreement with a supplier for pumps, tanks and other associated equipment. Accordingly key aspects of the reticulation design will be set by the particulars of these components and no variation will be possible.

5.7.2 STANDARDS AND REGULATIONS

All designs will be carried out in accordance with the WSAA Pressure Sewerage Code of Australia and all relevant Australian Standards. If those carrying out the design believe there is any conflict then these matters should be raised with the Director.

5.7.3 RETICULATION ZONES

Where the design is for large ongoing developments/ subdivisions the design is to utilise reticulation zones leading away from the connection point (or discharge point) to the existing reticulation system. All such zones should be clearly marked on the design drawings.

Where developments are to be staged the design must address the need for low, intermediate and high flow lines to service the development from the initial to the final stage.

5.7.4 DESIGN CRITERIA

Whilst Council has a master plan for the installation of low pressure sewer in the Forest Hills area, reticulation within individual developments will require detailed design whilst ensuring it complies with the master plan.

The developer is responsible for the design however; the design will be subject to formal approval by Council. Council requires that persons with appropriate skills and experience, in low pressure sewerage design, undertake the design work.

5.7.5 DESIGN FLOWS

The mains shall be designed to achieve a minimum velocity of 0.7m/s at least once in every 24 hours, for self-cleansing purposes.

5.7.6 PUMP DUTY POINTS

Pumps are capable of meeting the following duty points.

Head	= 45m
Flowrate	= 0.45l/s

The 45m head should be taken as the maximum head the pump is designed to accommodate (i.e. the total static head plus the friction losses that will occur in the designed reticulation system).

The flow rate of 0.45l/s should be taken as the minimum flow rate the pump is capable of discharging under normal operating requirements. Higher flow rates are permissible.

Design calculations showing the friction losses and the estimated static head are to be included in any submission to Council on the proposed installation of pressure sewerage systems. Council may require that some reticulation main sizes be increased if it believes the heads on the pumps are too high.

5.7.7 MAINS AND FITTINGS

The diameter of the pipes should ensure that effluent is stored in the pipelines for a minimal time. Ideally the effluent should be no older than 24 hours when it reaches the sewage treatment plant. It is recommended that where sewage is determined to be older than 24 hours that preliminary discussion be held with Council regarding odour suppression options.

5.7.7.1 MATERIALS

The reticulation mains are to be:

- Of varying diameter (DN40mm – DN315mm) polyethylene pipes;
- Class PN 16 (unless otherwise stated in dedicated areas);
- Minimum lengths of the pipe rolls to be 100m;
- Readily available in the commercial market place so that additional lengths can be purchased for repair or extension purposes;
- Capable of being crimped if required to effect repairs and
- Cream stripe black polyethylene pipe is to be used for pressure sewerage systems in accordance with WSA PS – 207S.

5.7.7.2 VALVES AND FITTINGS

The valves and fittings to be used on the pipelines need to be compatible with polyethylene pipe and the class of pipe used. The types of valves should also be readily available in the commercial market place and of a type compatible with the pumping stations.

The reticulation system must incorporate a number of designated isolating valves and may require the use of air valves. Details of their use (or non-use) must be provided to Council with the proposed design.

5.7.7.3 FLUSHING POINTS

A flushing point shall consist of a tee (in line) or 90 degree bend (end of line), a sampling valve located on a vertical riser and an isolation valve and quick connection coupling.

All dead-ends to pressure sewers shall be provided with an end flushing point where the number of connections in a branch line exceeds five (5).

In line flushing points shall be provided;

- downstream of isolation valves, except where there is a downstream flushing point within 100 metres;
- where there is more than one upstream connecting line; and
- at intervals not exceeding 500 metres.

Flushing points shall be designed to allow for scouring/flushing with flow initiation from the end flushing points and progressively downstream via in-line flushing points to the discharge end of the network.

Flushing points shall be located in pits with appropriate covers. The size of the pit shall allow for the adequate clearance between any part of the fitting and the pit to permit operation of the valve and the replacement of any component.

5.7.7.4 JOINING THE PIPES

All pipes are to be joined by electro fusion techniques in accordance with the manufacturer's requirements. Those carrying out the pipe joins are to be appropriately qualified, capable of demonstrating their experience with this technique and have the right equipment to affect the welds. Council will also consider butt welding of the pipes by persons with the appropriate qualifications, equipment and experience.

5.7.8 DEPTH AND LOCATION OF PIPEWORK

The mains are to be laid on a route that causes minimum disruption to the area involved.

All pipework is to be laid within the footway allocation as detailed in the General Requirement section of these Minimum Standards and laid parallel with the property boundaries. The pipe will be laid to a depth where there is a minimum 450mm of cover over the pipeline in the footpath and a minimum cover of 750mm in the roads.

The pipe can in most instances simply be backfilled with the excavated material where the trench has been dug by a trenching machine such as a ditch witch. This assumes that the main is excavated in what are all soil conditions.

Where rock or gravel is encountered in the trench or in some circumstances where there are a large number of timber pieces that might puncture the pipe then the pipe is to have a minimum of 50 mm of sand backfilling on all sides. Where sand fill is required, the trench is to be excavated an additional 50 mm with the pipe to be laid on top of this sand bed. The trench excavation will need to be wide enough to allow for the sand filling around the pipe.

Where it is difficult to gain the depth due to excavation difficulties, then the pipe is to be encased in a minimum of 100 mm of concrete. The trench will need to be widened to accommodate this encasement. Plans showing details of the proposed concrete encasement must be provided to the Director for approval prior to encasement.

5.7.9 ROAD CROSSINGS

All low pressure sewer reticulation that crosses public roads must be within a suitable conduit. PN9, uPVC pipe is required as a conduit.

Where the road is a sealed surface the pipeline route is to be excavated using under boring techniques. The pipe is then to be drawn through the excavation conduit in accordance with the appropriate Australian Standard. For unsealed roads, excavation can be by either open trench excavation or underboring of the road.

The underboring must be done with sufficient width of the sealed road so as not to compromise the integrity of normal operation of the road carriage way and in accordance with the traffic management plans.

5.7.10 LOCATION MARKERS

The locations of pressure sewerage pipes are to be marked in the following manner:

- A metal detectable tape complying with Australian Standard AS/NZS 2648 shall be laid with pressure sewerage pipes in accordance with the manufacturer's specifications. At a minimum such tape shall be continuous and capable of being energized; and
- A brightly coloured marker tape is to be laid 300mm above the top of the pipe. This marker tape shall indicate that there is a pressure sewerage system below it. Council’s preference is that the tape be yellow and at least have the letters PS on it, but is happy to negotiate these colours with the pipe layer if yellow is not readily available at the time Other Services

During the design phase a services location survey of the proposed pipeline route is to be undertaken to determine the proximity of other services to the pressure sewerage lines. Where other services are parallel to the pressure sewer mains and these intrude into the pressure sewer system allocation, the designer will need to work with both Council and the other service provider. Actions to be taken will be decided on a case by case basis.

The mains should where practical, cross other services at as close to right angles as can be practically achieved.

5.7.11 RESIDENTIAL ACCESS/ DRIVEWAYS

Where driveways are made of the following materials, the pipeline route is to be excavated using under boring:

- Sealed surfaces (irrespective of nature);
- Paved Surfaces; and
- Decorative Surface.

Where there is no defined driveway and the pipeline is installed by open excavation then the driveway is to be compacted as soon as possible thereafter to minimise the loss of access to the property. The Pipe Layer needs to provide a minimum of three working days notice prior to constructing the works in that street.

The Pipe Layer may provide this notice by letterbox drop but the information should include:

- Date the pipeline is to be constructed;
- Estimated time trenches will be open;
- Contact number for further enquiries; and
- Method of excavation.

5.7.12 PROPERTY CONNECTIONS

The reticulation main is to be connected to the property at the same time as it is being installed. All properties will be connected to the reticulation system through the boundary kit at each property.

Lines from the reticulation mains to the boundary kits will generally be perpendicular to the reticulation main.

The boundary kit is to be located a maximum of 1m from the front and side property boundary.

All property connections are to be located adjacent to the side boundary with the lowest relative level.

An additional non-return valve is to be used where a road crossing to service a property is required. This valve should be located near the pipe joint and there should be no pipe joints under the sealed road area.

5.7.13 DISCHARGE POINT TO COUNCIL SEWERS

Typically this will be one of the following:

- A Sewage Treatment Plant;
- Pumping Station in gravity reticulation system; or
- Manhole in gravity reticulation system.

The pressure system needs to be discharged to a point where the receiving system has sufficient capacity to receive the discharges from the pressure sewerage systems and transport it to the sewage treatment plant. A full analysis of the discharge point and downstream system capacity is to be provided with the design.

If the receiving systems capacity is insufficient during peak periods then a controlled discharge structure can be constructed to store peak system discharges allowing these to discharge at a controlled rate and take advantage of the systems peak capacity.

Such structures will be constructed on the basis of:

- Costs;
- System capacity;
- Odour suppression of any stored sewage (if required); and
- Ability to periodically clean the retaining structure.

5.7.14 ODOUR SUPPRESSION

Where unique system features, such as long rising mains to the treatment plant, the need for control storage devices etc are required, then the Designer must detail all odour suppression arrangements to be used. Council has no particular preference for the type of odour suppression arrangements other than:

- They need to be effective for the instances required; and
- They should be consistent with other Council odour suppression arrangements.

5.7.15 OWNERSHIP OF THE UNITS

The ownership of the units will reside with Council and includes the following:

- Pump;
- Storage vessel;
- Ancillary fittings;
- Property delivery line/s;
- Control panel; and
- Boundary kit.

Council ownership terminates at the first flexible joint on the inlet side to the pressure sewerage storage vessel.

In general Council will not seek to take out an easement over any part of the installation. Council reserves the right to create an easement if required on a particular property to ensure the safe ongoing operation of the system, the minimisation of any health concerns or the protection of Council Property.

5.7.16 SUPPLY OF THE UNIT

Council will supply and maintain the following components where a pressure sewerage system is to be installed:

- The storage vessel;
- Pump;
- Ancillary fittings;
- Control panel;
- Boundary kit;
- Valves (On Property); and
- Stand for control panel, where required.

5.8 APPENDIX A – Checklist - Sewer Design

Item No.	Description	Reference	Developer Confirmation	TRC Confirmation	Comments
1	Sewer Servicing Strategy	5.4.2			
2	Excavation or Building adjacent to or over Existing Sewer Mains	5.4.5			
3	Pumping Stations and Rising Mains	5.6			
4	Maximum and Minimum Allowable Loadings – Reticulation Mains	Table B & 5.5.10.3			
5	Low Pressure Sewer	5.7			
6	Low Pressure Sewer Pump Units Residential Property System – Advice for Developers	Appendix C			
5	Design Departure Application and Approval Documentation	1.6			

5.9 APPENDIX B – Information to be shown on Sewer Reticulation Drawings

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
1	**General**			
1a	Cover Sheet with Locality Plan, List of Drawings and DA number			
1b	Plans prepared in A1 format at a scale of 1:500			
1c	Drawing Scale is shown on drawings as a bar scale			
1d	Scale of Detail Drawings is shown as appropriate			
1e	Schedule of Symbols			
1f	Benchmark within 100 metres of development site is shown			
1g	North Point shown			
1h	Site topography is shown via contour lines			
1i	Datum reference incl. Benchmark at A.H.D adopted by N.S.W. Dept. of Lands			
1j	Each plan to be numbered with revision no. and revision schedule if required			
1k	Road names or number			
1l	Drawings to be signed by respective Consultant / Engineer			
1m	Lettering, line work and symbols to conform to AS 1100			
1n	Sewer mains to be shown on cross sections			
2	**Sewer Layout Plans**			
2a	Catchment area plan including sub-catchments and areas is submitted			
2b	Existing sewer mains, junctions, side lines and manholes are shown			
2c	Lot boundaries and numbers shown			
2d	Sewer main lines and manholes are numbered			
2e	Pipeline centreline chainages are shown			
2f	Pipeline diameters are shown			
2g	Dead end length to conform with Minimum Standards			
2h	Side lines to conform with Minimum Standards			

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
2i	Type and class of pipe work and fittings clearly indicated			
2j	Alignment of mains, side lines, junctions, dead ends, manholes etc. to be shown			
2k	Location of mains etc. in accordance with respective footway allocations for urban and rural residential to be shown			
2l	Location of proposed easements reserves etc. incl. downstream if required			
2m	Location of all drainage lines, water mains and other utility lines crossing the mains to be shown			
2n	Limit of construction to be shown including staging			
2o	Mains to be extended to the full length of the subdivision			
2p	Junction to each block slope type if main is within property, square type if main is external to property			
2q	Spot levels as necessary at the lot extremities to show that the whole of the lot can be sewered			
2r	Manhole spacing to be in accordance with maximum spacing according to main size			
2s	Rising mains to be shown with appropriate details according to Minimum Standards			
3	**Sewer Longitudinal Sections**			
3a	Sections are drawn at scale of 1:500 horizontal and 1:100 vertical			
3b	Levels to be shown at 20m chainage intervals, manhole locations, dead-ends for gravity mains and high and low points for rising mains			
3c	Chainages as per layout plans			
3d	RL of existing surface, design surface and pipe invert at each location of 3b above and at major variations in natural surface such as roads, gullies etc.			
3e	Design RL of all inlet and outlets at each manhole and all changes of grade			
3f	Design grades including length of each gradient between manholes			
3g	Pipe diameters and material type and class to be shown			
3h	Air valves and scour valves on rising mains at respective low and high points			
3i	Minimum cover requirements have been achieved			

Item No.	Item Description	Developer Confirmation	Council Confirmation	Notes/Comments
3j	Location and size of existing and proposed services and utilities crossing the main complete with invert levels			
3k	Sections to be taken along intersecting roads for a sufficient distance to allow connection design			
3l	Trench stops shown as required on steep grades			
4	**Miscellaneous**			
5a	Design is satisfactory for future extension			
5b	Pipe sizes and design conform to current strategies for future development			
5c	Detailed engineering drawings are required for any rising main structures such as pumping stations and specialised manholes and vents proposed for construction in conjunction with sewer supply works			
5d	Sufficient capacity in downstream reticulation system to cater for development			
5e	Engineering plans and subdivision plans agree			
5f	Engineering conditions of consent included in design plans			
5g	Junctions to each lot to comply with the soffit requirements in accordance with N.S.W. Code of Practice for Plumbing and Drainage 2006			
5h	Mains to be designed to satisfy minimum cover requirements			
5i	Minimum pipe size is 150mm diameter			
5j	Pressure sewer designed in accordance with WSA guidelines			
5k	All details conform to Standard Drawings including twin lift sewer manhole covers, drop structures, junction thrust restraints and trench design			

5.10 APPENDIX C – Low Pressure Sewer - Residential Property System – Advice for Developers

For the information of Developers the following additional information is provided in relation to on property installation of low pressure sewer pump units.

OWNERSHIP OF THE UNITS

The ownership of the units will reside with Council and includes the following:

- Pump;
- Storage vessel;
- Ancillary fittings;
- Property delivery line/s;
- Control panel; and
- Boundary kit.

Council ownership terminates at the first flexible joint on the inlet side to the pressure sewerage storage vessel.

In general Council will not seek to take out an easement over any part of the installation. Council reserves the right to create an easement if required on a particular property to ensure the safe ongoing operation of the system, the minimisation of any health concerns or the protection of Council Property.

SUPPLY AND MAINTENANCE OF THE UNIT

Council will supply and maintain the following components where a pressure sewerage system is to be installed:

- The storage vessel;
- Pump;
- Ancillary fittings;
- Control panel;
- Boundary kit;
- Valves (On Property); and
- Stand for control panel, where required.

STANDARD INSTALLATION PARAMETERS

A standard installation includes the provision of:

- One pump and tank;
- 40m of pipework from the boundary kit to the tank;
- The tank is to be located within 10m of the main building contributing the majority of the flow; and
- Connection of pools or spas with a capacity less than 250L.

All additional costs for items outside of the above parameters are to be met by the property owner.

PROPERTY INSTALLATION

The following will be required for pump/tank installation:

- The individual property owner must provide to Council six weeks notice to arrange the installation of the pump/tank units;
- The pump/tank units are only to be installed after storm water and sewer main lines have been constructed;
- The location of the pump/tank unit will be determined in consultation with the property owner; and
- The installation will be subject to the owner entering into a Maintenance Agreement with Council. Connection to Council's sewer system will not be approved until such an Agreement is entered into. Continued connection is conditional upon continuing such a Maintenance Agreement.

MAINTENANCE AGREEMENT

Every property owner will be required to enter into a formal maintenance agreement with Council as a precondition to being connected to Councils reticulation system. Such an agreement will set out what is expected of both parties.

This is a separate stand alone document.

OPERATION OF THE PUMPING UNIT

Pumping units operate automatically and do not require any specific input from the property owner. In relation to the overall operation of the pumping unit the following will apply:

- The property owner will meet the individual power costs.
- Council will meet all operational costs.

ON PROPERTY DESIGN

The design limits for the on property works will be from the outlet of the boundary kit to the inlet to the pumping station (i.e. the household drainage inlet). The standard design will include:

- Installation of the pumping station (pump unit);
- Electrical connections;
- Construction of the property delivery line;
- All restoration; and
- Making the pump accessible.

Council requires the property owner's written consent with the "on-property" layout design before commencing the installation. Where possible the property owner's reasonable needs will be accommodated.

STANDARDS AND REGULATIONS

All designs will be carried out in accordance with the WSAA Pressure Sewerage Code of Australia and the relevant Australian Standards. If those carrying out the design believe there is any conflict then these matters should be raised with the nominated Director.

PUMP DUTY POINTS

The pump supplied is capable of meeting the following duty points.

Head = 45m

Flowrate = 0.45l/s

The 45m head should be taken as the maximum head the pump is designed to accommodate (i.e. the total static head plus the friction losses that will occur in the designed reticulation system).

The flow rate of 0.45l/s is the minimum flow rate the pump should be capable of discharging under normal operating requirements. Higher flowrates are permissible.

NUMBER OF PUMP UNITS PER PROPERTY

A single pumping unit is to be provided for each residential property. Other alternatives will be investigated if a single pumping unit is not appropriate for the application.

PUMPING UNIT STORAGE VESSEL SIZE

The pumping station supplied will have:

Minimum Effective Storage - 600 Litres; or

Minimum Emergency Storage - 400 Litres.

INSTALLATION OF PUMP STORAGE VESSEL

The following steps need to be applied in relation to all pumping station installations in Tamworth:

- The pumping station should be installed as close as practical to the building contributing the majority of flow contributions on the property;
- The pumping station is not to be installed in a ground depression, where rainfall runoff water would normally pond;
- The pumping station must be installed within direct line of sight of the pressure sewerage control panel;
- A concrete ring beam is to be poured around the base of the storage vessel. The size of the ring beam will be in accordance with the Technology Suppliers requirements; and
- Excavation holes for the pumping station are not to be left open overnight.

VENTING

Where the 1 in 100 year flood level impacts the property, the venting of the pumping station is to be provided to a minimum of 500mm above the designated flood level.

HYDRAULIC CONNECTIONS

The lines need to be flushed to ensure no construction debris is in the lines before connecting to the pumping station.

The homes plumbing is to be tested in accordance with the NCC Volume Three Plumbing Code of Australia prior to connection to the pumping station. The plumber will then need to attest in the supporting document that the house lines meet this requirement.

An overflow relief gully is required in accordance with the NCC Volume Three Plumbing Code of Australia, to prevent internal overflows. This is to be included by the property owner's plumber, and must not be covered once the pump is operational.

INLETS AND OUTLETS

Pipe connections to the tank should be capable of being made without leakage through the joints. The pumping station should be supplied with appropriate sealing devices for these connections.

On the inlet side a short length of pipe should be extended to connect the household drainage lines. On the outlet side the internal pipework should be extended a short distance (minimum 1.0 metre length) beyond the pumping station to connect the property delivery line.

RESIDENTIAL PIPE MATERIALS

The property delivery lines for all Tamworth applications will be:

- 32mm internal diameter polyethylene pipe;
- Pipe Class PN12.5; and
- Where possible the pipe should be purchased in long rolls to minimise the number of joins required.

PIPE COLOURS

Cream striped black polyethylene pipe is to be used for pressure sewerage systems in accordance with WSA PS – 207S.

JOINING THE PIPES

All pipes are to be joined by electro fusion techniques in accordance with the manufacturer's requirements. Those carrying out the pipe joins are to be appropriately qualified, capable of demonstrating their experience with this technique and have the right equipment to affect the welds. Council will also consider butt welding of the pipes by persons with the appropriate qualifications, equipment and experience.

DEPTH AND LOCATION OF PIPEWORK

The property delivery line is to be connected to the boundary kit located at the low side of the front boundary. All pipelines are to be laid approximately 1.0m from the boundary and run parallel, to that boundary. Where the properties are large and this requirement is unreasonable, it will be laid in a position as agreed with the property owner.

The pipe will be laid to a depth where there is a minimum 450mm of cover over the pipeline in areas with no vehicular loading and a minimum cover of 600mm in areas with vehicular loading.

The pipe can in most instances simply be backfilled with the excavated material where the trench has been dug by a trenching machine such as a ditch witch. This assumes that the main is excavated in what are all soil conditions.

Where rock or gravel is encountered in the trench or in some circumstances where there are a large number of timber pieces that might puncture the pipe then the pipe is to have a minimum of 50 mm of sand backfilling on all sides. Where sand fill is required, the trench is to be excavated an additional 50 mm with the pipe to be laid on top of this sand bed. The trench excavation will need to be wide enough to allow for the sand filling around the pipe.

Where it is difficult to gain the depth due to excavation difficulties, then the pipe is to be encased in a minimum of 100 mm of concrete. The trench will need to be widened to accommodate this encasement.

Appropriate service separation is required to ensure minimum risk to the pipework if and when services require excavation for maintenance or replacement

MARKING THE PIPES

The locations of pressure sewerage pipes are to be marked in the following manner:

- Tracer wire, (capable of being energised) is to be laid in the trench for both the reticulation and residential pipe materials;
- Pipes are to be laid at the standard depth. Where the main is laid at depths greater than 600mm, this will be marked clearly on the plan; and
- A brightly coloured marker tape is to be laid 300mm above the top of the pipe. This marker tape should indicate that there is a pressure sewerage system below it. Councils preference is that the tape be yellow and at least have the letters PS on it, but is happy to negotiate these colours with the pipelayer if yellow is not readily available at the time.

CONTROL PANEL INSTALLATION

All electrical connections are to be carried out in accordance with AS 3000 and must be carried out by an appropriately qualified electrician.

In affixing the control panel to the building, the Installer and electrician are to:

- Ascertain the 1 in 100 year flood levels for the property and ensure that the bottom of the control panel is a minimum of 500mm above the level designated;
- Ascertain the local electrical supplier requirements and ensure that Installers Staff always meets those requirements;
- Ensure that the control panel and the pumping station always remain within an easy line of site of the pump storage vessel; and
- Affix the contact numbers sticker when the installation is completed.

The Control panel is to be generally mounted on the dwelling wall. Where the pumping station is to be installed away from the dwelling a stand-alone post (fit for the purpose) and as supplied by the Technology Supplier may be used.

SPA'S

Council requires that any installation of a spa include a device to regulate the discharge to prevent system alarms or overflows from the pressure sewerage system. Each installation will be determined on a case by case basis with formal approval of Council required

The costs for any additional equipment that is required to be installed to accommodate large sudden discharges will be met by the property owner.

In general:

Spa's with less than 250 litres in normal operating volume: Require that no special provisions are made and as such they can be treated as a standard household water-using appliance.

Spas between 250 litres and 700 litres capacity in normal operating volume: Require some additional measures be fitted to the pressure system to avoid system alarms. Typically these could involve the following and will be dealt with on a case by case basis, with the property owner to be advised by Council on what is the preferred option.

- Time delays to the alarm switch.
- Restricting the discharge rate of the Spa into the pressure unit.

Spas with a normal operating volume in excess of 700 litres: Require that differing flow restriction devices be added to the system. Typically these will involve the following and will be dealt with on a case by case basis, with the property owner to be advised by Council on what is the preferred option:

- Providing some form of upstream storage with a limited discharge rate to more closely match that of the pressure sewerage unit.
- Time delays on the alarm.

Spas with a backwash facility: Will be dealt with the same as for a swimming pool.

SWIMMING POOLS

Council requires that any installation of a swimming pool include a device to regulate pool backwash volumes and rates, to prevent system alarms or overflows from the pressure sewerage system. Each installation will be determined on a case by case basis with formal approval of Council required.

The costs for any additional equipment that is required to be installed to accommodate large sudden discharges will be met by the property owner.

In general:

Pools with a backwash pump up to 0.45l/s: Require some additional measures be fitted to the pressure system to avoid system alarms. Typically these could involve the following and will be dealt with on a case by case basis, with the property owner to be advised by Council on what is the preferred option.

- Time delays to the alarm switch; or
- Restricting the discharge rate of the pool into the pressure unit.

Pools with a backwash pump that exceeds 0.45l/s: An additional storage with a controlled discharge of less than 0.45l/s will be placed between the pool's discharge pump and the sewerage pumping station unless the pool pumps discharge can be regulated to below 0.45l/s.

PLANS

Following the initial meeting with the property owner, the Designer is to prepare a plan of the proposed on property design. This plan at minimum must show the following:

- Location of the pumping station, relative to the buildings, including tie lengths to any suitable reference points;
- The pipeline route, including ties at any change of direction;
- The location of the boundary kit;
- The point of connection to the Council reticulation mains, where the main is on the same side as the property;
- The location of the overflow relief gully;
- Any proposed under boring; and
- Any unique features of the property, which have impacted the design such as gardens, structures, etc.

The layout plan is to be in plan view only as it will be assumed the property main will be minimum depth. Where this is incorrect the plan view will show the locations, where the depth has varied. Details of the depth at the start of the deviation, as well as at 2m intervals along the deviation will be required.

It is intended that the property layout plan will become the property Work as Executed drawing, provided that there are not too many changes to the layout. It should also be in an electronic format compatible with Council's GIS system.

CONSTRUCTION REQUIREMENTS - COUNCIL TO INSTALL

Council will undertake or arrange installation of all units.

HOMEOWNERS MANUAL

Council will provide Homeowners' Manuals, which provides basic instructions on how to use the pressure sewerage system. It also provides basic instructions on what to do if an alarm is activated.

PART 6

DESIGN MINIMUM STANDARDS

FOR

LANDSCAPING

6 DESIGN MINIMUM STANDARDS FOR LANDSCAPING

6.1 Introduction

This document outlines Tamworth Regional Council's recommended practice for Street Tree Planting. It is in no way a comprehensive design "Manual" and it is intended to be read in conjunction with and as a supplement to relevant Department of Conservation and Land Management and New South Wales Department of Housing publications.

It is recommended that the handbook by the New South Wales Department of Housing - Soil & Water Management for Urban Development, be followed.

All references to the Director should be interpreted as referring to the Regional Services Director or his nominated representative.

6.2 Public Reserves

Council uses a hierarchy to classify all its open space parks. This hierarchy gives clear guidance to the level of development and maintenance standards.
Council staff will classify the park prior to any design work for a public reserve.

6.3 Hierarchy of Parks

The Hierarchy of open space provides for the following categories:

- Regional Parks;
- District Parks;
- Neighbourhood Parks; and
- Local Parks.

The hierarchy determines the level to which a parcel of open space can be developed. The table below outlines the hierarchy levels and what the desired standard of development within the categories.
Detention and retention basins will not be accepted as Public Open Space for the purpose of recreation.

Table 6-A 6.3 Hierarchy of Parks

PARK CATEGORY	DESCRIPTION / PURPOSE	APPROX. SIZE	POSSIBLE FACILITIES
Regional	A park that caters for a whole of city, multiple towns or a broader regional population. Regional Parks are usually larger areas of land that can attract significant visitors, protect and preserve biodiversity or contain significant infrastructure to support a range of age groups, recreational experiences and visitor facilities. Regional Parks can cater for large groups of people across multiple recreation areas at any time.	> 4 Hectares	Designated car parking Amenities Visitor facilities Quality and substantial park furniture Lighting / power All age playspace equipment Pedestrian / cycle paths Attractive landscaping / gardens
District	District Parks service multiple neighbourhoods and provide facilities and features that cater for a range of recreation activities. Infrastructure caters for a broad cross section of the community and offers multiple play spaces and types including formal sports facilities and amenities.	1 to 4 Hectares	Limited parking areas Amenities Picnic facilities Variable play equipment Informal recreation / sport areas Pedestrian paths Attractive landscaping / gardens
Neighbourhood	Located close to residential developments Neighbourhood parks serve as the recreational focus of a small local community. Neighbourhood parks provide sufficient space for at least two activities such as open grassed area and playground. Neighbourhood parks may exhibit good pedestrian connections and be maintained to a medium service level and retained for future embellishment.	0.5 to 1 Hectare	On street parking Natural shade Park seating Informal recreation / sport area
Local	Small parklands that service the needs of the immediate resident population and provide limited infrastructure. Local parks generally provide sufficient space for just one activity such as small grassed area OR small playground. Local parks are maintained to a minor service level with minimal future embellishment.	0.25 to 0.5 Hectare	May contain: Park seat Small grassed area Limited planting of trees / shrubs

6.4 Public Open Space Development Process

The process for the development of Public Open Space is as follows:

1. The Developer shall prepare and submit for approval a landscape master plan and relevant management plans.
2. The Developer shall prepare and submit for approval detailed landscape drawings prior to construction at the time of submitting civil design drawings.
3. Construction can commence only upon approval of the detailed landscape plans.
4. On completion of the works, the Developer shall arrange a practical completion inspection.
5. The Developer is required to maintain the Public Open Space reserve for a three year period from practical completion.
6. Three months prior to the expiration of the maintenance period, the Developer shall contact the Director to initiate the handover process, which shall commence with a joint inspection of the Public Open Space.
7. Once Tamworth Regional Council is satisfied the Public Open Space meets the Standards herein, the Council shall accept responsibility for maintenance of the Public Open Space.

6.5 Landscape Master Plan

The landscape master plan is to be submitted for approval in principle prior to the submission of detailed landscape drawings.
The landscape master plan shall include:

- A detailed feature and contour survey
- Location of Public Open Space with respect to the boundaries of the development
- Boundaries of the Public Open Space
- Reserve name suggestions (to be approved by the Council)
- Landscape theme (If any)
- Adjoining land uses (road, private lots etc.)
- Areas of natural vegetation to be retained
- Areas of natural vegetation to be cleared
- Wetland areas to be protected
- Trees worthy of retention
- Drainage functions including drainage infrastructure
- 10 year and 100 year flood water levels where applicable
- Areas to be planted/grassed
- Pathway alignments
- Playground locations
- Location of any structures (pergolas, amenities, barbecues, etc.)
- Entry statement location and conceptual design
- Fencing
- Reticulation
- Proposed contours (including retaining walls); and
- Maintenance and operations program, and
- Areas allocated for Public Open Space shall not be utilized for the purpose/function of drainage or stormwater retention.

6.6 Specifications for Public Open Space Design & Detailed Landscaping Drawings

Detailed landscaping drawings shall be submitted following in-principle approval of the landscape master plan. Three copies of the Landscape Plan including any Working Drawings and associated Landscape Specifications should be provided addressing items listed in **APPENDIX A.**

Detailed landscape drawings shall include:

- Irrigation system and source of irrigation water
- Bore licence information and bore construction details
- Schedule of trees and other vegetation to be planted which indicates the botanic name (genus, species and cultivar), pot sizes and quantities
- Trees, remnant vegetation or other site features being retained
- Design and specification of play equipment
- Seating and shelters
- Barbecues
- Disabled access facilities
- Pedestrian and cyclist facilities
- Signage
- The location and specifications of bollards and vehicle control
- Design contours; and
- Retaining walls (will require engineer's certification depending upon the height).

The following are minimum standards for elements:

6.6.1 AMENITIES BUILDINGS

These structures shall meet the appropriate code. Be able to be locked and use an electronic locking system with back to base feature.

6.6.2 BARBEQUES

Barbeques shall be electric and be of a robust construction.

6.6.3 BOLLARDS

The perimeter of any public open space that has frontage to a public road shall be fenced with vandal proof bollards to prevent vehicular access. Posts shall be installed at maximum 1.5m centres. A gate or removable bollard shall be placed in a suitable location for vehicle access so that maintenance can be undertaken within the park.

6.6.4 BRIDGES

Bridges shall be designed and certified by an engineer. All products shall be durable and slip resistant during heavy frosts.

6.6.5 FURNITURE

Furniture shall be of a commercial design and durability and installed on concrete slabs which are 0.5m larger than the item of furniture to reduce maintenance issues. Accessible furniture may be incorporated into the design.

6.6.6 GARDENS

Gardens shall be designed with the climate in mind and the responsible use of water and the use of mulch to reduce evaporation and weed growth. All gardens are to have drip irrigation for watering purposes.

6.6.7 IRRIGATION

6.6.7.1 PLANS

Plans of the proposed irrigation system/s are to be submitted to the Director prior to construction.

6.6.7.2 WATER SUPPLY - NON POTABLE

All irrigation systems shall be run from a non-potable water supply such as underground bore water. Access to potable water will only be approved once the developer has carried out all investigations and found that there is no alternative supply to undertake the irrigation of the park.
Developers shall cover all costs associated with the drilling and licencing of bores.
Bores shall be a minimum of 150mm in diameter cased using either PVC in fractured Rock and steel in Alluvial areas.
Bores shall be either fully underground or installed within a small enclosure depending on their location within the landscape.
Bore pumps shall be a variable speed drive with a screen over the inlet to prevent debris being pumped. The pressure transducer shall be installed within 1m of the mainline. A main ball valve and a hydrant point shall be installed adjacent to the bore water meter to allow flushing of the bore.

6.6.7.3 IRRIGATION CONTROLLER

Irrigation systems shall be controlled with an electronic irrigation system with remote access for controlling the system with either a Hunter ICC2 with Hydrawise (including WiFi connection) or Hunter ACC-99D controller fitted with a GPRS-E modem.
A Hunter HC Flow Meter or Flow-Sync shall be installed adjacent to the bore to measure water flow depending on which controller is used.

6.6.7.4 PIPE WORKS

All irrigation shall be built using HDPE pipe. Mainlines shall be a minimum of PN12.5 and lateral lines shall be a minimum of PN8.
UPVC pipe is not permitted to be used within any part of the irrigation system.

6.6.7.5 TRENCH DEPTH

Minimum cover over all pipe work shall be 350mm with a depth of 450mm.

6.6.7.6 VALVES AND VALVE BOXES

All solenoid valves shall be Hunter PGV or ICV and have a ball valve to allow the line to be isolated. All valves shall be installed in a valve box with a minimum size of 420mm long x 305mm wide x 160mm deep.

6.6.7.7 SPRINKLERS

All popup sprinklers are to be either Hunter PGP or I25 and with stainless steel shafts and 15cm popup height.

6.6.7.8 DRIP IRRIGATION

Council encourages the use of drip irrigation for all gardens and trees rather than the use of overhead sprinklers.

6.6.7.9 OPERATION AND MAINTENANCE MANUAL

A manual detailing the automatic irrigation system shall be provided to Tamworth Regional Council prior to handover. The manual shall include the following:

- Introduction
- Contact details
- Sprinklers, risers and other emitters
- Solenoid valves, value boxes, wiring, mainline isolation valves and air release valves
- Controller
- Poly pipes and fittings

- Pump unit
- Electrical works and services warranties, quality assurance and ‘as constructed’ drawings; and
- Design parameters.

6.6.8 LIGHTING

All pathway or security lighting shall be done using LED lighting.

6.6.9 LOCKS

Where locks are required (irrigation, electrical cabinets, gates, barbecues), the Developer shall provide locks keyed alike to Tamworth Regional Council’s, Sport and Recreation Divisions key system.

6.6.10 PATHWAYS

All pathways shall be either paved or concrete to allow for wheelchair accessibility and a minimum of 1.6m wide.
Shared paths (cycle and pedestrian) in Public Open Space shall be a minimum of 2.5m wide and be constructed to the same specifications as for paths constructed in road reserves.

6.6.11 PLAYGROUNDS

All play equipment and fall zones shall comply with all relevant Australian Standards including but not limited to AS/NZS 4685, 4422 and 4486. Evidence in the form of an independent playground audit is to be provided to Council prior to Practical Completion.
All playgrounds shall meet the current Australian Standard and use organic mulch as a soft-fall product with the appropriate certification. A copy of the certification certificate shall be supplied to Council. All playgrounds shall be either fully covered or have a minimum of 50 percent coverage using a shade structures with anti-climb devices at an appropriate height to stop climbing or rubbing on the play equipment.

6.6.12 POWER

Mains power shall be connected to parks if required to power amenities, irrigation, lighting or barbeques. The Developer shall be responsible for the power costs till such time as the park has been handed over to Council.

6.6.13 RUBBISH BINS

Parks which fit into either Regional or District shall have at least 1 x 240L MGB installed in an enclosure or on a bin stand.

6.6.14 SHELTERS

Shelters shall be of a commercial design and durability. To be incorporated into concrete slabs to reduce maintenance issues and shall be 0.5m larger than the shelter.

6.6.15 SIGNAGE

All parks shall have a park name sign including the remote supervision and prohibited activities (Council to provide information for the remote supervision and prohibited activities). All signage shall be consistent with Council’s standard

6.6.16 TURF

Parks and reserves shall be sprigged or solid turfed with a warm season turf species and appropriately watered and mown to promote establishment during the growth season. Periodic spraying for weeds shall be undertaken as required.

6.6.17 WATER - POTABLE

Parks shall only be connected to potable water depending on the hierarchy of the park. The Developer shall be responsible for the water costs till such time as the park has been handed over to Council.

6.6.18 WORKS AS EXECUTED PLANS

Works as Executed (WAE) plans shall be submitted prior to handover of the assets to Council. Completion acceptance shall not occur until such time as WAE plans are submitted. All documentation relating to WAE shall meet the requirements of the Works as Executed document.

6.6.19 HANDOVER

Tamworth Regional Council shall only take handover of infrastructure if, at the time of handover, all integrated infrastructure works have been completed and are also due for handover.

6.7 Landscaping Minimum Standards for Road Verges

The developer shall prepare a comprehensive Landscaping Plan, which shall be approved by the Director Regional Services, prior to issue of the Construction Certificate.

6.8 Planting Details

At the pre-construction stage detailed planting information must be provided. A list of recommended species is listed in Part 6 – Appendix A. The plan shall show the location and species name of the proposed plants in a key format that relates back to a plant schedule, the plant schedule shall have at least the following information:

- Botanical and common name relating back to the key name given;
- Number of plants to be used;
- Size of plant container;
- Growth rate;
- Mature growth height;
- Mature growth spread; and
- The expected size of plant to be planted at the time of planting.

The developer is also required to submit details of proposed maintenance programs of all landscaping elements and undertake to maintain all landscaping in sound health and condition until the expiry of the maintenance bond period. Prior to acceptance Council will inspect the landscape works before signing off and accepting future maintenance responsibilities. During the maintenance period, horticultural best practices must be undertaken to ensure quality workmanship throughout the development before Council will accept the works.

6.9 Trees & Shrubs

The developer will be required to lodge with Council sufficient funds to permit the planting of one, or two on corner lots, approved semi-advanced street tree per standard residential lot. These funds will be utilised by Council to purchase and plant street trees when the subdivision is 75% occupied or at the end of two years, whichever occurs first. Alternatively the developer may, with the approval of the Director Regional Services, plant one or two on corner lots, approved street tree/s per standard residential lot, such trees are to be located in the footway within the road reserve central to the lot and in accordance with the approved services locality plan.
Trees proposed for street planting shall be semi advanced tree species from an accredited supplier, unless otherwise approved by the Director Regional Services.
The theme of trees and shrubs to be planted shall be identified in the landscape plan and approved by Council based on criteria including suitability to site conditions, compatibility with existing vegetation and planting themes for the locality.
Clear zone requirements must be achieved for street trees in accordance with Section 2.9.5.1.

6.10 Road Verges

The following conditions shall be satisfied prior to notification of completion;

- The ground surface of all road verges, parks and public reserves shall be of uniform grade and generally consistent with no obvious depressions and be free of boulders, foreign material and debris;
- All areas shall be trimmed as per the design contours in accordance with AS1428, to facilitate easy and safe mowing;
- Entrance statements not to be placed on public reserves or road verges;
- Existing vegetation, both above and below ground, that is located on road verges is to be protected from damage resulting, or likely to result from, from subdivision development works; and
- Existing vegetation located on road reserves that are deemed by Council to be dead or dangerous is to be removed or made safe by the Developer prior to date of handover.

6.11 Topsoil

On construction disturbed sites, developers shall provide for topsoil to be stripped following the clearing of vegetation and stockpiled for re-use. Additional imported topsoil may be needed to establish vegetative cover on some hard or denuded sites.
The developer shall use topsoil stockpiled on site, where imported topsoil is required it shall comply with AS 4419 and shall;

i. Be of a friable, porous nature;
ii. Be free of weeds and weed seeds, bulbs, corms and vegetable propagules;
iii. Contain no refuse, contamination, or materials toxic to plant growth or human health;
iv. Contain no stumps, roots, clay lumps or stones larger than 50mm in size;
v. Have an organic content of at least 3 per cent by mass;
vi. Have a pH neither less than 5.5 nor more than 7.5;
vii. Have a soluble salt content not exceeding 0.06 per cent by mass; and
viii. The source of any imported topsoil shall be nominated and testing results shall be supply to Council.

Topsoil shall be uniformly applied to provide an average compacted thickness of 50mm with a minimum compacted thickness of 30mm at any location. The topsoiled area shall be cultivated to a depth of 50mm to provide a roughened surface with soil lumps not exceeding 50mm dimension.

6.12 Roundabouts and Median Landscaping

Roundabout and median strip landscape design must have due regard for plant siting and maintenance requirements. Planting in roundabouts and medians are to be set back from the inside kerb edge as follows:

6.13 Roundabouts

Turf grass is not a suitable landscape item for roundabouts and will not be approved by Council. The following is a guide for landscaping of roundabouts.

- 0.0m - 1.0m setback - appropriate pavement material;
- 1.0m - >3.0m setback - shrubs / native grasses /groundcovers only with a maximum mature unpruned height of 600mm above the road pavement (not top of kerb);
- 3.0m - >3.0m setback - trees and shrubs/ground covers. Roundabouts of 6.0m in diameter in low speed zones of 50km/h or less, a small single trunked tree with a mature diameter of 100mm may be located in the centre of the roundabout, providing such achieves a clear trunk height at planting of 1.5m above the road pavement level; and
- Turf is to be discouraged in roundabouts.

6.14 Median Islands

Turf grass is not a suitable landscape item for median islands and will not be approved by Council. The following is a guide for landscaping of median islands.

- 0.0m - 0.3m - appropriate pavement treatment;
- 0.0m - 1.0m setback - appropriate native grasses or ground covers, 200mm high, with minimal pruning requirements;
- 1.5m setback - shrubs / ground covers only. Shrubs and ground covers to have a maximum maintained mature height of 900mm above the road pavement (not top of kerb);min. 1.5m setback - trees and shrubs / ground covers. Trees are to be primarily single trunked species. Tree species chosen will depend on the species spatial requirements and clearance from service elements and light poles;
- Trees will generally not be planted in medians with an internal width less than 3.0m;
- In median strips, three (3) metres or wider, trees may be located centrally or staggered provided such accords with traffic engineering visibility requirements. Tree species will be selected for appropriate canopy shape;
- Ends of median strips require special consideration and discussion with Council with regards to clear zones and safety requirements;
- Irrigation is to be placed in medians with subsoil drainage installed to adequately stop the ingress of water into the roadway. Irrigation shall be of such a design and quality of material and workmanship that the ingress of water into the pavement due to failure or damage is avoided;
- The root system of plants must not interfere with subsurface drainage and shall have root control system where necessary to protect Council services (water and sewer) from root damage;
- The design shall minimise the requirements for maintenance;
- Interfaces between grass and areas of chip mulch are to be avoided. Where grass does interface with chip mulch, a concrete mowing strip of 300mm wide must be provided.

The mature unpruned height of under plantings on road verges or in roundabouts, medians and splitter islands is not to exceed 600mm above road surfaces. This height, however, may be reduced at the discretion of the Director and may vary from site to site.

6.15 APPENDIX A – Checklist – Landscape Plan

Item No.	Description	Reference	Developer Confirmation	TRC Confirmation	Comments
1	Detail boundaries, easements, fences, footpaths, gutter crossings, drainage and grassed areas. Services should be indicated on the plan and show at least, underground services (water, electricity, gas, telephone, sewer and stormwater);	6.6			
2	The location of overhead wires;	6.6			
3	Proposed surface materials including, turf, pathways, patios, mulched garden beds, etc. are to be shown and specified;	6.6			
4	All structures including existing and proposed building footprints and building F.L's are to be shown;	6.6			
5	Other landscape structures such as pergolas, gazebos, entry statements etc, with detailed documentation of how they are to be constructed, materials, colours etc;	6.6			
6	Fencing and retaining walls details and specifications;	6.6			
7	A contour plan showing all existing levels and proposed new levels;	6.6			
8	Lighting if applicable;	6.6			
9	Site furniture and play equipment, including type and colour;	6.6			

10	Details of edging treatment;	6.6			
11	Irrigation systems, including the location of the RPZ valve and the proposed location of the control box;	6.6			
12	Where the irrigation is to become part of Council's responsibility separate irrigation plans will need to be submitted for approvals by Council;	6.6			
13	Site drainage including any subsoil drainage and drainage pit locations.	6.6			

6.16 Appendix B – Recommended Street Tree Species

Recommended street trees species. Please note that this list may be updated at any time and any variations from the list need to be approved by Council prior to planting.

Recommended street trees species.	
Common Name(s)	**Botanical Name**
Weeping Myall	Acacia pendula
Trident Maple	Acer buergeranum
Box Elder	Acer negundo
Forest Oak	Allocasuarina torulosa
Strawberry Tree	Arbutus unedo
Dwarf Kurrajong	Brachychiton bibwillii
Kurrajong Tree	Brachychiton populneus
Queensland Bottle Tree	Brachychiton rupestre
Illawarra Flame Tree	Brachychitton acerifolius
Bottlebrush	Callistemon various species
She-Oak	Casuarina cunninghamiana
Himalayan Cedar	Cedrus deodara
Camphor Laurel	Cinniamomun camphora
Marri Gum	Corymbia calophylla
Red Flowering Gum	Corymbia ficifolia
Spotted Gum	Corymbia macullatta
Blakely's Red Gum	Eucalyptus blakelyi
Silver Princess	Eucalyptus caesia
Sugar Gum	Eucalyptus cladocalyx 'Nana'
Scribbly Gum	Eucalyptus haemastoma
	Eucalyptus leucoxylon 'Macrocarpa'
	Eucalyptus leucoxylon 'Megalocarpa'
	Eucalyptus leucoxylon 'Rosea'
Eastern Grey Box	Eucalyptus microcarpa
Grey Box	Eucalyptus punctata
Strickland's Gum	Eucalyptus stricklandii
Forest Redgum	Eucalyptus tereticornis (mediana)
Cadaghi	Eucalyptus torelliana
Coral Gum	Eucalyptus torquata
Claret Ash	Fraxinus augustifolia 'Raywood'
Golden Ash	Fraxinus excelsior 'Aurea'
Evergreen Ash	Fraxinus griffithii
Flowering Ash	Fraxinus ornus
Green Ash	Fraxinus pennsylvanica
Honey Locust	Gleditsia triacanthos
Silky Oak	Grevillea robusta
Native Frangipani	Hymenosporum flavum
Jacaranda	Jacaranda mimosifolia

Crepe Mrytle	Lagerstoemia indica
Brush Box	Lepostemon confertus
Liquidamber	Liquidamber styraciflua
Magnolia Little Gem	Magnolia grandiflors ' Little Gem'
Canary Island Date Palm	Pheonix canariensis
Plum Pine	Podocarpus elatus
Simon Poplar	Poplar simonii
Flowering Plum	Prunus x blireana
Callery Pear	Pyrus calleryana
Bradford Pear	Pyrus calleryana 'Bradford''
Manchurian Pear	Pyrus ussuriensis
Holly Oak	Quercus ilex
English Oak	Quercus robur
Evergreen Oak	Quercus virginiana
Golden Robinia	Robina pseudoacacia 'Frisia'
Umbrella Black Locust	Robina pseudoacacia 'Umbraculifera'
Chinese Tallow Tree	Sapium sebiferum
Qld Firewheel Tree	Stenocarpus sinuatus
Lilly Pilly	Syzgium smithii
Water Gum	Tristaniopsis laurina
Chinese Elm	Ulmus parvafolia
Golden Elm	Ulums glabra 'Lutescens'

PART 7

Changelog

7 DOCUMENT HISTORY AND CHANGELOG

7.1 Introduction and Document History

This document outlines Tamworth Regional Council's History of Infrastructure Design Standards. There have been a number of iterations of these design Standards and changes have been recorded for any improvements made after June 2011.

7.2 Changelog

This table details changes to the Standards as they have evolved to cater for changing Australian and Industry Standards and improvements nominated by Council and the Local Development Industry.

Table 7-A – Minimum Standards Changelog

Version	Changes	Date
Draft Version 1		November 2010
Draft Version 2		7 June 2011
Final Version 1		28 June 2011
Final Version 2		22 May 2012
Final Version 3		3/01/2013
Final Version 4		5/12/2014
Version 5		11/11/2016
Version 6	This revision of the Guidelines has been a much larger change than seen between previous iterations. The structure of the document has changed moving, removing and inserting sections. References have been updated or corrected and the language of the document has been altered to better show the intent of the document as Engineering Design Minimum Standards. **General** Title of document changed from "The Engineering Design Guidelines for Subdivision and Development" to "The Engineering Design Minimum Standards for Subdivision and Development" Replaced references to title or "Guidelines" to "Minimum Standards" Inserted List of Tables Added Part 7 Document History and Changelog and Moved the current change log to Part 7 Deleted previous change notes leaving document revision history only Large Amount of Formatting Changes Section orders have changed significantly Amended Table of Contents to show only 2 levels of reference e.g. 1.1 and 1.2 instead of 4 levels e.g. 1.1.1.1 and 1.2.4.2 Inserted Cross References within Document Clarified and updated Australian Standard References (AS/NZS	

	NNNN) to be consistent and not referring to old obsolete standards. Grammar, spelling, and syntax errors were rectified throughout the document All Standard Drawings have been removed from the document with the exception of the Footway Allocations. All standard drawings shall be part of a separate annexure and referred to within this document. **Part 1** 1.1 - Process to depart from Engineering Design Standard added. Names of Parts 2 - 6 amended to reflect titles 1.3 - Common Definitions section Inserted for common references for Director, Developer and Developer's Representative, Engineer, The Engineering Design Minimum Standards for Subdivision and Development, Registered Surveyor. These definitions have been removed from subsequent parts of the document. 1.5 - amended to include reference to Quality of Survey supporting Design, clarified submission address, clarified number of drawings required and provided ability of Designer to submit a preferred size of plan for return to them (Previously A1m can now be of size nominated by Designer) 1.5 - added statement "Repeated Submission of substandard drawings may necessitate in a meeting between Council and the Developer and the Developers Representative to resolve outstanding issues." 1.5.2 - Clarified Safety in Design report is to be lodged with the initial revision of plans indicating the safety in design has been taken during the design process and not as a consideration post design. Updated Table 1A to refer to Pavement Design Report and Line Marking and Signage Plan to be provided at initial plan submission, and Hydraulic Model to be provided as part of the WAE submissions 1.5.3 – Updated Persons Qualified to match Engineers Australia framework 1.5.4 – Section revised to refer to Tamworth Regional Council Construction Specification 1.6 - Inserted Design Departure application requirements (Departures from the minimum Standards nominated within this document) 1.7 - Amended to say Release of Subdivision Works Certificate instead of Completion of Required Works for Release of Subdivision Certificate. Clarified Performance Bond Amounts and also that bonds allowed only for works in road or drainage reserves. Clarified minimum bond amount of $2500 and increased bond lodged to be 200% of the value of outstanding works. Clarified Wording around maintenance bond release and requirements of maintenance bonds. 1.8 - Confirmation of capacity of detention basins required as part of WAE. Added requirement of supply of Hydraulic Model and conformance survey requirements at cross sections 1.8.1 – Clarified work as executed requirements for bonded works 1.8.3 – Allotment Fill Conformance requirements Clarified 1.9 – Amended policy title to be correct title as accepted by Council.	

	1.10.1 – Clarified Insurance requirements Annexure A Reworded Annexure B – Departure Documentation (Forms) inserted Removed all standard drawings and changed all references to new drawing list **Part 2** 2.2.2 – Removed industrial area off street parking concession 2.2.2 – Added minimum design traffic 2.2.2 – Clarified that local roads have two points of entry or more than 15 dwellings. 2.3.2.4 – Clarified that drainage is required on both sides of rural roads 2.3.5 – Added checking vehicle requirements 2.3.2 – Clarified that collectors are not to connect arterial road to sub-arterial roads. 2.4.4 – Clarified that for angles not shown in Table 2-E interpolation should be used. 2.5 – Clarification of requirements when batters extend into lots. 2.5.5 - Added 375mm minimum culvert size for driveway crossings in areas not zoned rural. 2.7.4 – Update to require LED street lights 2.8.1 – Cross intersections to have most appropriate intersection treatment as outlined in TIA. 2.8.3 – Amended Austroads warrants reference. 2.9.2 – Pavement design life changed to 40 years **Part 3** 3 – Full section restructured 3 – inclusion of ARR 2016 requirements 3.3 – Clarified rural area definition and trunk drainage definition 3.5.6 – Added design ARIs for transverse drainage 3.6 – Clarified applications of time of concentration methods 3.6.3 – Clarified that Watercom Drains is councils preferred stormwater modelling software 3.6.3.5 – Added typical ILSAX parameters 3.6.3.2 – Confirmed that lot sizes are based on permissible lot sizes 3.7 – Guideposts required at transverse culverts and pipe capacities to be in accordance with design ARIs. 3.7.1.1 – Blockage Factors added 3.7.2 – New requirements for minimum lengths of stormwater pits. 3.8.2.7 – Clarified trunk drainage requirements 3.10.1 – added max predeveloped lot size for OSD 3.10.5 – Clarified requirements for assessment under the Australian National Committee on Large Dams (ANCOLD) guidelines 3.10.3.6 – Added minimum spillway width and spillway requirements near public roads 3.10.3.9 –Removed allowance for batters steeper than 1 in 4 and retaining walls 3.10.3.12 - Minimum pipe size 375mm out of basins 3.10.4 - updated ARI requirements for detention system design 3.11.1 – Additional easement width requirements **Part 4**	

	4.1 - Update References to other standards and guidelines 4.4.1 - wording was clarified – removing duplication of wording for extension construction and changes to Councils infrastructure 4.5.6 - Removed " 100mm pipes may be considered in some isolated industrial areas" 4.5.7.2 - Hydrant spacing is along each water main clarified, kerb impression lettering specification clarified 4.5.8.3 - Amended Section Nominal Size of Water Services to include current references (NCC and AS3500) and amended Table Pat 4 C Size of Water Service formatting for clarification and added "Minimum" to Title 4.5.14.1 – Deleted Section - Pipe/Fittings Connection – Polyethylene and removed title of Section 4.5.14.2 - All other Materials 4.7.8 - Deleted Section and removed reference to mains less than 100mm in diameter **Part 5** 5.2 - Added section titled "References" 5.4.1 - wording was clarified – removing duplication of wording for extension construction and changes to Councils infrastructure 5.5.5 Clarification of distances for marking of Sewer Junctions **Part 6** Rewritten section. Notable changes about hierarchy of parks and sourcing water. Additional detail for Open Spaces / Parks	