Shellharbour City Council

Shellharbour Engineering Design Code

shellharbour.nsw.gov.au

19/11/2019

LIST OF SPECIFICATIONS IN THE DESIGN CODE

0010 QUALITY REQUIREMENTS FOR DESIGN

1 GENERAL

1.1 RESPONSIBILITIES

General

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

Council or the principals authorised person may choose to exercise its discretion to request some or all of the following are completed.

The following provisions must be adhered to unless the Principals authorised person/Council advice otherwise.

Seek clarification from the Principal's authorised person/Council as to what items are specifically required to be completed/tested/submitted as part of the works specific to the contract, if no direction is given, all requirements must be adhered to/addressed.

Al products and construction specifications must be adhered to unless the developer/contractors obtain endorsements from Council's authorised person for an alternative/equivalent.

1.2 STANDARDS

General

Standard: To AS/NZS ISO 9001. (Note: Compliance with the principles of ISO 9001 is required however formal accreditation requirements is at Council's discretion.

1.3 INTERPRETATION

Abbreviations

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

- NER: National professional engineers register by Engineers Australia
- QMS: Quality management system.

Definitions

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

- Accreditation: Certification by a statutory or approved authority of the facilities, capabilities, objectivity, competence and integrity of an organization or individual to provide a specified service and/or required operation.
- Certification: A written assertion of facts.
- Hold point: A mandatory verification position in the contract beyond which work cannot proceed without the designated authorisation.
- Non-conformance: The non-fulfilment of documented requirements.
- Professional engineer: As defined by the NER
- Quality design checklists: Forms completed during the design process verifying key steps, and records.
- Records: Documents and data, no longer subject to alteration, that provides evidence of activities performed.
- Validation: Confirmation, through the provision of objective evidence, that requirements for a specific intended use or application have been fulfilled.
- Verification: Provision of evidence or proof that a performance requirement has been met or a default exists.

(Note: Comment in section 1.2 Standards – General)

2 QUALITY MANAGEMENT SYSTEM FOR DESIGN

2.1 GENERAL REQUIREMENTS

System requirements

QMS: Plan, develop and maintain a documented QMS conforming to this work-section and AS/NZS ISO 9001.

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

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

(Note: Comment in section 1.2 Standards – General)

2.2 DOCUMENTATION REQUIREMENTS

General

QMS documentation requirements: Include the following:

- Quality policy and objectives.
- Quality plan(s).
- Procedure documents.
- Forms.
- Relevant external documents.
- Records.

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

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

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

Design quality plan

(Note: Comment in section 1.2 Standards – General)

Requirement: Provide a design Quality Plan, to AS/NZS ISO 9001 and AS/NZS ISO 10005. Include the following:

- Design program including stages.
- Review and verification for each stage and validation of the completed design.
- Responsibilities and authorities for design.
- Design team, including subconsultants, names of team members, roles and technical interfaces.
- Resources assigned to the project.
- Organisation chart including communication paths with the Superintendent, the Principal, other Consultants and Contractors.
- Design inputs such as requirements and acceptable criteria.
- Hold Points for the design stages.
- Programmed approvals/consultations with regulatory authorities.
- Third party review/verification/validation required by the Principal or regulating authority.
- Proposed design documentation.

- Procedure for managing design changes of project audits.
- Records of design processes and review, verification and validation.

Design input

Requirement: Identify, document and review for adequacy the following:

- Principal's brief.
- Site information, including survey information, geotechnical reports, environmental reports. and hydrology and local Environmental plans.
- Codes of practice, Development control Plans (DCP's) and Councils Engineering Requirements.
- Regulatory and statutory requirements.
- Performance criteria.
- Design criteria.
- Review: Give notice if the design inputs do not provide sufficient information for verification.

2.3 REVIEW, VERIFICATION AND VALIDATION

Design review

Requirement: Conduct regular reviews to evaluate the design and identify problems and propose corrective action. Include the following:

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

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

Design verification

Verification: At completion of each design stage certify the result of a given activity for conformance with the design input requirements for that activity. Include the following:

- Document the process.
- Identify responsibilities.
- Maintain records of the verification.

Design validation

Validation: At completion of design, certify the design for conformance with the design requirements. Include the following:

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

Certification

Requirement: Submit a Certification Report signed by the designer accompanied by drawings and specification, conforming to the design certificate and checklists included in **Annexure A** at the following stages:

- Each preliminary design stage.
- Completed design.

Exemption: A Certification Report is not required when submitting sketch or concept designs.

2.4 CONTROL OF NON-CONFORMANCE

General

Detection and reporting: Identify, control and report non-conformance with the design requirements.

Design variations: Record on the Certification Report checklists any aspects of the design that do not meet the design input requirements or tolerances and other applicable Council design and construction specifications.

2.5 CONTROL OF DESIGN CHANGES

Design changes

Requirement: Identify, review and control changes to the design. Include the following:

- Control of requests for changes.
- Review of impact of changes.
- Authorisation of changes.
- Verification of implementation of changes.

Process for changing design after issue of documents for construction: Review, verify and approve before re-release for construction.

Record: Maintain a register of design changes. The design register should have key information such as who proposed the design change, who from Council accepted the design change, when the change was originally brought up, when the change was implemented as well as any applicable dates and comments.

2.6 CONTROL OF DOCUMENTATION

Documentation

Requirement: Control and retain documents and data relating to the project, including from the Principal, other consultants or subconsultants and suppliers.

Distribution control: Maintain a master list of controlled documents. Include the following information:

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

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

Design change register: Record changes to documents after issue for construction.

2.7 CONTROL OF RECORDS

Records

Requirement: Retain design records in a format readily accessible without prior knowledge of the particular design.

Copies of records: Available to Council upon request without charge.

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

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

3 ANNEXURE A

3.1 CERTIFICATION REPORT

Design certificate

Project title:	
Documentation no:	
Designer:	

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

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

I certify that this design will not significantly impact on the environmental factors of the area as interpreted under the following:

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

Date:	
Contact phone:	
Contact postal address:	
Design Engineer/Surveyor:	
Qualifications:	
ABN:	

3.2 DESIGN CHECKLIST 1 - DOCUMENTATION OF EXISTING SITE FEATURES

Checkpoints

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

		By	**Date**	**NA**
1.1	Check detail survey by site inspection for existing drainage.	……	...../...../.....	☐
1.2	Check detail survey by site inspection for existing property descriptions, boundaries and accesses.	……	...../...../.....	☐
1.3	Check detail survey of contours as	……	...../...../.....	☐

		By	Date	NA
	representative of site terrain.			
1.4	Document trees and significant environmental features affected by the works.	……	...../...../.....	☐
1.5	Document significant features to heritage within the Works boundaries.	……	...../...../.....	☐
1.6	Document existing public and private property likely to be affected by the design.	……	...../...../.....	☐
1.7	Document survey (of contours and features) and benchmarks of the site and up to 3 metres within neighbouring lots.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided:

Non-conformance

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

3.3 DESIGN CHECKLIST 2 - HORIZONTAL ROAD ALIGNMENT

Checkpoints

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

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

		By	Date	NA
	with existing utility services.			
2.12	Document horizontal road alignment set out data.	…….	...../...../.....	☐
2.13	Check provision of superelevation and superelevation development lengths.	…….	...../...../.....	☐
2.14	Check adequate sight distance for corners.	…….	...../...../.....	☐
2.15	Check adequate Overtaking sight distance and Manoeuvre sight distance.	…….	...../...../.....	☐
2.16	Check widening of lanes on curves.	…….	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided:

Non-conformance

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

3.4 DESIGN CHECKLIST 3 - VERTICAL ROAD ALIGNMENT

Checkpoints

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

		By	Date	NA
3.1	Check that grades conform to maximum and minimum requirements as per Austroads guides.	…….	...../...../.....	☐
3.2	Check that vertical clearances to bridges and services conform to standards.	…….	...../...../.....	☐
3.3	Check that there is adequate vertical sight distance for drivers and pedestrians.	…….	...../...../.....	☐
3.4	Check that there is adequate cover to drainage structures or services.	…….	...../...../.....	☐
3.5	Check that there is adequate vertical alignment for disposal of surface drainage from properties and road.	…….	...../...../.....	☐
3.6	Check that grades conform to 1:100 year flood levels (or required planning flood return frequency).	…….	...../...../.....	☐
3.7	Check that vertical alignment is compatible with property access.	…….	...../...../.....	☐
3.8	Check that gradients on intersecting roads do not exceed the cross slope of the through pavement and no greater than 3% at give way and stop signs.	…….	...../...../.....	☐
3.9	Check that there is acceptable sight distance for all accesses to roundabouts (or systems for reducing speed are provided).	…….	...../...../.....	☐
3.10	Check that alignment coordination with horizontal alignment is in conformance	…….	...../...../.....	☐

		By	Date	NA
	with the Austroads design guides referenced in the AUS-SPEC specifications.			
3.11	Identify and resolve conflict with existing public utility services and not referred to construction.	…….	...../...../.....	☐
3.12	Document vertical road alignment set out data on the longitudinal sections.	…….	...../...../.....	☐
3.13	Check that sag curves are designed for headlight sight distance.	…….	...../...../.....	☐
3.14	Check that intersections are located as per AUS-SPEC design specification.	…….	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided:

Non-conformance

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

3.5 DESIGN CHECKLIST 4 - ROAD CROSS-SECTIONS

Checkpoints

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

		By	Date	NA
4.1	Document complete dimensions on typical cross-sections.	…….	...../...../.....	☐
4.2	Document kerb & gutter, road safety barrier and surface drainage on typical cross-sections.	…….	...../...../.....	☐
4.3	Document batter slopes and batter treatment where appropriate.	…….	...../...../.....	☐
4.4	Document pavement description and surface treatment including geotechnical reference.	…….	...../...../.....	☐

		By	Date	NA
4.5	Document property boundaries, service allocations and location of known existing underground services and pathway treatments.	…….	...../...../.....	☐
4.6	Document cross-sections to define all variations and width transitions.	…….	...../...../.....	☐
4.7	Document cross-sections allowing for assessment of impact of road level on adjoining property.	…….	...../...../.....	☐
4.8	Verify the stability of embankment slopes, batters and retaining walls as satisfactory.	…….	...../...../.....	☐
4.9	Check that cross section reference level conforms with vertical road alignment.	…….	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided:

Non-conformance

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

3.6 DESIGN CHECKLIST 5 - ROAD AND INTER-ALLOTMENT DRAINAGE

Checkpoints

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

		By	Date	NA
5.1	Document existing surface drainage and upstream catchments.	…….	...../...../.....	☐
5.2	Check that hydrological data is current.	…….	...../...../.....	☐
5.3	Make hydrologic and hydraulic design calculations available for audit.	…….	...../...../.....	☐
5.4	Check that underground drainage and structures do not conflict with public utility services.	…….	...../...../.....	☐
5.5	Check that the designed drainage lines are compatible with existing incoming lines and outgoing lines.	…….	...../...../.....	☐
5.6	Document pipeline length, type, size, class and bedding requirements for each drainage line.	…….	...../...../.....	☐
5.7	Check that height of fill over drainage lines is within recommended practical limits.	…….	...../...../.....	☐
5.8	Document drainage provisions for local depressions, e.g. median areas or areas adjacent to fills.	…….	...../...../.....	☐
5.9	Check that the effect of headwater and back-up water on private property is satisfactory and non-intrusive.	…….	...../...../.....	☐

		By	Date	NA
5.10	Document subsurface drainage by line and level if required.	…….	...../...../.....	☐
5.11	Document batter drains for fills and cuttings if required.	…….	...../...../.....	☐
5.12	Consider the height and energy level of downstream drainage including exit velocity.	…….	...../...../.....	☐
5.13	Locate drainage structures and flow paths to ensure safe vehicular and pedestrian transit.	…….	...../...../.....	☐
5.14	Document drainage structure number, set out, type and pipe on the drainage plans and schedule of drainage elements.	…….	...../...../.....	☐
5.15	Identify emergency overland flow paths to minimise impact on private property.	…….	...../...../.....	☐
5.16	Check that road drainage conforms with Council's drainage design criteria.	…….	...../...../.....	☐
5.17	Check that inter-allotment drains conform with Council's Pipe size and pits Specification and ARR rainfall data.	…….	...../...../.....	☐
5.18	Document appropriate land stabilisation and velocity controls to pipe systems, open channels and embankments to prevent scour.	…….	...../...../.....	☐
5.19	For flood controlled allotments ensure, the floor height controls are compatible with road and drainage levels as specified by town	…….	...../...../.....	☐

		By	Date	NA
	planning or from a flood study.			

Certified documents

Include the following certified documents:

List additional certified documents provided:

Non-conformance

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

3.7 DESIGN CHECKLIST 6 - PAVEMENT DESIGN

Checkpoints

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

		By	Date	NA
6.1	Document pavement design and surface treatment on the typical road and/or pathways and cycleways cross-sections. Document any variations on the specific cross-sections.	……	...../...../.....	☐
6.2	Check that the pavement design conforms to the *0042 Pavement design* work-section and/or the *0044 Pathways and cycleways (Design)* work-section for adequacy.	……	...../...../.....	☐
6.3	Assess geotechnical data and keep records of design calculations for pavement design recommendations.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided:

Non-conformance

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

3.8 DESIGN CHECKLIST 7 - BRIDGE/MAJOR CULVERT DESIGN

Checkpoints

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

		By	Date	NA
7.1	Check that the design engineer is suitably experienced in the relevant field and who has or is eligible for NPER registration with Engineers Australia.	……	...../...../.....	☐
7.2	Assess geotechnical data for adequacy and keep records.	……	...../...../.....	☐
7.3	Check that the type and functional dimensions of the bridges conform to AS 5100 series, AS 4100, AS 3600, AS 1684 series, AS/NZS 1170 series and AS/NZS 5131.	……	...../...../.....	☐
7.4	Document the type and class of all materials.	……	...../...../.....	☐
7.5	Keep records of all significant design calculations and make available for audit.	……	...../...../.....	☐
7.6	Check that the exit velocity for flow on the downstream side of the structure will not cause scour erosion.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided:

Non-conformance

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

3.9 DESIGN CHECKLIST 8 - EROSION AND SEDIMENTATION CONTROL PLANS (ESCP)

Checkpoints

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

		By	Date	NA
8.1	Check that the ESCP and supporting design documents conforms to the *0022 Control of erosion and sedimentation (Design)* work-section for the construction and operational phase and includes: - Construction detail drawings. - Remedial action plans for areas requiring corrective action.	……	…../…../…..	☐
8.2	Check that the erosion and sedimentation control conforms to	……	…../…../…..	☐

		By	Date	NA
	development consent conditions and state environmental legislations.			
8.3	Check that the soil management plans and water management plan conforms to *0022 Control of erosion and sedimentation (Design)* work-section and to state and local government authority requirements.	……	...../...../.....	☐
8.4	Check that stormwater management conforms to the *0074 Stormwater drainage (Design)* work-section.	……	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided:

Non-conformance

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

3.10 DESIGN CHECKLIST 9 - WATER SUPPLY

Checkpoints

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

		By	Date	NA
9.1	Check that the design engineer is suitably experienced in the relevant field and who has or is eligible for NPER registration with Engineers Australia for water supply.	…….	...../...../.....	☐
9.2	Check that a practicing registered Surveyor performed the survey.	…….	...../...../.....	☐
9.3	Assess geotechnical data for adequacy and keep records.	…….	...../...../.....	☐
9.4	Check that the type and functional dimensions of the reticulation and any pump station meet the State Department of Public Works and Services guidelines and the appropriate Australian Standards and are compatible with WSA 03.	…….	...../...../.....	☐
9.5	Document the type and class of all materials, fittings, joints, and plant, pumps special requirements for crossings and protection.	…….	...../...../.....	☐

		By	Date	NA
9.6	Keep records of all significant design calculations and make available for audit.	…….	...../...../.....	☐
9.7	Check that the design conforms to requirements of all Statutory Authorities.	…….	...../...../.....	☐
9.8	Check the design conforms to any development consent conditions.	…….	...../...../.....	☐

Certified documents

Include the following certified documents:

List additional certified documents provided:

Non-conformance

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

4 ANNEXURE - REFERENCED DOCUMENTS

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

AS/NZS 1170		Structural design actions
AS 1684		Residential timber-framed construction
AS 3600	2018	Concrete structures
AS 4100	1998	Steel structures
AS 5100		Bridge design

AS/NZS 5131	2016	Structural steelwork - Fabrication and erection
AS/NZS ISO 9000	2016	Quality management systems - Fundamentals and vocabulary
AS/NZS ISO 9001	2016	Quality management systems - Requirements
AS/NZS ISO 10005	2006	Quality management systems - Guidelines for quality plans
ARR	2016	A guide to flood estimation
WSA 03	2011	Water Supply Code of Australia

0011 DEVELOPMENT AND SUBDIVISION OF LAND

1 GENERAL

1.1 INTRODUCTION

Work-section

General: This work-section provides guidance on the design requirements and planning permission process for development and subdivision of land within Council area.

This specification provides the general procedures and practices of engineering design requirements for civil works and greenfield subdivision development of land within Shellharbour City Council Local Government Area. It should be read in conjunction with Council's Engineering Construction Specification for Civil Works.

The aims of this specification are to:

1. Set engineering design standards and requirements for the infrastructure associated with any subdivision and development within Shellharbour City Local Government Area;

2. Facilitate the efficient processing of engineering construction plans submissions; and

3. Ensure that infrastructure associated with any development is designed to be safe, liable, serviceable and economically maintainable without additional burdens on Council in order to meet community expectations and future needs.

4. Ensure the development of infrastructure associated with subdivision utilises sustainable methods and minimises environmental impact.

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

Nothing in this specification is to limit, in any way, the right of Council to impose differing conditions when approving engineering construction plans, nor restrict the discretion of Council's Engineering Services Manager and Development Engineering Coordinator or their nominated representative to vary any necessary engineering requirements in respect of a particular development or Council project, having regard to good engineering practice and site context.

This specification will be revised periodically to embrace new ideas and design practices and to co-ordinate with updated legislation and / or Council's planning and engineering policy.

Council reserves the right to interpret, change, amend, modify or delete any requirements of this specification.

Structure: This work-section is divided into six subsections:

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

Other documentation: This work-section also provides an introduction to other documentation affecting development and subdivision including:

- State planning legislation.
  - . Environmental Planning and Assessment Act (1979) as amended
  - . State Environmental Planning Policies (SEPP's)

- Council planning instruments.
  . Local Environmental Plan (LEP)
  . Development Control Plan (DCP)
- Council standard drawings.
- AUS-SPEC *Design* work-sections (Workgroup 00 *Planning and Design*).
- AUS-SPEC *Construction* work-sections (Workgroup *02 Site, Urban and open spaces, 03 Structure* and 11 *Construction – Roadways* and 13 *Construction – Public Utilities*).

1.2 COUNCIL'S OBJECTIVES

Planning

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

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

1.3 CROSS REFERENCES

General

Requirement: Conform to the following work-section(s):

- *0010 Quality requirements for design.*
  - **Design:** *0021 Site regrading*, *0041 Geometric road layout*, *0042 Pavement design*, *0043 Subsurface drainage (Design), 0044 Pathways and cycleways*, *0061 Bridges and other structures*, *0071 Water supply – reticulation and pump stations (Design), 0074 Stormwater drainage (Design)*, *0075 Control of erosion and sedimentation (Design)*.
  - **Construction:** *0136 General requirements (Construction), 1102 Control of erosion and sedimentation (Construction), 1111 Clearing and grubbing*, *1112 Earthworks (Roadways), 1121 Open drains, including kerb and channel (gutter), 1122 Kerb and channel (gutter) replacement*, *1351 Stormwater drainage (Construction).*

1.4 REFERENCED DOCUMENTS

Standards

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

Australian standards

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

(Note: As per section 1.2 in 0010 Quality requirements for design, pg.1).

1.5 INTERPRETATION

Abbreviations

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

- ARI: Average recurrence interval.
- DA: Development Application.
- RMS: Roads and Maritime Services.

- WAE: Work-as-executed.

Definitions

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

- Development assessment: The process for ensuring that a proposed development on land is consistent with the plans, zones and other instruments determining how the land is to be used.
- Hold point: A defined position in the different stages of the Contract beyond which work cannot proceed without mandatory verification and acceptance by the Superintendent.
- Planning: The process of making decisions to guide future allocation and development of land.
- Qualified surveyor: A surveyor who is eligible for membership of the Spatial Sciences Institute as a certified engineering surveyor.
- Registered Surveyor: A surveyor accredited by the Institution of Surveyors for civil design in the appropriate area.
- Rural land: Land, other than urban and rural residential, comprising larger holdings.
- Rural residential land: Rural home site and hobby farmland.
- Superintendent: Superintendent has the same meaning as Contract Administrator or Principal's representative. The Superintendent may be party to the contract or appointed by the Principal to administer the contract. The powers, duties and authorities of the Superintendent are covered in the contract. These can be changed in writing at any time during the contract by mutual agreement. As alluded to elsewhere, the Superintendent for a Council funded project is the Councils Superintendent. The Superintendent for a private development is the developers Superintendent. Note that for a private development project, that Council's Engineering Development Officer will have Hold Points to release that sit above those of the Principal's Superintendent.
- Urban residential land: Land within areas zoned residential, village or township.
- Witness point: A nominated position in the different stages of the Contract where the option of attendance may be exercised by the Superintendent, after notification of the requirement.
- Zones: A smaller area within the larger Council area which is identified in a development plan. A zone groups together areas with similar characteristics to integrate mutually beneficial uses and separate incompatible uses. Zones are typically based on land uses.

2 PRE-SUBMISSION PLANNING

2.1 PREPARING AN APPLICATION

Requirements

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

The applicant is to submit any Building Design Guidelines that are imposed on the subdivision or development of land to Council for review and approval.

It is the Applicant's responsibility to determine the type of approvals required and obtained from Council in order to satisfy the conditions of the development consent. Where there are uncertainties or the applicant is unsure of the meaning or extent of approvals required, the Applicant is recommended to contact Council's Engineer and seeks clarification.

Generally there are two (2) main types of approvals for civil works and/ or subdivision works within the Shellharbour City Local Government Area.

- Subdivision Works Certificate (formerly a Construction Certificate)

Section 6.13 (1) (a) of Environmental and Planning Assessment (EP&A) Act 1979 states that:

A subdivision works certificate is required for the carrying out of subdivision work in accordance with a development consent.

- Roads Act – Section 138

Under Section 138(1) of Roads Act 1993,
A person must not:

(a) erect a structure or carry out a work in, on or over a public road, or
(b) dig up or disturb the surface of a public road, or
(c) remove or interfere with a structure, work or tree on a public road, or
(d) pump water into a public road from any land adjoining the road, or
(e) connect a road (whether public or private) to a classified road,
otherwise than with the consent of the appropriate roads authority.

Private accredited certifiers do not have any authority to issue approval or carry out inspections for works on any public road reserves.

Any works on public road reserves will require approvals from the relevant roads authority. In most cases, Shellharbour City Council is the roads authority for all roads except classified roads where the RMS is the roads authority. Separate approvals from the Roads and Maritime Services (RMS) will be required for works on classified roads.

2.1.1 ENGINEERING PLANS AND CERTIFYING AUTHORITIES

In this Specification, whenever the term 'Engineering Plan' is used, it shall be deemed to refer to plans associated with a Subdivision Works Certificate issued by Council or a Certifying Authority under the EP&A Act, and Engineering Approvals issued by Council under the Roads Act 1993 and Local Government Act 1993.

A Certifying Authority may issue a Subdivision Works Certificate for Subdivision Works in accordance with the requirements of the EP&A Act. However the Act provides that only Council may be appointed as the Principal Certifying Authority in the case of subdivision works to Local Roads. Therefore any reference made in this Specification to approvals by Council for items to be addressed prior to the issue of a Subdivision Works Certificate under the EP&A Act shall also be deemed to be a reference to a Certifying Authority under the EP&A Act.

Certifying Authorities do not have the authority to issue approvals for proposed work on existing public roads under the EP&A Act and the Roads Act 1993.

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

Site Information

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

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

Fees/contributions

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

2.2 CONSULTATION

Council and other authorities

Purpose: To determine the planning, zoning, legislative and regulatory requirements and the extent of professional assistance required. The consultation process will identify the following:

- Any non-compliance.
- Council's specific requirements.
- Financial contributions for services and amenities.
- Modifications to application required before submission.
- Standards of construction acceptable to Council.

Requirement: Consultation with Council before submission of an application is not mandatory. However, consultation with Council is recommended for the following reasons:

- Reduction of costs in preparation of application
- Reduction of the time Council needs to consider the application.
- Increased likelihood of consent.

Sketch plan: Prepare a sketch plan for the consultation indicating the location, aspect and size of the various elements of the development including subdivision patterns surrounding the site. Provide enough information on the sketch plan so that Council is able to undertake an initial assessment of the proposal and provide appropriate advice on the application.

Suggested sketch plan inclusions:

- Plan
- Elevation
- Contours
- Easements
- Lot, DP, Sections

Utilities services

General: Consult public utility authorities to obtain their requirements.

Public consultation

Requirements: The applicant shall comply with the Council Public Consultation Policy

3 APPLICATION PROCESS

3.1 CONSENT AND EXEMPTIONS

Consent

Requirement: Submit an application for proposed development and/or subdivision in conformance with Environmental Planning and Assessment (EPA) Act 1979 and regulations and Council's requirements.

Exemptions

Applications deemed to comply or exempt: Refer to Council's Exempt and Complying Development Policy.

3.2 GOVERNMENT AUTHORITY

Council's authority

Authority responsible for approving applications: Shellharbour City Council

Provisions for development and subdivision are included in the following:
- Council planning instruments and guidelines
- Local Government Act
- Environmental Planning and Assessment Act 1979 (as amended)
- Environmental Planning and Assessment Regulation 2000
- Land title registration authority:
    - Land Property Information Services.
- Other consent authorities required to give recommendations of approval:
    - Public Utilities
    - Crown Lands
    - Government Departments

Approval criteria: Conformance with the provisions of the state Acts or Regulations does not imply that Council is required to consent to, or approve, an application.

Restrictions: Council's authority to approve the development and subdivision of land is set out in the state Acts and Regulations.

Responsibility: The Developer (or its consultants) is responsible for making sure that all works are designed and constructed in conformance with Council requirements. Obtain advice from Council's planning/engineering/environmental/services sections on any restrictions that apply to the land.

Conditions of contribution: Council's authority to impose conditions for contributions are set out in the state Acts and Regulations.

3.3 SUBMITTING APPLICATION

Preparation

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

Development application form: Available from Shellharbour City Council

Fees schedule: Available from Shellharbour City Council

Contributions schedule: Available from Shellharbour City Council

Submission: Submit application to Shellharbour City Council

Owner's approval: If the applicant is not the owner of the land to be developed, written authority from the owner must be submitted with the application form. Permission shall be gained from the proper authority/ person in regards to the use of any external easement that is required for the development.

3.4 ASSESSMENT BY COUNCIL

Assessment Criteria

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

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

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

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

3.5 DETERMINATION AND APPEAL

Determination

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

Appeal

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

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

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

3.6 APPLICATION APPROVAL

General

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

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

4 APPLICATION REQUIREMENTS

4.1 ACCOMPANYING INFORMATION

Plans

Details: Provide the following information on the plans accompanying the application:

- Title description of land.
- Scale (preferably 1:500 for subdivisions, 1:100 for developments).
- Location, boundary dimensions, site area and north point of the land.
- Existing vegetation and trees on the land. Refer to Council's tree preservation order.
- Location and use of existing buildings on the land and adjoining properties. Include measured floor plans of existing buildings for calculation of floor space ratios.
- Contours to Australian height datum at 1m intervals based on existing levels of the site.
- Natural features of the site, including rock formations or cliffs, watercourses, flood levels, wetlands, forest areas and slip areas.
- Existing drains, easements or rights-of-way affecting the site.
- Details of existing and proposed subdivision pattern, including the number of lots and location of roads.
- Details of extents of named roads, including the proposed datum point, general intersection configuration and any proposed one-way streets. Where proposed road names are not known, roads may be numbered on the plan.
- Long Section along Road Centreline.
- Typical Cross Sections
- Horizontal Curves
- Designated fire prone areas.
- Heritage items (buildings and sites), or relics defined by a heritage Act or considered of local significance.

- Details of proposed access to the site and the legal status of that access.
- One design drawing file in accordance with the ACAD specification, which is available on Council's website.
- Other details relevant to consideration of the application.

Record of consultation

Details: Provide details of consultation with Council, the public, public utility authorities and/or other authorities.

Additional Information

Requirements: Provide the following additional information:

- Principles, assumptions and calculations behind stormwater drainage and on-site detention (OSD) proposals.
- Rationale for the design of utilities, roads, open space, bicycle and pedestrian ways, bus routes, etc.
- A contamination assessment.
- Evaluation of housing types, house type distribution, building lines, fencing, building materials etc.
- Existing site stormwater flows.
- Existing traffic situation.
- Existing utilities service plans.

4.2 ENVIRONMENTAL CONSIDERATIONS

Environmental input

General: Provide an environmental impact assessment (EIA) to address the following matters:

- Suitability of the land.
- Access.
- Traffic generation.
- Risk of flooding or other natural hazards.
- Flora and fauna.
- Local amenity.
- Waste management.
- Threatened species.
- Filling/earthworks.
- Erosion and sediment control/soil and water management.
- Coastal development/reclamation of coastal areas.
- Sacred sites, heritage, conservation.
- Fire management.
- General pollution.
- Acid sulphate soils.
- Air quality.
- Water quality.
- Biting insects.
- Buffer area management.

Tree protection

Tree preservation: Identify vegetation that is significant to the overall landscape of the area and proposed removal of trees.

Do not prune, damage or remove trees without the consent of Council's tree preservation officer. Contact Council officer before clearing or under-scrubbing is carried out.

Native vegetation: Submit a management plan for the protection of native vegetation in rural areas.

Covenant on land clearing: If required by Council, place a covenant on land clearing prohibiting the following acts to any tree without consent of the Council:

- Ringbarking.
- Cutting down.
- Topping, pruning.
- Removal.
- Endangering.
- Wilful destruction.

Heritage sites

Heritage, Aboriginal and other relics: Identify sites of Aboriginal or heritage significance. Maintain adequate curtilage around any significant item to protect its setting.

Contact for heritage/Aboriginal/other sites: Contact the following services:

- The National Parks and Wildlife Service for details and verification.
- The Heritage Council for details and verification.

Natural Hazard areas

Coastal flooding/erosion: Submit an environmental impact statement for development and subdivisions of land susceptible to tidal inundation or coastal erosion.

Flood prone land: Submit details for the subdivision of flood prone land in conformance with Council requirements.

Bushfire: Provide protection zones and access for fire fighting vehicles and maintenance vehicles to minimise the risk of bushfire damage.

Sensitive Environments

Environmentally sensitive sites: Development and subdivision will not generally be considered for the following environmentally sensitive sites:

- Estuarine wetlands.
- Rainforests.
- Dune areas.
- Steep slopes.
- Flood prone lands.

4.3 URBAN RESIDENTIAL AREAS

Roads

Access: Provide access in conformance with the following Council objectives:

- To provide for flow of through traffic, at the intended speed limit, giving regard to pedestrian priorities.
- To establish a road hierarchy in conformance with function and usage.
- To provide variation in alignment, allowing for existing natural features and creating interest in the streetscape.
- To provide traffic facilities and parking controls to suit the intended speed limit and streetscape.
- To provide safe pedestrian and cycle routes to each allotment and through the street network, including ramps, public transport infrastructure and environmentally sensitive illumination.
- To provide a logical road layout and intersection arrangement to assist with road naming and addressing requirements.

Requirement: Provide a fully serviced subdivision including a sealed road system with drainage, and kerb and gutter, allowing functional and safe vehicular and pedestrian access to each allotment in accordance with Council requirements.

Costs: The applicant will be required to meet the full cost of kerb and channel (gutter) across all existing road frontages of any development and subdivision in urban areas, except where direct vehicular access is restricted.

Adjoining roads: Provide kerb and channel (gutter) to provide safe vehicular and pedestrian access. Provide footpaths if required by Council.

Lot size

Requirements: Conform to state legislation and regulations and Council requirements for lot sizes, lot widths, building line setbacks and the supply of services to allotments.

Legal easements width: Provide over stormwater drains and watercourses in conformance with state legislation and regulations and Council requirements.

Services

Water: Provide reticulation of water services and connections to existing services in conformance with the relevant water authority requirements.

Electricity: Provide reticulation of underground electricity services in conformance with the relevant electricity authority requirements. If underground services are not appropriate seek approval from Council and the relevant electricity authority.

Gas: Provide reticulation of gas services in conformance with the relevant gas authority requirements.

Telephone and data services: Provide underground telephone services. If underground services are not appropriate seek approval from Council Stormwater runoff: Provide for urban stormwater runoff in conformance with Council's requirements, both within the development and to an external point of discharge.

Water: Town Water to be provided to all Urban Residential developments.

Telecommunications: Provision has been made to connect to telecommunications for all lots, subject to Telecommunications Authority requirements.

Street lighting: The Lighting of residential roads and public places must comply with AS/NZS1158 Lighting for Roads and Public Places. Where possible energy efficient LED luminaires must be used.

To address public safety from a criminal standpoint street lighting must be assessed using the NSW Police 'Safer by Design' or Crime Prevention through Environmental Design (CPTED) principles and protocols. The development proposal must demonstrate how public safety and risk will be managed.

The lighting of subdivisions must comply with the following:

(a) For residential roads in areas having underground reticulation of electricity the minimum lighting category should be P4; this implies utilising columns at about 55-metre spacings;

(b) For sub-arterial or principal roads which connect arterial or main roads to areas of development within a region, or which carry traffic directly from one part of a region to another part the minimum lighting requirement should be either V5 or P3 and in accordance with the standard; and

(c) Compliance with Endeavour Energy document 'General Terms & Conditions for the Connection of Public Lighting Assets'.

(d) The determination of lighting category's for roads will be at the discretion of Council and applied generally in accordance with AS 1158.

The appropriate levels for street lighting need to be identified by Council's Manager Subdivision Development. In order for this to be identified, proposed schemes showing the limits of the proposed works showing proposed traffic management devices and other relevant information be forwarded to Council's Traffic Investigation Unit so that an accurate assessment can be undertaken to ensure compliance with Council's Street Lighting Guidelines and Australian Standard AS/NZS 1158 in its various parts. The appropriate street lighting categories will be forwarded to the applicant by way of a Design Brief Checklist to enable street lighting designs to be prepared for Council's approval and acceptance.

To further assist the designer, designs should also be prepared in line with Endeavour Energy document SPJ 4004 Network Connections Contestable Works General Terms and Conditions Section 6 - Public Lighting Assets.

Where street lighting is to be provided within the central median islands, barrier kerb is to be provided.

Public Domain Lighting must consider sustainable options.

Flooding

Consideration: The development/subdivision of urban land, other than boundary adjustments, will only be considered if it can be clearly demonstrated that flood free building sites/allotments can be provided and that the creation of these developments/allotments will not adversely affect flood patterns or levels in the area.

Requirement: For development and subdivision on urban land to be considered, demonstrate the following:

- The provision of flood free building sites/allotments to the designated ARI.
- No adverse effect on flood patterns or levels from the provision of allotments.

4.4 RURAL RESIDENTIAL AREAS

Roads

Requirement: Provide kerb and channel (gutter) and underground stormwater drainage in conformance with Council's requirements. Provide concrete lined table drains where scour velocities are excessive and/or the soils are susceptible to erosion from stormwater.

Lot size

Requirements: Conform to state legislation and regulations and Council requirements for lot sizes, lot widths, building line setbacks and the supply of services to allotments.

Services

Electricity: Provide reticulation of electricity services in conformance with the relevant electricity authority requirements.

Telecommunications and street lighting: Should telecommunications and street lighting be required as a condition of redevelopment Contract, refer to section 4.3.

Water: Town Water to be provided to all Rural Residential developments.

Natural Features

Configuration: Configure the subdivision with consideration of the following natural features:

- Rivers.
- Creeks.
- Topography of the land.
- Tree groupings.

- Other prominent features.

Buffers: Provide buffers to separate conflicting land uses and to protect water courses.

Run-off to streams: Conform to state legislation and regulations on the diversion or storage of rainfall run-off to allow passage to natural streams.

4.5 RURAL DEVELOPMENT AREAS

Roads

Access: Provide a dedicated all-weather road system for functional and safe vehicular access to the development or each allotment, taking into consideration the following:

- The status of the road.
- Existing road surface condition.
- Cost of upgrading.
- Flooding frequency and hazards of creek or river crossings.
- Potential population catchment.
- Bushfire hazard.

Sealing of roads: Provide bitumen sealing to all new roads which are to be an extension of existing sealed roads.

Right-of-way: Council may consider the creation of a right-of-way to serve allotments having the minimum dedicated road frontage but not having road access. Such right-of-way should link an allotment directly to an existing or proposed dedicated road, constructed in conformance with Council's requirements.

Services

Electricity: Extend reticulation of electricity services to each allotment within the subdivision in conformance with the relevant electricity authority requirements.

Electricity in remote areas: If the subdivision is remote from reticulated electricity services, submit a written agreement from the relevant electricity authority to not supply electrical mains with the application.

Telecommunications and street lighting: Refer to section 4.4 as required.

Flooding

Requirement: For development and subdivision on rural land partly flood prone to be considered, demonstrate the following:

- The provision of flood free homestead and stock holding areas on each allotment to the designated ARI.
- No adverse effect on flood patterns or levels from the provision of allotments.
- No significant embankments formed by internal roads.

4.6 INDUSTRIAL/COMMERCIAL AREAS

General

Lot Size: Provide lots of a size to accommodate parking and landscaping and the specific industrial or commercial use in accordance with Council requirements.

Heavy vehicles: Provide pavement for heavy vehicular traffic.

Services

Water: Provide reticulation water and connections to existing services in conformance with the relevant water and authority requirements.

Electricity: Provide reticulation of underground electricity services in conformance with the relevant electricity authority requirements. If underground services are not appropriate seek approval from Council and the relevant electricity authority. Determine the maximum loading requirements of the electricity service.

Gas: Provide reticulation of gas services in conformance with the relevant gas authorities requirements.

Telephone and data services: Provide underground telephone services. Where underground services are not appropriate seek approval from Council.

Stormwater runoff: Provide for urban stormwater runoff in conformance with Council's requirements, both within the development and to an external point of discharge.

Street lighting: The Lighting of residential roads and public places must comply with AS/NZS1158 Lighting for Roads and Public Places. Where possible energy efficient LED luminaires must be used.

To address public safety from a criminal standpoint street lighting must be assessed using the NSW Police 'Safer by Design' or Crime Prevention through Environmental Design (CPTED) principles and protocols. The development proposal must demonstrate how public safety and risk will be managed.

The lighting of subdivisions must comply with the following:

(a) For residential roads in areas having underground reticulation of electricity the minimum lighting category should be P4; this implies utilizing columns at about 55-metre spacings;

(b) For sub-arterial or principal roads which connect arterial or main roads to areas of development within a region, or which carry traffic directly from one part of a region to another part the minimum lighting requirement should be either V5 or P3 and in accordance with the standard; and

(c) Compliance with Endeavour Energy document 'General Terms & Conditions for the Connection of Public Lighting Assets'.

(d) The determination of lighting category's for roads will be at the discretion of Council and applied generally in accordance with AS 1158.

The appropriate levels for street lighting need to be identified by Council's Manager Subdivision Development. In order for this to be identified, proposed schemes showing the limits of the proposed works showing proposed traffic management devices and other relevant information be forwarded to Council's Traffic Investigation Unit so that an accurate assessment can be undertaken to ensure compliance with Council's Street Lighting Guidelines and Australian Standard AS/NZS 1158 in its various parts. The appropriate street lighting categories will be forwarded to the applicant by way of a Design Brief Checklist to enable street lighting designs to be prepared for Council's approval and acceptance.

To further assist the designer, designs should also be prepared in line with Endeavour Energy document SPJ 4004 Network Connections Contestable Works General Terms and Conditions Section 6 - Public Lighting Assets.

Where street lighting is to be provided within the central median islands, barrier kerb is to be provided.

Public Domain Lighting must consider sustainable options.

4.7 CONTRIBUTIONS FOR OFF SITE PROVISIONS

Council's authority

General: Council has the authority to impose conditions of contribution towards off site provisions This may be in the form of a Voluntary Planning Agreement (VPA), Council may also charge for contributions under an approved section 7.11 of the EPA Act. Alternatively, instead of a contribution, "works in kind" may be provided to an equal value subject to Council approval.

Open space

Public reserve in residential subdivisions (both rural and urban): Provide an area of public reserve (open space) useable for recreation, or a monetary contribution in lieu of land or a combination of both.

Public reserve in rural subdivisions: Provide an area of public reserve (open space) where the subdivision contains significant areas of special scenic or public recreational value.

Contributions

Requirement: Provide a contribution in conformance with the Section 7.11 contribution plan for the following:

- Roadworks where upgrading requirements can be attributed to the development.

5 POST-DETERMINATION REQUIREMENTS

5.1 CERTIFICATES

Building approval

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

Certifying authority: Shellharbour City Council

Occupation certificates

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

Certifying authority: Shellharbour City Council

Subdivision certificates

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

Certifying authority: Shellharbour City Council

Following development consent approval, the applicant will need to submit a Subdivision Works Certificate Application for approval by Council or an Accredited Certifier in accordance Division 6.4 of the Act. It should be noted that private accredited certifiers have no authority to vary the requirements of this specification. Should a variation to the requirements of this specification is required, the private accredited certifiers shall discuss with Council's Development Engineering Section.

The Engineering Plans submitted with the Subdivision Works Certificate Application must be prepared by a suitably qualified person with proven experience in the preparation of plans for Subdivision Works. This Specification includes a checklist which can be used as reference to assist in preparing the Engineering Plans. The checklist is not comprehensive and additional notes will be required to reflect local site conditions. Where additional notes are used, the numbers should higher than those given in the standard notes.

The lodgement of full and complete suite of Engineering Plans with the Subdivision Works Certificate Application will assist in its efficient processing and approval. Consultants are advised to fully address the peculiarities of each site and the impact on adjoining land to ensure that proposed construction works are acceptable in terms of safety and operational effectiveness.

Engineering Drawings are to be submitted in triplicate, with the Subdivision Works Certificate application. One set of approved plans will be retained by Council, with the remainder returned to the

Applicant. It is suggested that one (1) set of plans be submitted for an initial check by Council, followed by the submission of additional copies upon completion of any required amendments.

The engineering survey is to be carried out using the Geocentric Datum of Australia (GDA) co-ordinate reference system and the projection system to be used is the Map Grid of Australia (MGA) Zone 56. All levels are to be to Australian Height Datum (AHD). The survey must accurately show the landform to facilitate the best possible design and construction of road works and drainage consistent with minimum interference to the existing amenity of the area.

The assessment and approval of a Subdivision Works Certificate within the Shellharbour City Local Government Area will be subject to compliance with this specification. It is the responsibility of the person(s) or company to submit the documents as outlined in Section 5.1.

It should be noted that the approval is conditional on the above basis and does not relieve the applicant from rectifying any errors or omissions which become evident during construction.

5.1.1 QUALIFICATIONS OF DESIGNER

Engineering design for subdivisions and civil works requires specialist knowledge. Council must be satisfied with the competence of the Consultants. As such, Council requires that engineering design and construction plans shall be prepared by:

- a civil engineer, experienced and qualified in preparing civil works design and holding qualifications acceptable as a Member (Occupational Category of Professional Engineer) of Engineers Australia; or
- other suitably qualified persons who can demonstrate to Council's Engineer having proven experience in the preparation of plans and specifications for subdivisions and developments.
- Note Council's Development Control Plan sets out the qualification requirements for landscaping design.

Designers are encouraged to consult with Council and other relevant authorities during the preparation of design plans.

5.1.2 WRITTEN CONSENT FROM ADJOINING OWNERS

Where ancillary works are necessary to be carried out on adjoining private properties as part of the required construction works, the applicant(s) and / or owner(s) must submit the written consent of the owner(s) of the adjoining properties allowing the required works to be carried out. The written consent shall be submitted to Council prior the approval of civil works.

Upon completion of works, a written clearance from the owner(s) of the adjoining properties stating that works have been completed and that the area has been repaired to their satisfaction, shall be lodged with Council.

5.2 ENGINEERING DOCUMENTATION

Certification

General: Provide certification of all drawings for the following works by a qualified designer (refer to section 5.1.1 above) Professional Engineer or Registered Surveyor:

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

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

- Bridgeworks.
- Retaining walls.
- Street lighting.
- Other major structures.

- All relevant conditions of the development consent and all relevant requirements imposed by other public authorities / utility services providers (if any) have been addressed by the details and information shown on the engineering construction plans;
- All engineering construction plans shall comply with the following documents:
    - NSW Floodplain Development Manual;
    - Relevant Austroads publications;
    - Australia Rainfall and Runoff;
    - Shellharbour City Council's Engineering Design Specification for Civil Works;
    - Shellharbour City Council's Engineering Construction Specification for Civil Works;
    - Shellharbour Local Environmental Plan (LEP) and Development Control Plan (DCP);
    - Relevant Australian Standards; and
    - Relevant Local, State and Federal Government Legislation.
    - Relevant preceding approvals.
- The details and information shown on all engineering construction plans shall be consistent with landscape plans, site plans / architecture plans and all other plans approved as part of development consent;
- The extent of new construction and future works shall be clearly defined on the engineering construction plans and differentiated from the existing utility services and / or natural and constructed features.
- One design drawing file in accordance with the ACAD specification, which is available on Council's website.

Documentation

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

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

Design drawings

Requirement: Provide drawings for the following works:

- All engineering construction plans shall have the following information in the title block:
    - Drawing title;
    - Site address, including Lot and Deposited Plan (DP) Number;
    - Development description;
    - Description of works;
    - Name of the applicant(s);
    - Name, address and contact number of consultant(s);
    - Drawing number, Sheet number and Amendment / Revision number;
    - Schedule showing date and nature of amendments;
    - Development consent number;
    - Stage number (if applicable)
    - Scale (1:200, 1:500 or 1:1000) with scale bar; and
    - Signature of the designer / consultant satisfying the qualification requirements (see Section 2.2.1 for full requirements)
- The following details and shall be included in the engineering construction plans:
    - North Point;
    - Locality sketch;

- Road names / numbers;
- Existing and proposed lot boundaries and numbers;
- Location and level of benchmarks (in Australian Height Datum (AHD));
- Existing location of any Permanent and State Survey Marks (if any);
- Existing and proposed levels and contours of the development site and surrounding area;
- Existing and proposed easements, right of carriageways, road widening etc. (if any);
- Existing natural features including trees, dams, mounds, creeks, etc. All trees to be removed as part of the engineering works are to be clearly identified;
- Existing constructed features including fences, kerb and gutter, pipes, pits, road pavements, etc;
- Existing utilities services and associated structures, including electricity, water, sewer, gas and telecommunications;
- Extent of proposed works;
- Location and details of overland flow path shown (if any);
- Details and specifications of construction; and
- Schedule of symbols.

A cover sheet with a locality plan and list of drawings shall be included

For uniformity of plan presentation and to assist record keeping, all plan sizes, lettering, line work and symbols are to conform to AS1100 – Technical Drawing.

- Earthworks (site regrading).
- Roadworks.
- Road pavement.
- Road furnishings.
- Stormwater drainage.
- Foreshore works.
- Landscaping works.
- Erosion control works.
- Works and signage management (if required)
- Design to be based on AHD datum.
- Design title block to include “Certified by” with name provided with qualifications stated.
- Street lighting.

Approval for works within the road reserve requires the applicant to complete Council’s Application Form and comply with the relevant requirements of the approval sought. This requires the payment of appropriate fees and charges and submission of the application for approval. Under Roads Act - S138 the applicant will not be accepted by Council, unless the specified documents are submitted to Council including the Qualifications of the Designer.

5.3 COMMENCEMENT OF WORKS

Necessary conditions

Approval: Do not commence works on site before approval is issued. Works shall not commence on water infrastructure until Section 68 of the Local Government Act ,1993 approval has been acquired and Works shall not commence on road infrastructure in the public domain until Section 138 of the Roads Act 1993 approval is acquired

Quality control

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

Quality assurance
Standard: To AS/NZS ISO 9001.

(Note: As per section 1.2 in 0010 Quality requirements for design, pg.1).

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

Drainage
Certifying authority: Sydney Drainage

5.4 INSPECTIONS AND TESTING

General
Requirement: Submit test results to verify the materials supplied and the work carried out conform to the approved documentation and in accordance with Council requirements.

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

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

Records
Procedures: Submit records of all test results to the certifying authority prior to Practical Completion. Testing to conform to documented test procedures by a NATA testing organisation approved by Council before commencement of works.

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

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

5.5 INSURANCES

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

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

Submission of insurance documentation: Before the commencement of the works.

6 COMPLETION

6.1 COMPLETION OF WORKS AND TITLE ISSUE

Documentation

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

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

- The final survey plan.
- Street name approval from: Shellharbour City Council
- Other information.
- Forms required: Shellharbour City Council

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

Maintenance period

Commencement Defects Liability period: At the date of registration with LPI.

Note: During Defects Liability Period should contractor need to repair any portion of the works on a dedicated road, approvals are required under section 138 of the Roads Act, 1993.

Water system commissioning

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

6.2 WORK-AS-EXECUTED

Requirement

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

Certification for digital submission: Adopt ADAC standard

At completion, submit an accurate record, one work-as-executed drawing file in accordance with the ADAC specification, which is available on Council's website, including any variations from the design certified by the lead consultant.

6.3 BONDS

Please refer to the Development Consent and Council's fees and charges.

0012 WATERFRONT DEVELOPMENT

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide design and documentation for waterway facilities and structures.

Federal legislation: Aus. Gov Act No. 91 - *Environment Protection and Biodiversity Conservation Act 1999*.

1.2 CROSS REFERENCES

General

Requirement: This is not a self-contained design document, conform to the following work-section(s):

- *0010 Quality requirements for design*.
- *0022 Control of erosion and sedimentation (Design)*.
- *0061 Bridges and related structures*.
- *0074 Stormwater drainage (Design)*.

1.3 INTERPRETATION

Abbreviations

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

- NWQMS: National water quality management strategy.

2 PRE-DESIGN PLANNING

2.1 ENVIRONMENTAL INVESTIGATION AND PLANNING

Survey

Requirement: Carry out detailed hydrographic and terrestrial surveys. Prepare survey reports using the same uniform grid and recognised datum.

Standard: To the recommendations of AS 3962 clause 2.1 and AS 4997 clause 2.2.

Qualifications: Registered surveyor.

Geotechnical investigation

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

Standard: To the recommendations AS 3962 clause 2.2 and AS 4997 clause 2.3.

Qualifications: Professional geotechnical engineer.

Wind, hydrodynamic and sediment movement assessment

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

Standard: To the recommendations AS 3962 clause 2.3.

Qualifications: Professional engineer with experience with wind hydronamic and sediment assessment.

Protection of existing infrastructure

Existing plans: Obtain drawings of existing adjoining structures.

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

Environmental impact assessment

Requirement: Investigate the surrounding waterways, natural estuary process, water quality and contaminant flows originating from agricultural, industrial or urban run-off. Analyse the environmental impact of the proposed development and any other possible developments in the future, including future increases in road and navigation traffic. Prepare a detailed report.

Qualifications: Professional engineer with experience in environmental assessment.

Habitat assessment

Requirement: Investigate the flora and fauna in the surrounding waterways, sand dunes, estuary flats, coastal wetlands, salt marshes, mangrove forests, lagoons, oyster farms, etc. Analyse the impact of the proposed development on the existing flora and fauna. Prepare a detailed report.

Qualifications: Environmental biologist with experience in habitat assessment.

2.2 CONSULTATION

Council and other Authorities

Requirement: Consult with the Council and other relevant Authorities during the preparation of the design. In addition to the requirements of this work-section, identify the specific design requirements of these authorities.

Public consultation

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

Utilities services plans

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

3 DESIGN CRITERIA

3.1 GENERAL

Design objective

Requirement: Design waterway facilities and structures for the proposed development/subdivision to support the following objectives:

- To retain and enhance the biological diversity of the local flora and fauna.
- To preserve or improve the local ecosystem.
- To maintain or improve the flood levels in the area.
- To improve public access to the intertidal area of the waterfront.
- To maintain or improve the quality of water, air and land.
- To minimise the disruption of the natural shoreline.
- To minimise future maintenance.
- To integrate the waterfront developments into the natural landscape.
- To conserve the waterfront or offshore items of heritage significance.

Sea level rise: Design for sea level rise due to global warming based on the latest projections of regional sea level rise. Minimum allowance for future sea level rise to AS 4997 Table 4.1.

3.2 ARTIFICIAL WATERWAYS

Critical design features

Requirements:

- Multiple entrances connected in a loop to natural bodies of water to allow circulation of fresh water.
- Interconnected channels to produce flow-through currents.

- Bends and meandering channels with low aspect ratio and rounded corners.
- No dead-end channels or coves.
- Artificial islands and roughness elements to enhance local circulation.
- Alignment of the artificial waterway in the direction of prevailing summer winds to receive maximum turbulent mixing.
- Shallow depths to allow efficient tidal flushing.

Aquatic ecology

Existing wetland features: Preserve any existing ecosystems including mangrove wetlands, sand dunes, estuary flats, salt marshes, lagoons, oyster farms, migrating bird habitats, fish habitats.

Surrounding waterways: Preserve or improve the ecological condition of surrounding waterways.

Biological diversity: Maintain or improve the local biological diversity.

Water quality

Buffer strips: Maintain existing buffer zones of natural vegetation or design new buffer zones to act as a contaminant filter to industrial, agricultural and urban run-off.

Erosion and sedimentation

General: Conform to the *0022 Control of erosion and sedimentation (Design)* work-section.

Alignment with prevailing winds: Analyse the advantages and disadvantages of increased wind action.

Temporary sedimentation control: Include measures and devices to eliminate sedimentation within the canal system during the construction phase, especially if excavation of acid sulphate soils or large-scale earth moving operations are expected.

Control of fill: If using imported fill on site, specify measures for permanent erosion and sedimentation control.

Stormwater outlets: Choose locations which will minimise erosion or local scour. Make allowance in the design for sedimentation of material at stormwater outlets and scour protection.

Stormwater design

General: Conform to the *0074 Stormwater drainage (Design)* work-section.

Water quality: Demonstrate that the proposed method of stormwater management will not adversely affect water quality within the artificial waterway or lead to problems associated with siltation and erosion.

Stormwater outlets: Locate at points of maximal flushing.

Flood control

Requirement: Prepare a flood study model to show that the proposed works will not cause increased or substantial afflux flood levels upstream of the proposed works.

3.3 GEOMETRIC REQUIREMENTS FOR ARTIFICIAL WATERWAYS

Waterway depths

Central, navigable area: Conform to AS 3962.

Non-navigable areas: Keep non-navigable areas shallow. Create wetland habitats.

Waterway widths

Vertical mixing: Maximise the width of the water surface in the canals to enhance vertical secondary mixing.

Structures: Allow for any proposed structures, such as jetty and ramp when establishing the overall canal width.

Waterway cross sections
Batters and stability coefficients: To the geotechnical report.

Edge treatment: Demonstrate that the proposed method of edge treatment will not adversely affect water quality within the artificial waterway or lead to problems associated with siltation and erosion.

Stability analysis: Carry out stability analysis of proposed waterway cross sections for relevant loads as described in AS 3962 and AS 4997.

Waterway entrances
Standard: To AS 3962.

Locations: Avoid areas of naturally occurring sedimentation. Locate entrances in areas sheltered from excessive wave action and strong currents.

Orientation: Consider alignment of the entry with the tide currents and prevailing winds. Consider impact on tidal flushing, water circulation and sedimentation movements.

Multiple entrances: Provide at least one additional entrance, navigable or non-navigable.

Navigation: Consider the safety of craft likely to use the waterway.

3.4 STRUCTURES

Marinas
Standard: To AS 3962.

Wharfs, jetties and boardwalks
General: To AS 4997.

Disabled access: To AS 1428.1.

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

Ramp width: To AS 3962.

Boat ramps
Standard: To AS 4997.

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

Floating structures and fenders
Standard: AS 4997.

Construction materials selection: Consider marine growth.

Access and safety structures
Standard: AS 4997 and AS 1657.

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

Run-off: Provide a kerb and gutter arrangement to the top of revetment.

Seawalls
General: To AS 4997 and AS 4678.

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

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

Bridges and related structures
General: Conform to the *0061 Bridges and related structures* work-section.

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

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

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

3.5 MATERIALS

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

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

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

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

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

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

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

4 DOCUMENTATION

4.1 GENERAL

Approvals
Requirement: Document the approval conditions advised by the appropriate authority which contribute to the basis for the design.

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

- Design criteria.
- Site investigation reports supporting the design.
- Detailed design calculations (civil, structural and hydraulic).
- Hydraulic design models (drainage, flood control, tidal movements, sedimentation).

- Flood study report, including flood control measures.

Environmental management report for construction

Requirement: Provide environmental management plan as part of overall construction management plan. Include the following if applicable:

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

Calculations

Requirements: Provide a design report incorporating, calculations and references supporting the design.

Design certification

Requirement: Provide a signed and dated design certificate.

Final certification of completed works

4.2 DRAWINGS

General

Requirement: Provide drawings defining the works and assumed operating and maintenance procedures.

Drawing content

Requirements: Provide design drawings to include the following:

- Locality plan.
- Site plan showing relevant building restriction lines, relevant flood level lines and waterway regulation lines.
- Waterway profiles: Typical sections showing depths, relevant high and low water lines and flood lines.
- Structures: General arrangement plans and typical sections.
- Site works: General arrangement plan and typical details.
- Bulk earthworks plans.
- Landscape plan showing riparian vegetation and soft foreshore treatments.
- Design loads/design life information.
- Earth/water works such dredging, land reclamation works, entrance works plan layouts, sections and details.
- Site works such as roads, pavements and retaining walls.
- Waterways: Plans, sections and details.
- Flood and sedimentation control devices.
- Drainage and stormwater harvesting: Plans, sections and details.
- Services: Plans, sections and details.
- Landscaping: Plans, sections and details.
- Structures: General arrangement plans, sections, elevations and structural details.
- Foundations: Plans, details and geotechnical information.
- Construction sequence and temporary works.

Work-as-executed drawings

General: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor in accordance with the ADAC Specification, which is available on Council's website.

4.3 SPECIFICATIONS

Construction documentation

Requirement: Prepare technical specifications using the AUS-SPEC Construction work-section *Templates* from the National Classification System workgroups 02, 03, 11, 13.

5 ANNEXURE

5.1 ANNEXURE - REFERENCED DOCUMENTS

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

AS 1428		Design for access and mobility
AS 1428.1	2009	General requirements for access - New building work
AS 1657	2018	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS/NZS 3661		Slip resistance of pedestrian surfaces
AS/NZS 3661.2	1994	Guide to the reduction of slip hazards
AS 3962	2001	Guidelines for design of marinas
AS 4586	2013	Slip resistance classification of new pedestrian surface materials
AS 4678	2002	Earth-retaining structures
AS 4997	2005	Guidelines for the design of maritime structures
Aus. Gov Act No. 91	1999	Environment Protection and Biodiversity Conservation Act

0013 BUSHFIRE PROTECTION (DESIGN)

1 GENERAL

1.1 INTRODUCTION

Work-section application

This work-section is applicable to the design and documentation requirements for bushfire protection facilities for urban and rural subdivisions.

1.2 RESPONSIBILITIES

General

Requirement: Provide design and documentation for subdivision road layouts and bushfire protection zones on bushfire prone land to the requirements of the state or territory, local government and state fire authority guidelines.

1.3 INTERPRETATION

Definitions

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

- Asset protection zone (APZ)/Defendable space: An area surrounding a development managed to minimise fuel loads and reduce the bushfire hazards. It is also referred to as a fire protection zone. It aims to protect human life, property and highly valued public assets. It comprises an inner protection area (IPA) and outer protection area (OPA).
- Bushfire attack levels (BAL): A method of measuring a site's potential exposure to ember attack, radiant heat and direct flame contact as defined in AS 3959. It takes into consideration Fire danger index (FDI), the slope of the land, types of surrounding vegetation and the site's proximity to any building.
- Bushfire prone area: An area declared as likely to be subject to bushfire attack by the local council or a state government.
- Crossfall drainage: Drainage which occurs when the surface of a track has sufficient cross slope to cause water to flow across and off the surface, rather than along it. Stormwater drainage for unsealed tracks can be classified as follows:
  - . Crown: Where water sheds from both sides.
  - . Infall: Where water flows into the hillside.
  - . Outfall: Where flow is away from the hillside.
- Emergency access way: Access used to connect roads and provide alternative access and egress during emergencies where the traffic flow design does not allow two-way access.
- Fire access route: A designated route established to separate bushfire hazard areas from developed areas and to provide access within and around the edge of the subdivision. It may be used during firefighting but may also be used for fire prevention.
- Fire break: A gap in vegetation or other combustible material (or fuel) that acts as a barrier to slow or stop the progress of a bushfire. A fire break may also serve as a public road.
- Perimeter roads: Part of the asset protection zone. They provide a separation between the building and the bushfire hazard by acting as a wide, permanent and low maintenance fire break.
- Perimeter track: A track constructed and/or maintained expressly for fire management purposes.
- Property access: Access from a public road system to private land and habitable buildings for firefighting.
- Public roads: Includes the perimeter road and internal road system of any urban or rural subdivision.
- Setback: The distance required, through planning provisions, to separate a building from the bushfire hazard, street frontage or adjacent buildings.
- State fire authority: An organisation authorised to manage fire and emergency services within a state. It is also responsible for providing development guidelines and controls in bushfire prone land for that state.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Site hazard assessment

Hazard assessment method: Determine the site hazard and associated requirements using the following assessment process:

- Area to be assessed: Determine the area to be assessed, including all land within 100 to 150 m (outside) of lot boundary or within 100 to 150 m of vegetation change, where vegetation is not homogenous.
- Classification criteria: Assess site hazard to AS 3959, using the following criteria:
  . Classification and location of vegetation.
  . Distance from classified vegetation.
  . Effective slope under the classified vegetation.
- Determine the asset protection zone and bushfire attack level (BAL).
- Determine the appropriate construction requirements.
- Site hazard assessment should include areas of revegetation

Bushfire attack level: To AS 3959.

2.2 CONSULTATION

Council and other authorities

Council consultation: Liaise with the Council's officer(s) for the following:

- Roads and traffic management.
- Landscaping.
- Stormwater drainage.
- Subdivision and planning.

State fire authority: Consult the state fire authority, relevant to the location of the subdivision, to confirm planning requirements for bushfire prone areas:

- NSW: NSW Rural Fire Service - refer to www.rfs.nsw.gov.au preparing for Bushfire Protection (2006) for more information.

Other authorities: Consult with and seek approval for the subdivision design from the following state government authorities:

- Road authority.
- Planning department.

Public consultation

Public engagement: Once a basic scheme has been developed, undertake public consultation to the Council's requirements.

Utilities services plans

Existing services in the development area/precinct: Liaise with the utility authorities affected by the subdivision design and if required, obtain service plans from the authorities of the proposed development area for above ground and below ground services.

3 DESIGN CRITERIA

3.1 GENERAL

Design objective

Requirement: Incorporate requirements for minimising bushfire hazards in the development design. The requirements are applicable to rural and urban developments in bushfire prone areas.

3.2 ACCESS ROADS

Requirements

Perimeter tracks: If a subdivision abuts bushland in a bushfire prone area, locate perimeter tracks/roads immediately between the created allotment and the bushland.

Property access: Provide at least one alternative property access road for developments that are located more than 200 m from a public through road. The access road is to be dedicated as a public road or a road carriageway easement dedicated to Council. Council ownership provides legal protection for carrying out the annual maintenance work such as vegetation clearance.

Road reservations and easements: Provide as follows:

- Road or easement width: For allotments abutting bushfire prone areas, provide a 20 m road reservation or easement containing the perimeter track. This serves as a fire protection measure and will not be considered as part of the public reserve dedicated to the subdivision.
- Access to road reservation or easement: Provide access to the road reservation or easement from the local road system at regular intervals, in a system of loops. If an easement is created, do not fence to allow free access as if a public road.

Site conditions: When laying out facilities, include vegetation classifications and ground slope effects to AS 3959.

Fire hydrants: If the subdivisions have reticulated water, locate fire hydrants at appropriate intervals or near potential fire hazard areas to AS 2419.1 or as determined by the Council. Provide posts to indicate the location of reticulated water supply.

Mapping: Determine asset protection zones, access tracks, perimeter tracks, erosion control features and revegetation requirements.

Access requirements table

Access type	Minimum trafficable surface (m)	Horizontal clearance (m)	Vertical clearance (m)	Minimum weight capacity	Maximum grades	Maximum grades < 50 m	Maximum average grade	Maximum crossfall	Minimum inner radius (m)
Perimeter track[1] (road)	6	6	4	15 tonnes	To **Perimeter track design**.				12
Public road	6[6]	6	4	15 tonnes	1V:8H	1V:5H	1V:7H	1V:33H	12
Emergency access way[2]	6	6	4	15 tonnes	1V:8H	1V:5H	1V:7H	1V:33H	12
Fire access route[3]	6	6	4	15 tonnes	1V:7H	1V:4H	1V:5H	1V:33H	12
Cul-de-sac[4] (road)	6	6	-	15 tonnes	1V:8H	1V:5H	1V:7H	1V:33H	21 at the head
Battle axe[5] (road)	4	6	-	15 tonnes	1V:8H	1V:5H	1V:7H	1V:33H	12

Notes:
[1] The requirements vary depending on site hazard classification.
[2] Allow for signpost in compliance with requirements by the state fire authority.
[3] No dead end permitted and access surface is to be all weather.
[4] Maximum length = 200 m.

Access type	Minimum trafficable surface (m)	Horizontal clearance (m)	Vertical clearance (m)	Minimum weight capacity	Maximum grades	Maximum grades < 50 m	Maximum average grade	Maximum crossfall	Minimum inner radius (m)
[5] Maximum length = 600 m, minimum width = 6 m. [6] Where the distance of the most external part of the proposed building to the nearest hydrant is greater than 70 m.									

Internal access from perimeter road

Subdivision design: Provide internal access incorporating the following requirements in the subdivision design:

- Width, vertical clearances, dips and crests: To allow two-way movement of firefighting appliances.
- Road surfaces and bridges carrying capacity:
  - 15 tonnes in reticulated areas.
  - 28 tonnes or 9 tonnes per axle in non-reticulated areas.
- Curves:
  - Number: Minimise.
  - Minimum inner radius: 6 m.
- Sealed roads:
  - Maximum grade: 15% (1V:7H).
  - Maximum average grade: 10% (1V:10H).
- Clearly signpost roads.
- Dead end roads:
  - Maximum road length: 100 m.
  - Turning circle: 12 m outer radius at the head.
- Wetland or subject to periodic inundation (other than a flood or storm surge): Do not traverse.
- Parking bays: Minimum 2.6 m wide from kerb edge to the road pavement.

Perimeter track design

Requirement: Plan tracks to the following requirements:

- Form: Gradient of 1 to 4% and following the land contour.
- Drainage: Provide so that track is trafficable under all weather conditions.
- Crossfall: Maximum 4% generally and 10%, if evidence can be provided that 4% is not achievable.
- Widenings: Provide as required by the state fire authority for fire vehicle passing.

Location: Locate track as follows:

- Do not locate: Along the centre of a valley or at the centre of an overland flow path.
- Flood level: Above the 1 in 2 year flood level and above the low bank of streams.
- Waterways: Avoid disturbing riparian zones and use the vegetation as a buffer zone (between track and stream). Allow for a minimum width of 30 m or the width of the stream (whichever is the lesser) between the stream and track.

Unsealed track drainage

Requirement: Design track so that stormwater sheds from the track at regular intervals into a sediment trap or is released as sheet flow into adjacent grassland or bushland via a level spreader. Provide drainage as follows:

- Outfall: Do not use when the following conditions exist:

  - Where down-slope fill batters are unconsolidated and likely to erode.
  - Where down-slope fill batters exceed 1.5 m in height.
  - Where maintenance procedures are likely to create earth windrows along the outside edge of the track.
  - Where runoff is sediment laden.
- In-fall: Provide where the outer road embankment is of unstable or poor soils and where it is unsuitable to use outfall drainage.
- Crown: Provide where the track is a permanent road with high traffic volume or where constructed along a ridge.

Tracks following fence lines: If located on a long, steep slope, deviate track every 60 to 80 m to divert runoff at regular intervals.

Elevation: Allow regular rise and fall so that stormwater will drain from the track at regular intervals.

3.3 ASSET PROTECTION ZONES/DEFENDABLE SPACE (APZ)

Requirements

Primary purpose: Design the APZ to provide progressive reduction of fuel, and to reduce potential radiant heat levels, and flame, ember and smoke attacks between the bushfire hazard and the buildings.

Secondary purpose: Design the APZ to provide the following:

- Maximum separation between high intensity fire and any building, to reduce heat radiation and direct flame contact.
- An area free of combustible material where embers can fall, to minimise further fire outbreaks.
- Safe access to a building for firefighters by reducing the heat level from the main fire.
- Safe retreat for firefighters.
- A clear control line from which back burning or hazard reduction operations can begin.

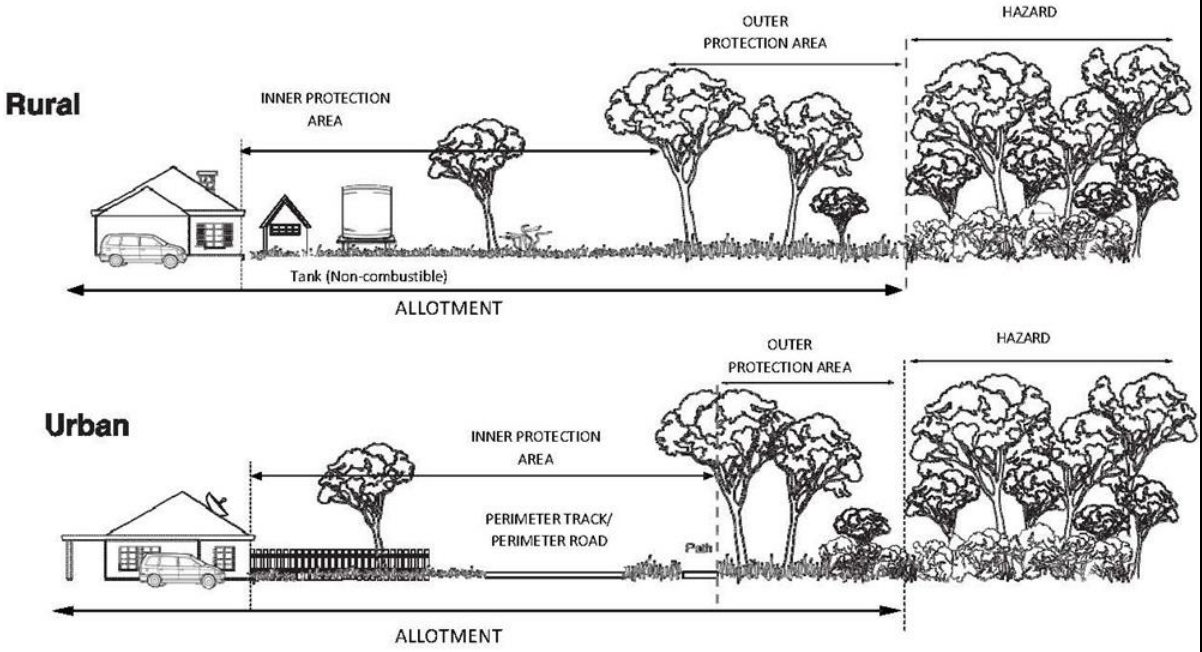
Subdivision design: As part of the subdivision planning, provide an APZ for any development fronting a bushfire hazard area, to act as a buffer zone between the development and the fuel comprising:

- Outer Protection Area.
- Inner Protection Area incorporating the following:
  - A perimeter road or reserve (which incorporates an access track).
  - A setback (currently defined by minimum lot depths), which is usually part of the allotment.

Allotment design: For each individual allotment, allow adequate space for the main building (usually a dwelling), an area of open space and the APZ (which may include part of the allotment open space and/or the neighbouring allotment). Figure 3.1 illustrates a typical APZ.

Vegetation: Provide vegetation control plans to minimise fuel loads.

Figure 3.1: Components of an asset protection zone: RFS



Source: *Planning for bushfire protection. A guide for councils, planners, fire authority and developers*.

Firefighting: If fires are fought from the property and not along the perimeter track, provide access to a public road from the property for emergency and other vehicles at all times.

3.4 OUTER PROTECTION AREA (OPA)

Planning

Location: Adjacent to the hazard or unmodified fuel source.

Objective: Conform to the following objectives:

- Fire behaviour control: To moderate fire behaviour coming from an unmodified fuel source and to reduce radiant heat on a building.
- Flame and ember attack: To draw the fire out of the canopy to a level where ember attack and flame contact with the building is reduced.

Width of OPA: To the state fire authority's planning requirements.

Fuel loadings

Reduction: Reduce fuel loadings by thinning vegetation, mechanical clearing, hazard reduction burning or location of suitable developments such as playing fields or carpark.

Maximum fuel loading: 8 tonnes/hectare of total fuel.

Vegetation

Shrubs and trees: Not to form a continuous canopy.

- Shrubs where grouped, to be 10 m^2 maximum with minimum 10 m separation.
- Overall tree canopy cover to be 30% maximum at maturity.

3.5 INNER PROTECTION AREA (IPA)

Planning

Location: Locate IPA between the building and OPA.

Objective: To reduce radiant heat on a building through the reduction of fire intensity, to a level where the building is unlikely to be ignited during a fire.

Width of IPA: Conform to the state fire authority's planning requirements.

Perimeter roads, tracks and reserve

Location: Locate the perimeter road, track or reserve between the OPA and the boundary of the allotments. Figure 3.2 illustrates perimeter roads and perimeter tracks.

Requirement: No fuel to one side of the perimeter road, track or reserve.

Form: Conform to the council's policy for road construction and firefighting and as follows:

- Road reserve: 20 m wide minimum, with a 6 m access track and passing bays every 200 m.
- Track: To **Perimeter track design**.

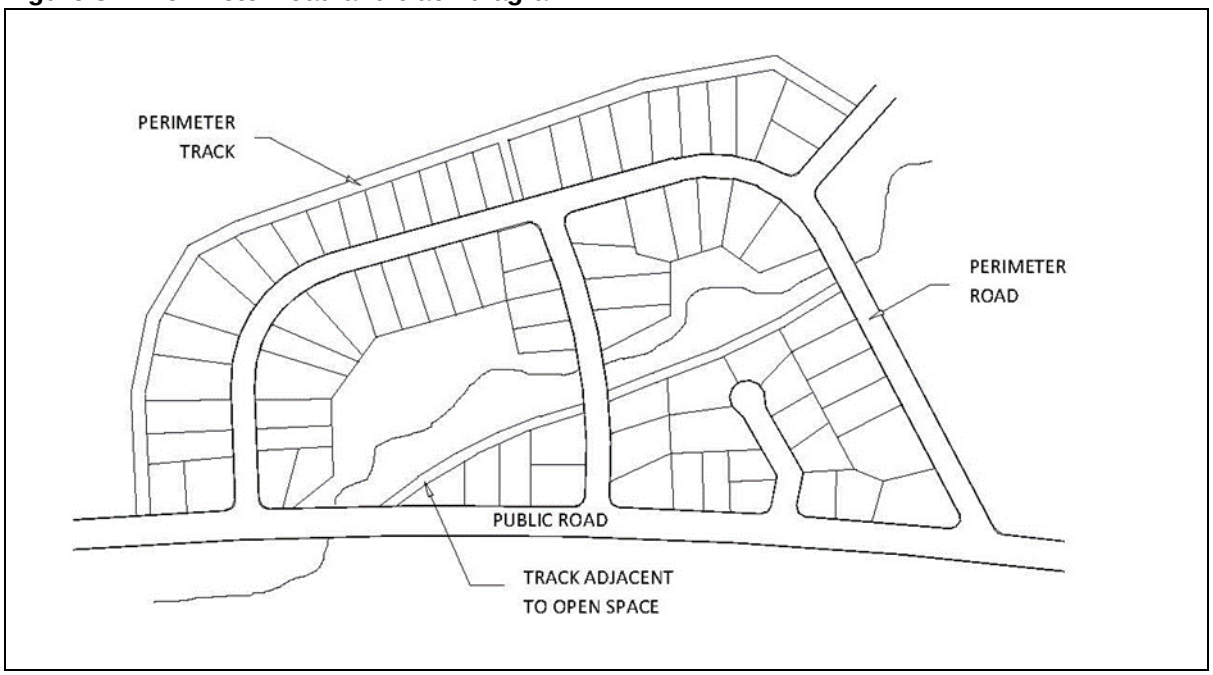
Width of fire break: If the perimeter road also serves as a fire break, provide the greatest width in areas where fire intensity is the highest.

Vegetation

Shrubs: Do not plant under trees. Allow for a separation of 1.5 times their mature height.

Tree canopy: Allow for a separation of 2 m minimum and overall canopy cover of 15% maximum, at maturity.

Figure 3.2: Perimeter road and track diagram



Allotment size

Minimum lot depth: 30 to 35 m minimum.

Rear setback: Set minimum depth to allow for required IPA width.

3.6 MODIFICATIONS TO OPA AND IPA

Approval criteria

Requirement: If modifications to the width of the OPA or IPA are proposed, obtain written approval from the Council and RFS.

3.7 SERVICES

Reticulated water supply areas

Requirement: Provide a ring main system for urban subdivisions as follows:

- Reticulated water supply above ground and external to the building: Non-corrodible metal components.
- Fire hydrant spacing, sizing and pressures: To AS 2419.1.
- Do not locate hydrants within any road carriageway or parking reserves.

Supplementary supply: If the reticulated supply is insufficient, supplement with a dedicated static source, in the form of a non-corrodible and non-combustible tank storage. Do not use swimming pools, creeks and dams as a substitute for a dedicated static supply.

Non-reticulated water supply areas

Requirement: Provide a water supply reserve dedicated to firefighting purposes for all developments in bushfire prone areas.

Where these sources are to be used, a pump will be required.

Connections: Provide a 65 mm Storz outlet with gate or ball valves, or as required by the state fire authority, located within the IPA away from the building.

Tanks: Provide the following facilities:

- Underground tanks: Provide a 200 x 200 mm access hole to allow tankers to refill directly from the tank. Provide a hardened ground surface within 4 m of the access hole. Protect the tanks from loads.
- Below ground pipelines: Provide minimum soil cover over pipes as follows:
  - Subject to vehicle traffic: 300 mm.
  - Under buildings or concrete slabs: 75 mm.
  - Other locations: 225 mm.
- Above ground tanks: Provide concrete or metal tanks and supports. Protect stands for raised tanks. Provide adequate shielding for the protection of firefighters for tanks located on the hazard side of the building.
- Tank location: Between 5 and 60 m to the outer edge of the building.
- Pipework between the water supply and the outlets: 64 mm (minimum) nominal bore.

Lots > 500 m^2: Install and locate water supply as follows:

- To allow firefighting vehicle to get within 4 m of the water supply outlet.
- Face outlet away from the building, if located less than 20 m away from the building.

Minimum dedicated water supply for firefighting table

Development type	**Water requirement**
Lot size less than 500 m^2	2,500 litres/lot
Residential lots (< 1,000 m^2)	5,000 litres/lot
Rural-residential lots (1,000 – 10,000 m^2)	10,000 litres/lot
Large rural/Lifestyle lots (> 10,000 m^2)	20,000 litres/lot
Residential units	5,000 litres/unit to 20,000 litres maximum

Electricity services

Location: Locate electricity services to minimise potential ignition of surrounding bushland or the fabric of the building.

Underground transmission lines: Provide underground transmission lines where practical.

Overhead transmission lines: If proposed, provide lines with short pole spacing of 30 m, except where crossing gullies, gorges or riparian areas.

Clearance between trees and powerlines: Provide at least the minimum distance recommended by the electricity distributor.

Gas services

Location: Locate gas services to minimise potential ignition of surrounding bushland or the fabric of the building.

Reticulated gas or LP storage systems: To AS/NZS 5601.1 or AS/NZS 1596 as appropriate.

Material: Use metal piping.

LP storage systems: Locate fixed cylinders minimum 10 m from flammable materials and shield from the hazard side. If cylinders are located close to the building, direct the release valve at least 2 m away from the building.

Sheathing: Do not use polymer sheathed flexible gas supply lines to gas meters adjacent to buildings.

4 DOCUMENTATION

4.1 STATUTORY DOCUMENTATION REQUIREMENTS

Approvals

Requirement: Document any prerequisite for approval of the development advised by the following authorities:

- Council's officer for road layout and traffic management, landscaping, stormwater drainage, and subdivision planning.
- State road authority for any roads not under Council's jurisdiction affected by the development.
- State planning department for general land use and layout proposals.
- Utilities authority for any public or private utility affected by the development.

4.2 DRAWINGS

General

Requirement: Provide drawings defining the works and assumed operating and maintenance procedures.

Drawing content

Requirements: Provide design drawings to include the following:

- Subdivision/property access.
- Easements
- Fire hydrants.
- Asset protection zones, access tracks, perimeter tracks and erosion control features.
- Internal access from perimeter road.
- Perimeter track design.
- Asset protection zones (APZ)/Defendable space.

4.3 SUPPORTING DESIGN DOCUMENTS

Design reports

Requirement: Provide a design report covering the following:

- Design criteria adopted for the development design.
- Site investigation reports supporting the design.

Specifications

Construction documentation: Prepare technical specifications using the AUS-SPEC Construction work-section templates from the National Classification System workgroups 02, 03, 11 and 13.

Design certification

Certificate: Provide a signed and dated design certificate as evidence that a suitably qualified bushfire assessment officer (Bushfire Planning and Design – Accredited Practitioner Level 3) has reviewed all the design documents, including program and plans for the development, and can verify that the designed bushfire protection requirements for the development site meet the Council and statutory requirements.

4.4 WORK-AS-EXECUTED

Work-as-executed documents

Drawings: Provide an additional set of final construction drawings for the purpose of recording the work completed by the Contractor.

Drawing format

Work-as-executed drawing format: one design drawing file in accordance with the ADAC specification, which is available on Council's website.

5 ANNEXURE

5.1 REFERENCED DOCUMENTS

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

AS/NZS 1596	2014	The storage and handling of LP Gas
AS 2419		Fire hydrant installations
AS 2419.1	2017	System design, installation and commissioning
AS 3959	2009	Construction of buildings in bushfire prone areas
AS/NZS 5601		Gas installations
AS/NZS 5601.1	2013	General installations
RFS	2006	Preparing for Bushfire Protection

0021 SITE REGRADING

1 GENERAL

1.1 INTRODUCTION

Work-section application

Description: This work-section is applicable to the design and documentation requirements for site regrading for both Council works and land development and subdivisions.

1.2 RESPONSIBILITIES

General

Requirement: Provide design and documentation for site regrading works for land development and subdivisions.

1.3 INTERPRETATION

Abbreviations

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

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

Definitions

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

- Advanced plants (species): Plant species containerised and established in 300 mm containers but less than 45 L containers.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Site suitability for the proposed development

Initial appraisal: Determine if the natural state of the development site is suitable for the proposed development and whether site regrading is required to:

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

Land use restrictions

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

2.2 ENVIRONMENTAL INVESTIGATION AND PLANNING

Development precinct investigation

Geotechnical investigation: To AS 1726.

Requirement: Prepare a survey and geotechnical report to establish locations of site features, levels and grade, and soil conditions.

Soil properties: Investigate the development precinct soil condition to determine the following:

- Chemical characteristics and compatibility of the soils when they are in contact with foundations of buildings, roads, sewers and services for the development and the appropriate precautions that can be taken.
- Acid sulphate soils.
- Climatic conditions, such as frost susceptibility, especially for road subgrade construction.
- Soil salinity: Evaluate existing soil conditions in known salt affected areas, or areas found to be salt affected by the geotechnical investigations.

Embankments: Determine the stability and base/top levels of embankment.

Potential environmental impacts

Requirement: Check the development area/precinct for potential environmental impacts by the development including the following:

- Heritage items.
- Effects on water quality and inundation.
- Endangered species requiring protection.
- Wildlife habitat.

Details of potential impacts: If there are potential impacts, provide details of the issues and proposed control measures for minimising the impact and protecting the surrounding environment before starting design. This may be in the form of an environmental impact statement (EIS), to be included in the Preliminary design report.

2.3 CONSULTATION

Council and other authorities

Requirement: Consult with the Council and other relevant authorities during the preparation of design.

Council consultation: Liaise with the Council's officer(s) before starting design to identify design requirements, including the following:

- Haul routes: Consult to define acceptable routes for haulage and applicable load limits.
- Tree protection: Consult with the tree preservation officer to identify requirements and restrictions relating to tree protection and site clearing.
- Waste disposal: Consult and obtain approval for cleared/excavated materials disposal facilities.
- Fill materials: Consult to establish restrictions, if any.

Other authorities: Consult with and seek approval for the development from the following state government authorities:

- Land and water resources department: Consult the authority to identify areas requiring action to prevent salination.
- EPA: Consult the EPA on sedimentation, siltation, erosion and salination control requirements.

Utilities services plans

Existing services in the development area/precinct: Liaise with the utility authorities affected by the scheme and if required, obtain service plans from the authorities of the proposed development area for above ground and below ground services. Plot these services on the relevant drawings, including the plan and cross-sectional views.

Utility services location: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables. Any existing services within the site must be located by a suitably qualified underground service locator prior to the start of works.

Adjoining property owners

Protection of existing asset/infrastructure: Obtain drawings of existing infrastructure, including landscaping within and adjacent to the site. Consult with owners to identify protection requirements.

Property owner approval: After liaising with the EPA and obtaining approval from the Council for proposed sediment, siltation, erosion or salinity control measures, obtain written agreement from the adjoining property owners before carrying out construction work on their property.

Agreement records: Submit all agreements to the Council.

3 DESIGN CRITERIA

3.1 GENERAL

Design objective

Requirement: Design site regrading works for the proposed development/subdivision to:

- Provide an efficient and economical design.
- Enhance the environment of the site and maintain the site's natural features.
- Provide safe conditions for construction.
- Provide equal building conditions for all residential development allotments.
- Minimise impact on existing natural environment, adjoining properties and other works.
- Minimise regrading in heavily treed areas.
- Maintain or improve drainage, overland flow paths, riparian zones and existing watercourses.

Haulage: For areas where site regrading is required, design regrading requirements in conjunction with the roadworks design, taking into consideration the following objectives:

- Balancing cut to fill.
- Achieving economical works.
- Minimising the haulage of imported fill or spoil.
- Minimising adverse effect of bulk haulage on adjacent developments and infrastructure.

Related design requirements

Control of erosion and sedimentation: To *0022r Control of erosion and sedimentation (Design)*.

Road system design: To *0051 Geometric rural road design - sealed* or *0052 Geometric rural road design - unsealed*.

Balancing earthwork volumes for road vertical alignment: To the Austroads AGRD07 clause 4.3.2.

Drainage and run-off: To *0074r Stormwater drainage (Design)*.

Geotechnical design

Requirements: Incorporate all requirements and recommendations from the geotechnical investigation report.

Statutory performance requirements

Requirements: Define specific local performance requirements/policies/laws relating to site regrading.

Authority requirements: Draw attention to any specific requirements of other regulatory bodies.

Salination prevention

Regrading strategies: Allow for strategies aimed at lowering the groundwater table and measures to prevent extension of salination.

3.2 DRAINAGE AND RUN-OFF

General

Surface water drainage: Design site regrading so that surface water flow naturally to roads or drainage reserves, without excessive concentration. Minimise the use of underground drainage systems with surface inlet pits.

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

A permanent batter of no steeper than 1:4 is required in all parks and reserves to be handed over to Council, unless otherwise approved by Council.

Flood prone areas

Inundation areas: In areas known to be affected by stormwater flows, assess the existing conditions in relation to the proposed development. Submit to the Council, data obtained and recommendations of contour adjustments required.

Areas abutting 100 year ARI flood levels: Design regrading to a minimum level of 0.5 m above the 100 year ARI flood levels. Make sure other areas are not affected by flooding. Identify these areas on the drawings with site specific requirements included.

Finished surface levels of building areas

Building area finished surface levels: Design surface gradients to the catchment area drainage system as follows:

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

Steep building areas: For building areas with natural ground slopes greater than 15%, obtain confirmation from a geotechnical engineer of the site's suitability for the proposed development. Include specific requirements on the drawings, address requirements included in **Site suitability for the proposed development**.

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

Temporary diversion drains

Requirement: Design diversion drains to divert surface flows away from the regrading area and minimise soil disturbance and material loss from the development site.

Control measures: Measures which can be used include but are not limited to the following:

- Trench stops at 30 m spacing along a trench with overtopping directed to the kerb.
- Blue metal bags placed along the kerb and gutter at maximum 30 m spacing.
- Blue metal bags placed around downstream drainage pits.
- Specific requirements for the control of erosion and sedimentation.

Construction requirements: To *1102 Control of erosion and sedimentation (Construction)* for further erosion and sediment control requirements.

Adjoining properties

Stormwater easement: If diverting or directing piped stormwater into adjoining properties is proposed, create drainage easement rights over adjoining lots to *0074r Stormwater drainage (Design)*.

3.3 CLEARING

Areas to be cleared

Requirement: Identify areas for clearing of the following:

- Low scrub.
- Fallen timber.
- Debris.
- Stumps.
- Large rocks.

- Roots and loose timber which may contribute to drain blockage.
- Trees the Council considers are approaching the end of their functional life or dangerous/hazardous for the proposed development.

Construction requirements: Refer to *1111 Clearing and grubbing* for clearing, grubbing and vegetation removal for site works.

Stripping and stockpiling

Stripping of topsoil: Design regrading so that topsoil stripping is minimised, taking into consideration the subsoil properties and earth moving plants required. For example, clay subsoil deteriorates when exposed to wet weather and quickly becomes unworkable.

Spoil stockpiling: Determine location and size of spoil stockpile, taking into consideration the following:

- The need to keep topsoil on site.
- Reusability of the topsoil.
- Locations where topsoil is to be replaced.
- Time period before topsoil is to be re-used. Topsoil can deteriorate if stockpiled for a long time, e.g. segregation by weathering or changes in internal water pressures from excessive stockpile height.
- Construction working areas.
- Slope stability.

Maximum topsoil stockpiling period: Check suitability of topsoil, if stockpiled for lengthy periods. State the maximum length of time, acceptable to Council, the topsoil may be stockpiled.

Disposal of cleared materials

Requirement: Identify materials for removal from the site, including all cleared materials, and allow for its disposal to regulatory requirements.

Spoil: Obtain approval from the Council for proposed excavated material disposal facilities.

3.4 FILLING AND EMBANKMENTS

Slope stability

Stabilisation measures: Allow for stabilising measures, including retaining walls, as appropriate for the development site conditions. Consider future access and maintenance requirements.

Slope angle: Determine safe angles for slopes based on material properties under the worst site conditions possible.

Trees

Filling over tree butts: Where overfilling is required, allow for clearing/relocation of trees and replanting (with advanced species if cleared). Obtain approval from the Council for the type and number of trees for clearing, relocation and replanting.

Replanting: Allow for trees to be planted clear of probable future building locations, after filling is completed and graded. Include provisions for watering and maintenance during the contract period.

Trees requiring preservation: To AS 4970 for guidance on protecting trees on development sites. For trees selected for preservation, provide measures for protecting against damage caused by fill placement or other actions within the tree drip zone.

Fill material

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

Material selection: Select suitable fill materials based on following considerations:

- Purpose of embankment.

- Availability of local material.
- Consolidation and settlement properties of the fill material.
- Wet weather working.
- Plant equipment required on site.
- Fill material requirements to *1112 Earthworks (Road reserve)*.

Placing of fill: Fill placement over prepared areas cannot start without Council's permission. Include in the development documentation, requirements for obtaining Council's approval before starting.

Quality and compaction: Conform to the recommendations of AS 3798 and Austroads AGPT08 section 4.

Quantity: Design site regrading so that the balance between cut and fill is the most economical.

Restricted fill: If use of restricted fill is intended, obtain approval from the Council for material type and intended location before including in the development proposal. This is applicable to fill material comprising natural sands or industrial wastes/by-products.

Top dressing

Landscaping: Identify areas where fill placement will be required. Allow for dressing of clean arable topsoil, fertilised and sown with suitable grasses.

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

Construction requirements: To *0257 Landscape - road reserve and street trees* for further topsoil sowing and fertilisation requirements.

Special requirements

Requirements: Make provisions for any special requirements for the development.

Retaining walls

Filling to the site boundary: If required, design retaining walls to sit fully inside the site. Submit the retaining wall design with site regrading design to the Council for approval.

Wall design: The retaining wall design is to be designed and certified by a qualified Structural Engineer on the National Engineering Register (NER).

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

Construction requirements: Refer to *0292 Masonry walls*, *0293 Crib retaining walls* and *0294 Gabion walls and rock filled mattresses* for further retaining wall requirements.

4 DOCUMENTATION

4.1 GENERAL

Actions and document content

Standard: Conform to the recommendations of AS 3798 Section 3 for details for documenting earthworks design.

4.2 STATUTORY DOCUMENTATION REQUIREMENTS

Approvals

Requirement: Document any prerequisite for approval of the development advised by the following authorities:

- Council for:
  . Haul routes.

  . Tree clearing or relocation.
  . Waste disposal.
  . Fill materials.
  . Stormwater drainage and erosion and sediment control.
- Planning and water resources department for general land use and salination prevention measures.
- The EPA for other general environmental impact requirements.
- Utilities authority for any public or private utility affected by the development.

4.3 DRAWINGS

General

Requirement: Provide drawings defining the earthworks areas and specific treatments required.

Geotechnical testing stage: Provide drawings that show the location of site features in relation to the site boundaries, monuments, and other features for the purpose of testing.

Site regrading plan content

Requirements: Provide design drawings to include the following:

- Road longitudinal sections: With road construction details showing construction depths.
- Regrading layout: With finished levels as contours superimposed on existing ground contours. Include spot levels to clarify areas not covered by regrade contour and features associated with the regrading, such as retaining walls, banks or steps.
- Site cross section: Showing proposed and existing levels.
- Cut and fill areas: With cut areas clearly distinguished from the fill areas using hatching. Show the range of depth variations and earthwork quantities.
- EPA requirements: Incorporate sediment, siltation, erosion or salination control measures with references to the stage when measures will be provided.
- Haulage routes: Show details of haulage routes including the load limits for each route.
- Temporary diversion drains: Show the location of temporary drains required to divert surface flows away from the regrading area, including any erosion or sedimentation control treatment. Size drains to accommodate the volume of water to be diverted.
- Trees for preservation, removal, relocation and replanting.

Drawing presentation

Drawing format: State requirements for design drawings at different design stages, particularly final design drawings. For example, paper copy, number of paper copy sets, digital format (PDF or CAD version).

Drawing size: State required original drawing size or insert drawing sheet sizes to comply with AS 1100.101.

Drawing numbering and identification: State any special requirements for drawing numbering and titles.

Title block format: State any specific information which needs to be shown on the title block, e.g. Council's logo or consultants' details. Consider providing a title block template.

4.4 SUPPORTING DESIGN DOCUMENTS

Design reports

Preliminary design report: Provide a report covering all geotechnical requirements, including the following:

- Site preparation and compaction requirements.
- Recommended minimum acceptable fill quality.
- Proposed regrading strategies.

Report guidelines: To Austroads AGRD07 section 2.5 for further guidelines on report content.

Environmental impact statement: Include details of potential impacts and measures adopted for minimising the impact.

Calculations

Requirements: Provide a design report incorporating calculations and references supporting the earthworks design.

Specifications

Construction documentation: Prepare technical specifications using the AUS-SPEC Construction work-section *Templates* from the National Classification System workgroups 02, 03, 11 and 13.

Design certification

Certificate: Provide a signed and dated design certificate as evidence that a suitably qualified professional has reviewed all the design documents, including program and plans for the development, and can verify that the site regrading requirements for the development site meet the Council and statutory requirements.

Other documentation

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

4.5 WORK-AS-EXECUTED

Work-as-executed documents

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

Drawing format: Provide any specific requirements regarding the presentation of the drawings such as layout scale, size, title block information.

Digital drawing/data format: If applicable, request digital information conforming to the ADAC (Asset Design and As Constructed) standard for describing asset design and work-as-executed data which is available from Council's website. www.adac.com.au

Final certification of completed works

Requirement: State Council's requirements for final certification, e.g. inspections required by the designer.

Geotechnical report

Certification: Provide a geotechnical report certifying the development site with the proposed regrading works is suitable for the proposed development. Include any other supporting documents such as test results/certificates and survey data required to confirm this.

5 ANNEXURE

5.1 REFERENCED DOCUMENTS

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

AS 1100		Technical drawing
AS 1100.101	1992	General principles
AS 1726	2017	Geotechnical site investigations
AS 3798	2007	Guidelines on earthworks for commercial and residential developments
AS 4970	2009	Protection of trees on development sites
Austroads AGPT		Guide to pavement technology
Austroads AGPT08	2009	Pavement Construction

Austroads AGRD		Guide to road design
Austroads AGRD07	2008	Geotechnical investigation and design

0022 CONTROL OF EROSION AND SEDIMENTATION (DESIGN)

1 GENERAL

1.1 INTRODUCTION

Work-section application

This work-section is applicable to the design and documentation requirements of control measures for mitigating the effects of erosion and sedimentation from construction activities and stormwater run-off, as required for the development erosion and/or sediment risk level. It includes both temporary and permanent control measures.

1.2 RESPONSIBILITIES

General

Requirement: Provide design and documentation for temporary and permanent erosion and sedimentation control measures to minimise short and long term soil erosion and the impact of erosion.

1.3 INTERPRETATION

Abbreviations

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

- ARI: Average recurrence interval.
- ESC: Erosion and sediment control
- ESCP: Erosion and sediment control plan.
- GPT: Gross pollutant trap.

Definitions

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

- Average recurrence interval: The average or expected value of the period between exceedances of a given discharge, it is generally expressed in years.
- Catchment (area): A topographically defined area drained by a stream, river or reservoir of water (into a groundwater system).
- Clean water: Water conforming to one of the following:
  - . Water that enters the development site from an external source and has not been further contaminated by sediment within the site.
  - . Water originating from the site and does not require treatment to reach the required water quality level.
  - . Water that would not be further improved if it was to pass through the sediment trap for the site.
- Erosion control measures: Measures to prevent or reduce soil movement from wind, rain or flowing water from a construction site resulting from both natural processes and human activity.
- Low gradient flow diversion (drainage) technique: A flow diversion drain, channel or bank with a gradient sufficiently low to maintain subcritical flow along its length.
- Permanent control measures: Measures/works implemented to control run-off water quality beyond the construction and maintenance stages.
- Rainfall erosivity: The R-factor is a measure of rainfall erosivity and is defined as the mean annual sum of individual storm erosion index values, EI30, where E is the total storm kinetic energy and I30 is the maximum 30-min rainfall intensity. It is measured as (MJmm/ha/hr). When factors other than rainfall are held constant, soil losses are directly proportional to the magnitude of rainfall erosivity. The R-factor represents the climatic influence on water-related soil erosion, and can be used to quantify broad-scale, climate-driven, soil erosion potential.
- Sediment control measures: Measures to reduce the impact of erosion by trapping and retaining sediment before it is discharged into the surrounding environment. Flowing sediment is captured and held in place long enough for it to settle.

- Steep gradient flow diversion technique: A flow diversion drain, channel or chute with gradient sufficiently steep to cause supercritical flow within its length.
- Sub-catchment: A topographically defined area drained by a tributary or branch drain of a primary stream, river or main draining catchment.
- Temporary control measures: Measures required to control and filter the run-off from areas disturbed by the contractor's activities.
- Unsealed road: A road surface that comprises of either natural parent material or gravel added and is not surfaced by bitumen or concrete.

Qualifications

Expertise: Use suitably qualified or experienced personnel to assess the erosion risk level of the development site and prepare the ESCP.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Key characteristics

General: The principles of erosion and sediment control for urban development equally apply for unsealed roads, but some key differences relating to planning, design, construction and maintenance for unsealed roads include:

- They are linear and produce large amounts of sediments in stormwater runoff and can cause serious environmental damage on reaching waterways.
- Cross multiple catchments and have various discharge points making effective sediment control measures difficult to implement.
- Control of erosion and sedimentation are required at all stages of construction and ongoing maintenance to minimise erosion, sediment and pollutant transport.
- Specific works like bridges, culverts, causeways and borrow pits, road safety and constructability may influence the selection and location of erosion and sediment control measures.
- Management of roadside drainage in controlling sediment runoff, with an emphasis on slowing drainage flows and dispersing them more frequently.
- Roadside vegetation in maintaining good stormwater quality by slowing and filtering stormwater runoff.

Data collection

Requirement: Collect data required for assessing the development site erosion risk level and for preparing the erosion and sedimentation management strategies for the development.

Erosion risk assessment: Collect site data required to inform the risk assessment, including the following:

- Geotechnical investigation: To AS 1726.
- Soil data: From Council's soil maps or, if this is not available, from soil sampling and testing. Identify soil properties such as soil type, erodibility, dispersion potential, salinity, shrink swell capacity, texture and drainage characteristics. If required by a regulatory authority or if the development involves varied and complex land use where changes are expected, prepare a soil survey to identify the existence of problematic soils.
- Site constraints and attributes: Including the following:
  - Topography and landform: Slope, gradient and aspect.
  - Lithology: Rock outcrops and substrate material.
  - Climate and hydrology: Rainfall, flood liability, groundwater level and rainfall erosivity.
  - Vegetation.
- Area of disturbance or prone to mass land movement.
- Distance of site to existing drains/watercourses.

- Areas with drainage problems.

Erosion and sedimentation strategies: Collect site data to assist in preparing management strategies, including the following:

- Site properties/constraints and development impact data to assist in the selection and design of drainage, erosion and sediment control measures, including identification of the following:
  . Site contour.
  . Off-site and on-site hazards.
  . Potential impacts of the development.
  . Potential site constraints, including soils, topography, water supply and vegetation.
  . On-site natural watercourses and receiving water such as creeks, ponds, lakes, wetlands, waterways, swamps, springs and artesian features.
  . Active coastal erosion zones.
  . Potential flood prone land.
  . Coastal and intertidal areas.
  . Critical environmental habitats.
- Nature of land disturbance resulting from the proposed development.
- Site and development data to assist in the design of site revegetation.
- Soil treatments required to facilitate site revegetation.
- Natural drainage paths on the site.
- On-site water quality levels/values and discharge standard.
- Non-erodible areas and potential diversion routes.
- Locations of potential dispersive soils.
- Locations of potential acid sulphate soils.
- Areas of potential landslip/mass movement.
- High and extreme erosion risk areas requiring protection.
- Areas with soils of extreme pH and/or requiring amelioration.

Site erosion risk assessment

Risk level assessment: Determine the development site erosion risk level by calculating the predicted total soil loss from the site over the total period the site will be disturbed, e.g. 6 months. Use the Council's risk class or scale criteria to determine the site erosion risk level.

Higher risk areas on site: Identify areas with higher risk so that management measures can be addressed at the planning stage. These areas include the following:

- Areas with high potential for soil loss.
- Areas with high potential to cause environmental harm.
- Areas located within or within close proximity to critical habitats such as wetlands, creeks and waterways.
- Areas with monthly rainfall erosivity (R factor) more than 285.
- Areas affected by high risk construction activities, including the following activities:
  . Which disturb natural wetlands or flowing streams.
  . Which disturb threatened species and habitats.
  . Which disturb protected vegetation.
  . With the potential to cause significantly more soil loss and/or environmental harm.
  . Which run longer than 6 months.

Site sediment risk assessment

Risk level assessment: Determine the development site sediment risk level based on predicted soil loss from the site over the total period the site will be disturbed for determining sediment control methods required for the site.

Land capability assessment and site actions required

Requirement: Determine site/land/urban capability based on extent of land disturbance required by the development, and water erosion and water pollution risk.

Areas requiring remedial action: Identify existing areas subject to erosion, where remedial measures are required.

Severe rainfall: If severe rainfall events are expected, prepare a contingency plan.

2.2 CONSULTATION

Council and other authorities

Council consultation: Liaise with the Council's officer(s) for the following:

- Soil and contour mapping.
- Vegetation mapping.
- Tree/vegetation subject to statutory protection.
- Flood prone areas.
- Council's policy and Development control plans for ESCP requirements for erosion and sediment control, and stormwater drainage.

Other authorities: Consult with and seek approval for the scheme development from the state government authorities responsible for the following:

- Bushland areas.
- Wetlands.
- Waterways and developments in coastal areas.
- Catchment water quality.

Other project development team members

Other development project design team members: Identify high risk areas as early as possible in the project development and liaise with other members of the design team to address the control measures in the project concept design so that risks and hazards can be mitigated or eliminated.

Integrated development planning: In particular liaise with members of the development design team preparing the design of the following:

- Works in or close to a watercourse.
- Layouts of lots, roads, cycleways and pedestrian pathways.
- Recreational facilities, open spaces or natural heritage reservations.
- Stormwater drainage systems.
- Services installations.
- Site rehabilitation.

3 DESIGN CRITERIA

3.1 GENERAL

Classification of unsealed roads

General: To Austroads AGRD02 Table 2.2.

Design objective

Requirement: Design erosion and sediment control measures for the proposed development with the following objectives:

- Integration of measures with the site and construction planning.
- Compatibility with the anticipated soil, weather and construction conditions.

- Minimisation of the extent and duration of soil disturbance, with limitations on the time surfaces are exposed.
- Control water movement through the site.
- Minimisation of soil erosion.
- Prompt stabilisation of disturbed areas.
- Maximisation of sediment retention on the site.
- Measures are functional at all times.
- With monitoring measures to maintain the required performance standard.
- ESC measures are appropriate for the environmental risk; type, cost and scope of proposed development.

Design considerations: Address all aspects of site disturbance, stormwater management, erosion and sediment control, and site rehabilitation for the duration of the construction from initial clearing to project completion.

Location of unsealed roads

For new unsealed roads: Select the location considering the following factors:

- Locate the road along a ridge or as high as possible on side slopes to reduce the catchment area above the road or track.
- Minimise disturbance to soil and vegetation.
- Minimise the number of watercourse and drainage line crossings.
- Avoid steep cross-slopes (greater than 18 degrees).
- Avoid high erosion hazard soils (e.g. dispersive soils, soil loss classes 5, 6 and 7).
- Avoid areas of riparian vegetation and maintain buffer strips between the road and any watercourse.
- Avoid areas where there are perched water tables, swamps, or areas of poor drainage.
- Avoid areas prone to mass movement or slope stability problems.
- Avoid soil types having poor construction quality.

3.2 DEVELOPMENT PLANNING CONSIDERATIONS

Construction and site planning

Control measures and staging of works: Design type, location, and timing of measures and actions in relation to the disturbance activities for each phase of work, including clearing, earthworks, civil construction, services installation and landscaping/rehabilitation. Design the measure/action to minimise erosion, manage flow and capture sediment in relation to the construction and access areas at each phase of work.

Protection measures: Provide measures based on the following requirements:

- Existing buffer zones protecting the site.
- Sensitive natural and indigenous features requiring protection.
- Fencing and isolation measures required to protect features including habitats.
- Temporary drainage works required to divert water and sediment through works in progress.

Site conditions: Apply the appropriate site conditions for designing run-off control measures to withstand storm event.

Development planning

Integrated development planning: Review proposed development layout and coordinate soil and water management with engineering requirements. If required, modify development layout to:

- Minimise land clearing and land shaping.
- Minimise the risk of erosion within downstream waterways.

- Minimise changes to the volume, frequency, duration and velocity of stormwater run-off affecting the natural water cycle.
- Minimise earthworks and construction activities along property boundaries.
- Allow disturbance areas to be permanently stabilised.
- So that non-disturbance areas can act as sediment control buffer zones.
- Allow for early installation and operation of permanent stormwater drainage system.
- Avoid placing critical structures or buildings in regions with the lowest land elevation.
- To integrate identified site constraints.

Risks that cannot be eliminated as part of the design: Develop measures to manage the risks.

Site evaluation tools

Requirement: If required for the development, use the appropriate mapping tool to determine the suitability of the proposed development for the site as follows:

- Site/land/urban capability mapping: To assess land use (for the development) through soil investigation.
- Erosion risk mapping: Include mapping of site constraints that directly relate to soil erosion and zones of various erosion risks. Base the selection/design of control measures on the assessed risk.
- Erosion hazard assessment: Use a system appropriate for the development, to assess all the erosion hazard items affecting the erosion risk level of the proposed development, e.g. average slope of disturbance area, duration of soil disturbance, climate, topography, geology, drainage and surface hydrology.
- Available contour mapping.

Site constraints

Requirement: Design development layout and erosion control measures to reflect known site constraints and regional factors.

Soil limitations: From the soil data collected, assess the potential and limitations of soils for the proposed development and soil management measures required for the site. If a soil survey has been prepared, use the survey to assess the appropriateness of land use proposed by the development; plan, design grading and erosion control measures for the development; make recommendations for soil treatments and allow for soil management technique such as vegetation selection.

Topographic limitations: Minimise land reshaping, utilise the existing topography where practicable and where appropriate, address the following topography regions in the development design and layout:

- Coastal and intertidal areas.
- Drainage problem areas.
- Areas with existing erosion problems.
- Flood prone land.
- Land prone to mass movement erosion.
- Land prone to storm surges.
- Rock outcrops.
- Steep slopes.
- Wetlands.

Water limitations: Determine the expected seasonal water quality, quantity and supply cost. If required, allow for sediment basins as a temporary water supply for dust control and plant irrigation.

Vegetation limitations: Consider the following in the development design and layout:

- Retention or rehabilitation of critical areas such as watercourses, floodplains, steep slopes or wetlands with natural vegetation cover for soil stabilisation.

- Selecting trees for preservation before locating roads, buildings and open works.
- Locate roadways, construction storage areas and parking bays away from the drip zone of trees selected for preservation.
- Avoid excavation, traversing, filling, trenching within the drip zones of trees selected for preservation.
- Retain existing ground cover on slopes steeper than 10% and deep rooted vegetation on slopes steeper than 20%.

Ecological limitations: Consider any adverse effect the erosion and sediment control measure selected may have on the natural ecology of the site. For example, reinforcing mesh applied in bushland areas may cause native fauna (birds or ground dwelling reptiles) to become entangled.

3.3 DRAINAGE CONTROL

Design standards

Permanent drainage design: To *0074 Stormwater drainage (Design)*.

Drainage design standard for temporary drainage works table

Drainage structure	**ARI based on the anticipated design life**		
	< 12 months	**12 to 24 months**	**> 24 months**
Temporary drainage structures[1]: NSW	1 in 5 year	1 in 10 year	1 in 10 year
Temporary drainage structures[1, 2]: Located immediately upslope of an occupied property that may be adversely affected by the failure of the structure (e.g. catch drain, flow diversion bank)	1 in 10 year	1 in 10 year	1 in 10 year
Temporary culvert crossing	Minimum 1 in 1 year hydraulic capacity wherever reasonable and practicable.		
[1] Design capacity excludes minimum 150 mm freeboard. [2] Design flow rates based on upslope drainage structures, excluding freeboard.			

Drainage for unsealed roads

Requirement: Design road drainage to divert the stormwater away from the road by minimising the sediment load by slowing the drainage flows and dispersing them more frequently. Drainage design for unsealed roads applications include:

- Pavement surface drainage.
- Table drains.
- Catch drains and batter slopes.
- Culverts and pipes.
- Creeks and drainage line crossings.
- Road drainage in areas with high water tables.
- Road drainage in semi-arid and arid areas.
- Road drainage in wet tropics.

Maximum distance of water flow along road surfaces and table drains prior to diversion into under road culverts table

Road grade (degrees)	**Maximum distance (metres)**	**Road grade (degrees)**	**Maximum distance (metres)**
1	250	8	70
2	200	9	65
3	150	10	60
4	125	11	55
5	100	12	50

Road grade (degrees)	Maximum distance (metres)	Road grade (degrees)	Maximum distance (metres)
6	90	13	45
7	80	14 and 15	40

(Source: *NSW State Office of Environment and Heritage*).

Drainage control measures

Requirement: Allow for control measure to suit the site drainage gradient/slope, drainage surface and function required.

Low gradient drainage technique: Select from the following measures:

- Catch drain.
- Compost berm.
- Diversion channel.
- Flow diversion bank – earth, sandbags.
- Straw bale flow diversion bank.

Drainage down slopes, steep gradient flow diversion technique: Select from the following measures:

- Chute.
- Level spreader.
- Slope drain.

Outlet structures for temporary drainage systems: Select from the following measures:

- Level spreader.
- Outlet structure.

Velocity control structures for channels and drains: Design drainage channels so that the maximum flow velocity does not exceed that allowed for the surface material to minimise channel erosion, including along the invert. If channel width, depth or gradient cannot be altered, control invert erosion through the following options:

- Reducing flow velocity through check dam placement.
- Increasing effective scour resistance of the drain by incorporating channel liners such as erosion mats or rocks.

Check dam techniques: Select from the following measures:

- Fibre roll.
- Rock check dam.
- Recessed rock check dam.
- Sandbag check dam.
- Triangular ditch check.

Channel/chute lining techniques: Select from the following measures:

- Cellular confinement system.
- Erosion control mats.
- Geosynthetic lining.
- Grass lining.
- Grass pavers.
- Hard armouring.

- Reinforced grass.
- Rock lining.
- Rock mattresses.
- Turfing.
- Turf reinforcement mats.

Drainage control on unsealed roads: Select from the following measures:

- Discharge of water as sheet flow:
  . Level spreader.
- Drainage from unsealed access roads:
  . In-fall drainage.
  . Out-fall drainage.
  . Crowned.

Temporary watercourse crossings: Select from the following measures:

- Bridge.
- Culvert.
- Ford.

Control measure selection considerations

Sandbag check dams: Allow in drains shallower than 500 mm.

Rock check dams: Allow in drains deeper than 500 mm.

Track drainage: To **TRACK AND TRAIL EROSION CONTROL MEASURES** of the *0281 Bushfire perimeter tracks (Construction)* work-section.

Stripped topsoil: Where possible re-use stripped topsoil to form flow diversion banks upslope of the soil disturbance.

Watercourse crossings: Design watercourses to filter run-off through surrounding grass or bushland before it enters streams.

Temporary culvert crossings: Design crossing so that head loss across the structure is limited to 300 mm maximum at the point when overtopping first begins to occur.

Long unstable slopes: Subdivide into manageable areas to prevent rill erosion.

3.4 EROSION CONTROL

Risk assessment

General: Develop and adopt local risk assessment procedure. Alternatively adopt the erosion risk rating based on average monthly erosivity, or average monthly rainfall depth or on the estimated soil loss rate as appropriate.

Erosion risk rating table

Erosion risk rating[1]	Average monthly erosivity (R-factor)	Average monthly rainfall (mm)	Soil loss (t/ha/yr)
Very low	0-60	0-30	0-150
Low	60-100	30-45	150-225
Moderate	100-285	45-100	225-500
High	285-1500	100-225	500-1500
Extreme	> 1500	> 225	> 1500

[1.] Risk rating categories are defined in IECA Book 1 Table 4.4.7 *Best practice land clearing and rehabilitation requirements*.

Erosion control measures

Soil stabilisation techniques: Select from the following measures, as appropriate for the site erosion risk assessment:

- Bonded fibre matrix.
- Cellular confinement system.
- Compost blanket.
- Erosion control blanket.
- Gravelling.
- Heavy mulching.
- Light mulching.
- Revegetation.
- Rock mulching.
- Soil binders.

Mulching

Requirement: Select light or heavy mulching for soil stabilisation and to prevent soil crusting of non-vegetated areas or areas where garden beds are proposed on flat or mild slope.

Light mulching: Select from the following measures:

- Bonded fibre matrix.
- Brush mulch.
- Dead or dormant grass cover (temporary seeding).
- Hydromulch.
- Straw mulching including sugarcane mulch.

Heavy mulching: Select from the following measures:

- Brush, bark, woodchip mulch.
- Compost blanket.
- Rock mulching.
- Straw mulching including sugarcane mulch.

Grass seeded areas: Allow for protection from raindrop impact erosion with light mulch immediately after seeding.

Erosion control blankets

Requirement: In areas of strong winds or overland flows, allow for erosion control blankets as an alternative to loose mulching or for stabilising mulch from washing or blowing away. Select from the following measures:

- Hydraulically applied blankets.
- 100% biodegradable jute and coir blankets.
- Jute and coir mesh.
- Short-term synthetic reinforced composite blankets.
- Permanent turf reinforcement mats.

Control of soil erosion on slopes

Requirement: Consider the following practices when designing erosion control measures for soil areas that are sloped:

- Establishing non-erosive drainage conditions for periods when rainfall may occur.

- Establishing 70% of soil surface for periods when rainfall may occur.
- Establishing complete and continuous vegetation cover.
- Slopes that are likely to be vegetated: Allow for slope to be as flat as possible to reduce the shear stress of the slope from stormwater run-off.
- Slopes that are unlikely to be vegetated: Allow for slope to be as steep as possible to reduce exposure of slope effective surface area to raindrop impact erosion.
- Steep grass seeded slopes: Allow for turf strips to be pinned along the contour in maximum 2 m spacing to maintain sheet flow down the slope and reduce the risk of rill erosion.

Application of erosion control measures to soil slopes table

Flat land (flatter than 1V:10H)	**Mild slopes (1V:10H to 1V:4H)**	**Steep slopes (steeper than 1V:4H)**
Erosion control blankets	Bonded fibre matrix	Bonded fibre matrix
Gravelling	Compost blankets	Cellular confinement systems
Mulching	Erosion control blankets, mats and mesh	Erosion control blankets, mats and mesh
Revegetation	Mulching well anchored	Compost blankets
Rock mulching	Revegetation	Revegetation
Soil binder	Rock mulching	Rock armouring
Turfing	Turfing	Turfing

Dust control

General: Dust control treatments vary with site conditions. Select the appropriate treatment from the **Dust control practices table**.

Wind erosion: To prevent wind erosion, incorporate the following measure(s):

- Revegetation.
- Maintaining moist soil conditions.
- Chemical sealants (soil binders) placed over the soil surface.
- Surface roughening.
- Wind breaks.

Dust control practices table

Site conditions	**Treatment options**						
	Permanent vegetation	**Mulching**	**Watering**	**Soil binders**	**Gravel road**	**Stabilised entry/exit pad**	**Minimise site disturbance**
Areas not subject to traffic	✓	✓	✓	✓	✓		✓
Areas subject to traffic			✓	✓	✓	✓	✓
Material stockpiles			✓	✓			✓
Clearing and excavation			✓	✓			✓
Unpaved roads			✓	✓	✓	✓	
Earth transport					✓	✓	

Major drainage channels and watercourse stabilisation

Stabilisation of disturbed areas: Allow for disturbed areas to be revegetated to the water's edge, to link aquatic and riparian habitats. Stabilise by rock protection during plant establishment.

Vegetation management

Vegetation management planning: Where site clearing is required, minimise soil disturbance to the development site; and allow for site revegetation to provide short or long term erosion protection to suit the following site properties:

- Natural slope (gradient) of the site.
- Site topography.
- Current and future land use within and adjacent to the site.
- Existing native flora.
- Soil condition, including structure, water holding capacity, nutrient content and dispersion potential.

Vegetation clearing: Plan land clearing operations in conformance with the following:

- So that vegetation clearing does not start before a vegetation management plan is prepared and sedimentation control measures and drainage have been installed.
- Clearing is staged to minimise the extent and duration of soil exposure to wind, rain and running water.
- Clearing is limited to 5 m from the edge of proposed construction works.

Plant selection: Select plants suited to the site erosion likely to occur at the development site. For example, where sheet erosion is likely, ground cover grasses are suitable to provide continuous cover; where wave erosion is likely, reeds and mangroves are suitable for coastlines, rivers and lakes.

Management of problematic soils: Allow for soil protection measures or soil adjustments so that vegetation can establish. If required, allow for erosion control blanket, mat or mesh to protect the soil from short-term erosion during the plant establishment period.

3.5 SEDIMENT CONTROL

Design standards

Sediment control standard: Design sediment control measures based on the allowable soil loss rate limit (t/ha/yr) or the monthly erosivity (R-factor) and average monthly rainfall for the development site.

Design discharge for sediment traps: Allow for design storm of 0.5 times the 1 in 1 year ARI peak discharge.

Design objectives

Design criteria: Design sediment control measures in conformance with the following:

- Sediment laden run-off: So that sediment is collected and retained wholly within the development work site and trapped before the run-off moves onto road surfaces.
- Sediment laden run-off originating from the road surface: So that sediment is prevented from entering sealed (e.g. hard lined) drainage systems or permanent drainage systems (e.g. piped or open channel drain).
- Sediment controls within or adjacent to roadside stormwater outlets: Allow for gully bags in preference to road-surface sediment traps.
- Kerb inlet sediment traps: So that inlet traps do not replace sediment traps up-slope of stormwater inlets, as required by the relevant regulatory authority or to suit **Design standards**.
- Sediment traps at outlets of stormwater pipes: If required, locate downstream of the influence of outlet jetting,10 to 13 x pipe diameters downstream of the outlet.

Development site environmental protection: Do not rely solely on sediment control measures, consider more efficient and economical means of protection, such as drainage and erosion control measures.

Sediment trap locations: Locate sediment traps in conformance with the following:

- Trap efficiency: So that clean water is diverted around the sediment trap to maximise sediment trap efficiency.
- Protection of surrounding environments: So that adjacent properties and downstream environments are protected from the adverse effects of sediment and sediment laden water discharged from the site.

Sediment trap properties: Allow for traps with the following features:

- Able to pond water.
- Adequate retention time so that suspended particles can settle.
- The capacity to collect the required volume of sediment.
- Adequate hydraulic capacity required before start of flow bypassing.
- The maximum depth pooling limits required for public safety.

Straw bales as sediment traps: Do not include in the design unless site conditions prevent the use of other more appropriate sediment control systems.

Sediment control measures

In areas of sheet flow: Select from the following measures:

- Buffer zones.
- Compost berm.
- Fibre roll.
- Filter fence.
- Filter sock.
- Filter tube dam.
- Grass filter strip.
- Modular sediment trap.
- Mulch berm.
- Sediment fence.
- Stiff grass barrier.

At kerb inlets: Select from the following measures:

- Gully bag sediment trap.
- On-grade kerb inlet sediment trap.
- Sag inlet sediment trap.

At field (drop) inlets: Select from the following measures:

- Block and aggregate drop inlet protection.
- Excavated drop inlet protection.
- Fabric drop inlet protection.
- Filter sock drop inlet trap.
- Mesh and aggregate drop inlet protection.
- Rock and aggregate drop inlet protection.

Areas of minor concentrated flow: Select from the following measures:

- Check dam sediment trap.
- Coarse sediment trap.

- Filter tube dam.
- Modular sediment trap.
- Stiff grass barrier.
- U-shaped sediment trap.

In areas of concentrated or instream flow and sediment control techniques: Select from the following measures:

- Cofferdam.
- Filter tube barrier.
- Floating silt curtain.
- Geo lot.
- Isolation barrier.
- Modular sediment barrier.
- Rock filter dam: Filter cloth used as the primary filter medium or aggregate used as the primary filter medium.
- Sediment fence isolation barrier.
- Sediment filter cage.
- Sediment weir.

At entrances to culverts and open stormwater pipes: Select from the following measures:

- Block and aggregate sediment trap.
- Excavated sediment trap.
- Filter sock sediment trap.
- Mesh and aggregate sediment trap.
- Sediment fence (woven or non-woven).
- Sediment weir.

At outlets of stormwater pipes: Select from the following measures:

- Excavated sediment trap.
- Filter tube dam.
- Sediment weir.
- Straw bale barrier.

Dewatering measures: Select from the following measures based on expected flow level:

- Low flow:
  . Sump pit.
  . Filter bag.
  . Filter tube.
  . Grass filter bed.
  . Compost berm.
  . Filter fence.
  . Sediment fence.
- Moderate flow:
  . Filter tube dam.
  . Filter sock.

  . Filter pond.
  . Portable sediment tank.
  . Settling pond or stilling pond.
  . Hydro-cyclone (centrifuge).
- High flow:
  . Sediment basin.

At development site entry and exit points: Select from the following measures:

- Rock pad.
- Vibration grid.
- Wash bay.

3.6 STOCKPILE MANAGEMENT

General

Location: Locate stockpiles in conformance with the following:

- Clear of existing or proposed drainage works.
- Clear of areas likely to be disturbed during construction.
- Clear of the drip zone of trees.
- On reasonably flat areas.
- At least 5 m from concentrated water flows and at least 10 m from waterways.
- At least 2 m from hazardous areas, retained vegetation and overland paths, especially for stockpiles of fine non-cohesive material.
- Up-slope of an appropriate sediment control system.

Topsoil stockpiles: Isolate topsoil from subsoil material in separate stockpiles.

Erosion control measures

Up-slope stormwater: Design control measures so that stormwater is diverted around stockpiles if the following conditions exist:

- Periods when rainfall is possible.
- Up-slope catchment area: > 1500 m².
- Average monthly rainfall: > 45 mm.

Stockpile protection: Allow for stockpile protection from wind and rain, especially those of clayey soils which are more susceptible to raindrop impact erosion than sand stockpiles.

Sediment control measures

Down-slope of stockpiles: Allow for woven sediment fencing or other control measures to suit the stockpile material, for example, sand, gravel, topsoil or subsoil.

4 DOCUMENTATION

4.1 SUBMISSIONS PROCESS

Document submission and approval process

Requirement: Submit ESCP and supporting documentation at the following development design phases:

- Functional layout submission: Include the following as part of the development functional layout submission for approval before detailed design work:
  . Site risk and hazard assessment.
  . Conceptual ESCP for high risk sites.

  - Layout of drainage and roads within and affecting the development.
- Detailed design submission: Include the following as part of the development application/approval submission:
  - ESCP and supporting information including soil data, site constraints, erosion risk/hazard assessment, sediment risk assessment and site capability.
  - A catchment map defining sub-catchment boundaries.
  - Documentation showing the preferred location and area requirements of major sediment traps (such as sediment basins) and whether they can be permanently incorporated into the stormwater management system, e.g. detention basins or wetlands.
- Final design submission: After detailed design is approved, submit final design documentation with the following as part of the submission:
  - Final ESCP with supporting information for the construction and operational phase.
  - ESCP specification.
  - Water management plans.
  - Construction details and drainage plans.
  - Certification documents.
  - Remedial Action Plan (RAP): If remedial action is identified, submit details.

Conceptual erosion and sedimentation control plan (ESCP)

Requirement: Prepare a concept ESCP if any of the following conditions apply to the development site:

- Average slope of proposed land disturbance: > 10%.
- Site erosion risk: High risk, including for construction.
- Emerson class 1 or 2 soils.
- Expected soil disturbance: > 6 months and > 1 ha.
- Earthworks or construction within a natural watercourse.

4.2 STATUTORY DOCUMENTATION REQUIREMENTS

Approvals

Requirement: Document the conditions, advised by the appropriate authority, required to obtain approval of the development for the following:

- Council for:
  - Functional layout and concept ESCP.
  - Tree clearing or relocation.
  - Stormwater drainage design and water management plans.
- Planning and water resources department for general land use and problematic soil management measures.
- The EPA for other general environmental impact requirements.
- Utilities authority for any public or private utility affected by the development.

4.3 DRAWINGS

Conceptual erosion and sedimentation control plan (ESCP)

Conceptual ESCP drawing content: Include the following on the drawing(s):

- Control measures required based on soil data collected.
- Control measures required based on site constraints.
- Means of feasibly constructing the development whilst protecting the environment.
- Requirements for sediment basins on site.
- Adequate space for the construction and operation of major sediment traps and essential flow diversion systems.

- Location of problem soil areas including dispersive soils, acid sulphate soils, areas of potential mass movement.
- Environmental features requiring protection such as vegetation.

Conceptual ESCP scale: < 1:1000.

ESCP

Drawing content: Prepare separate ESCPs for the construction and operational phase for the development incorporating the following:

- North point and plan scale.
- Legend of standard symbols used within the plans.
- Proposed development layout, taking into consideration local issues, concerns, site constraints and development approval conditions.
- Site and easement boundaries and adjoining roadways.
- Existing site contours (unless the provision of these contours adversely impacts the clarity of the ESCP).
- Final site contours including locations of cut and fill.
- Limits of disturbance.
- Retained vegetation including protected trees. Location and description of existing vegetation.
- Soil information and location of problematic soils. If required, prepare soil maps for the site to identify problematic soils including dispersive and acid sulphate soils, sandy soils and clayey soils.
- Location of all drainage, erosion and sediment control measures.
- Full design and construction details (e.g. cross sections, minimum channel grades, channel linings) for all drainage and sediment control devices, including diversion channels and sediment basins.
- Site revegetation requirements (if not shown on a separate plan).
- Location of potential areas of non-disturbance and critical areas (vegetated buffer strips, drainage lines and structures, water bodies, unstable slopes, flood plains and seasonally wet areas).
- The final limits of disturbance.

Construction phase ESCP: Incorporate the following in the construction phase ESCP for the development:

- General layout and staging of proposed works.
- Construction access points.
- Site office, carpark and location of material stockpiles.
- Location and stabilisation measures for temporary construction roads and watercourse crossing.
- Location of access haulage tracks and borrow pits.
- Location of all earthworks including roads, areas of cut and fill and regrading.
- Location of major sediment traps (including truck cleaning facilities where required).
  - Controls for clean water run-off, including type and location of diversion works that direct uncontaminated run-off around areas of future disturbance.
  - Controls for flow velocities in drains.
  - Controls for dirty water run-off.
- Protection of channels and outfall zones.
- Divide the site into hydraulically manageable drainage areas and coordinate this with the construction drainage plans.
- Erosion control measures on disturbed boundary.
- Proposed vegetated buffer strips and no access areas.
- Revegetation program.

Construction phase drainage plans

Disturbances greater than 1500 m²: Prepare construction drainage plans for each stage of the earth works, this can either be part of the ESCP or separate drawings showing the following:

- Flow entry and exit points.
- Areas of sheet flow and lines of concentrate flow (including all drainage channels).
- Sub-catchment boundaries.
- All permanent and temporary roads.
- Site contours.
- Location of watercourses.

4.4 SUPPORTING DESIGN DOCUMENTS

Calculations

Requirement: Provide a design report incorporating the criteria, computer studies, calculations and references supporting the design and maintenance requirements.

Program

Recurrence interval storms: Provide drawings and/or computer output defining the works and the sequential program required to minimise erosion risk from ARI storms.

ESCP specifications

Construction documentation: Prepare technical specifications using the AUS-SPEC Construction work-section Templates from the National Classification System workgroups 02, 03, 11 and 13, including the *1102 Control of erosion and sedimentation (Construction)* work-section.

ESCP specification content: Include the following information:

- Basis of design: Development description, estimate of soil loss, erosion and sediment risk assessment.
- Principles to minimise sediment discharge from the site, including:
  - Land clearing.
  - Site management and temporary ESC measures installed at the end of the working day.
  - Watercourse management.
  - Site rehabilitation.
  - Vegetation management, including application rates (or minimum application rates) for mulching and revegetation measures.
  - Soil management including earthworks, topsoil and problematic soils.
  - Dust control.
- Detailed design information of ESC measures: Include information of the ESC measures required for each catchment, such as contributing catchment size for each measure, holding capacity, dimensions, supporting calculations, associated components of the measure (e.g. outlets and emergency spillways). Other requirements such as revegetation techniques, time frame and methods of achieving stabilisation.
- Site monitoring and maintenance program, including the location of proposed water quality monitoring stations.
- Emergency ESC measure (including drainage) and heavy rainfall response and contingency measure.
  - Temporary ESC measures in case of impending storms, or emergency situations.
- Inspection and test plans, and procedures for review and/or amendment to the ESCP.
- Identification of site responsibilities.
- Construction program and installation sequence for ESC measures.

Design certification

Certificate: Provide a signed and dated design certificate as evidence that a suitably qualified professional has reviewed all the design documents, including erosion and sediment program and plans for the development, and can verify that the designed measures will effectively mitigate sediment migration from the development site.

Additional certification

Sites with a soil disturbance greater than 2500 m²: Provide certification by a professional engineer that the ESCP conforms to the following:

- Satisfies the intent and design/performance standards established by all relevant local state and federal policies relating to erosion and sediment control.
- Has been reviewed and approved for construction, soil science, hydrology/hydraulics and site revegetation/rehabilitation.

Certification by a hydrology and hydraulics professional engineer: Required for sites greater than 1 ha or where the ESCP incorporates a sediment basin.

Certification by a geotechnical specialist: Required if ESCP incorporates a sediment basin with a constructed earth embankment with a height greater than 1 m.

4.5 REFERENCED DOCUMENTS

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

AS 1726	2017	Geotechnical site investigations
Austroads AGRD		Guide to road design
Austroads AGRD02	2015	Design Considerations
asOEH	2012	Erosion and sediment control on unsealed roads

0041 GEOMETRIC ROAD DESIGN

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

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

- Improved urban structure and revitalisation.
- A safe, efficient, functional and economical road network, considering the volume, type and distribution of traffic that is appropriate to the existing built fabric and landforms, climate, heritage and cultural context of the area.
- Convenient and safe access for movement of pedestrians, vehicles and cyclists.
- Appropriate access for buses, emergency and service vehicles.
- A quality road network using integrated design that minimises maintenance costs.
- A convenient zone for public utilities, landscaping and street furniture, signals, signs and markings within the road reserve.
- Potential for expansion of the road network with minimum reconstruction by considering traffic growth and development nearby.
- Provide safe, logical and hierarchical transport linkages with the existing street system.
- Convenient parking for visitors.
- Street lighting.

1.2 CROSS REFERENCES

General

Requirement: This is not a self-contained design document, conform to the following work-sections:

- *0010 Quality requirements for design*.

1.3 STANDARDS

General

Road design: To Austroads AGRD01 and Austroads AGRD02.

Geometric design: To Austroads AGRD03.

Intersection design: To Austroads AGRD04 and Austroads AGRD04A.

Traffic management: To Austroads AGTM series.

Shellharbour Development Control Plan

Planning for Bushfire Protection (2006)

1.4 INTERPRETATION

Abbreviations

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

- AADT: Average annual daily traffic.
- ASD: Approach sight distance.
- AU: Auxiliary.
- BA: Basic.
- CH: Channelised.
- DDA: Disability Discrimination Act
- EDD: Extended design domain.
- HOV: High occupancy vehicle.

- LATM: Local area traffic management.
- MGSD: Minimum gap sight distance.
- NDD: Normal design domain.
- SISD: Safe intersection sight distance.

Definitions

General: For the purpose of this work-section, the definitions given in Austroads AP-C87 and Austroads AGRD03 and the following apply:

The words ‘street’ and ‘road’ are interchangeable throughout all parts of this work-section.

- Activity centre: Urban planning term for those places that are vibrant hubs where people shop work, meet, relax and often live.
- Approach sight distance: Relates to the ability of drivers to observe the roadway layout at an anticipated approach speed.
- Batter:
  . The uniform side slope of walls, banks, cuttings, etc. Usually expressed as a ratio of horizontal to vertical.
  . The amount of such slope or rake, usually expressed as a ratio of horizontal to vertical, distinct from grade.
  . To form a uniform side slope to a wall, bank, or cutting.
- Carriageway: That portion of a road or bridge devoted particularly to the use of vehicles, that is between guide posts, kerbs, or barriers where these are provided, inclusive of shoulders and auxiliary lanes.
- Crossfall: The slope of the surface of a carriageway measured normal to the design or road centreline.
- Cycleway: Portion of a road or footpath for the exclusive use of cyclists.
- Extended design domain (EDD): The design domain for the assessment of existing roads. EDD is a range of values below the lower bound of the NDD.
- Footpath (pathway): A public way reserved for the movement of pedestrians, motorised wheelchairs and personal mobility devices.
- Horizontal alignment: The bringing together of the straights and curves in the plan view of a carriageway. It is a series of tangents and curves that may or may not be connected by transition curves.
- Landform: The type and shape of terrain, usually including topography, geological characteristics, coastlines, rivers and water bodies.
- Length of superelevation development: The transition of crossfall from a normal roadway on straight alignment to that of a fully superelevated crossfall on a circular curve.
- Level of service: A qualitative measure describing operational conditions within a traffic stream such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience and safety and their perception by motorists and/or passengers.
- Legibility distance: The maximum distance that the various types of traffic control signs or devices can clearly be seen under normal operating conditions and where there is no restriction to the line of sight.
- Minimum gap sight distance: Critical acceptance gap that drivers are prepared to accept when undertaking a crossing or turning manoeuvre at intersections.
- Minor road: All roads which become part of the public road system and are supplementary to arterial and sub-arterial roads. Minor roads may include local sub-arterial roads, collector roads, local roads, and access streets.
- Network: Defined as:
  . A connected system of roads and infrastructure that heavy vehicles can travel on. Can be restricted to a certain class(es) of heavy vehicles (NHVR).

  . Set of roads which provide a means of road-based travel within a region. In transport terms it is defined in terms of links and nodes.
- Normal design domain (NDD): The design domain for a new road that defines the normal limits for the values of parameters that have traditionally been selected for new roads.
- Outer separator: The portion of the road reserve separating a through carriageway from a service road.
- Pathway: See footpath.
- Pavement: The portion of a carriageway placed above the subgrade for the support of, and to form a running surface for, vehicular traffic including subbase and base course.
- Plan transition: The length over which widening, and shift is developed from the 'tangent-spiral' point to the 'spiral-curve' point; i.e. the length between the tangent and the curve.
- Reaction time: The time taken for a driver to perceive and react to a particular stimulus and take appropriate action. It is measured in seconds.
- Road network: A framework for movement by other modes, including pedestrian, bicycle and bus and plays a vital role in supporting neighbourhoods and town centres.
- Road reserve: The strip of public land between abutting property boundaries, specifically gazetted for the provision of public road and controlled by the definitions of the Roads Act (as per applicable State legislation). It includes the road carriageway, as well as footpaths, verges and landscape.
- Roundabout: A form of intersection channelisation in which traffic circulates clockwise around a central island and all entering traffic is required to give way to traffic on the circulating roadway.
- Safe intersection sight distance (SISD): Relates to an overall check that vehicles utilising the intersection have sufficient visibility to allow reaction and deceleration so as to provide adequate stopping distance in potential collision situations.
- Service road: A low traffic volume roadway parallel to and separated from an arterial road by an outer separator to limit vehicular access direct to the low volume road.
- Shoulder: The portion of formed and sealed carriageway that is adjacent to the traffic lanes and flush with the sealed surface of the pavement.
- Shoulder width: The measurement taken from the outer edge of the traffic lane to the edge of usable carriageway and excludes any berm, verge, rounding or extra width provided to accommodate guideposts and guard fencing.
- Side friction factor (f): A measure of the frictional force between the pavement and the vehicle tyre.
- Sight distance: The distance, measured along the carriageway, over which the visibility occurs between the driver and an object or between two drivers at specific heights above the carriageway in their lane of travel.
- Speed (85th percentile): The speed at or below which 85% of the vehicles travel:
  . Design speed: A speed fixed for the design and correlation of those geometric features of a carriageway that influence vehicle operation.
  . Desired speed: The speed over a section of a road adopted by a driver as influenced by the road geometry and other environmental factors.
  . Operating speed: The speed for an existing road at a time when traffic volumes are low and which allows a free choice of speed within the road alignment.
- Stopping sight distance: The sum of the braking distance and the distance the vehicle travels at a design speed during a reaction time of 2.5 seconds.
- Superelevation: A slope on a curved pavement selected to enhance forces assisting a vehicle to maintain a circular path.
- Traffic lane: That part of the roadway set aside for one-way movement of a single stream of vehicles.
- Traffic lane width: Traffic lanes are measured to the face of the kerb or to the lane line for multi-lane roads or roads with shoulders.
- Verge (rural): Defined area of the formation in rural roads outside the shoulder at the top of the batter slope.
- Verge (urban): That portion of the road formation not covered by the carriageway or footpath.

- Vertical alignment: The longitudinal profile along the centreline of a road consisting of series of grades and vertical curves.

1.5 HIERARCHICAL ROAD NETWORK

Road functions

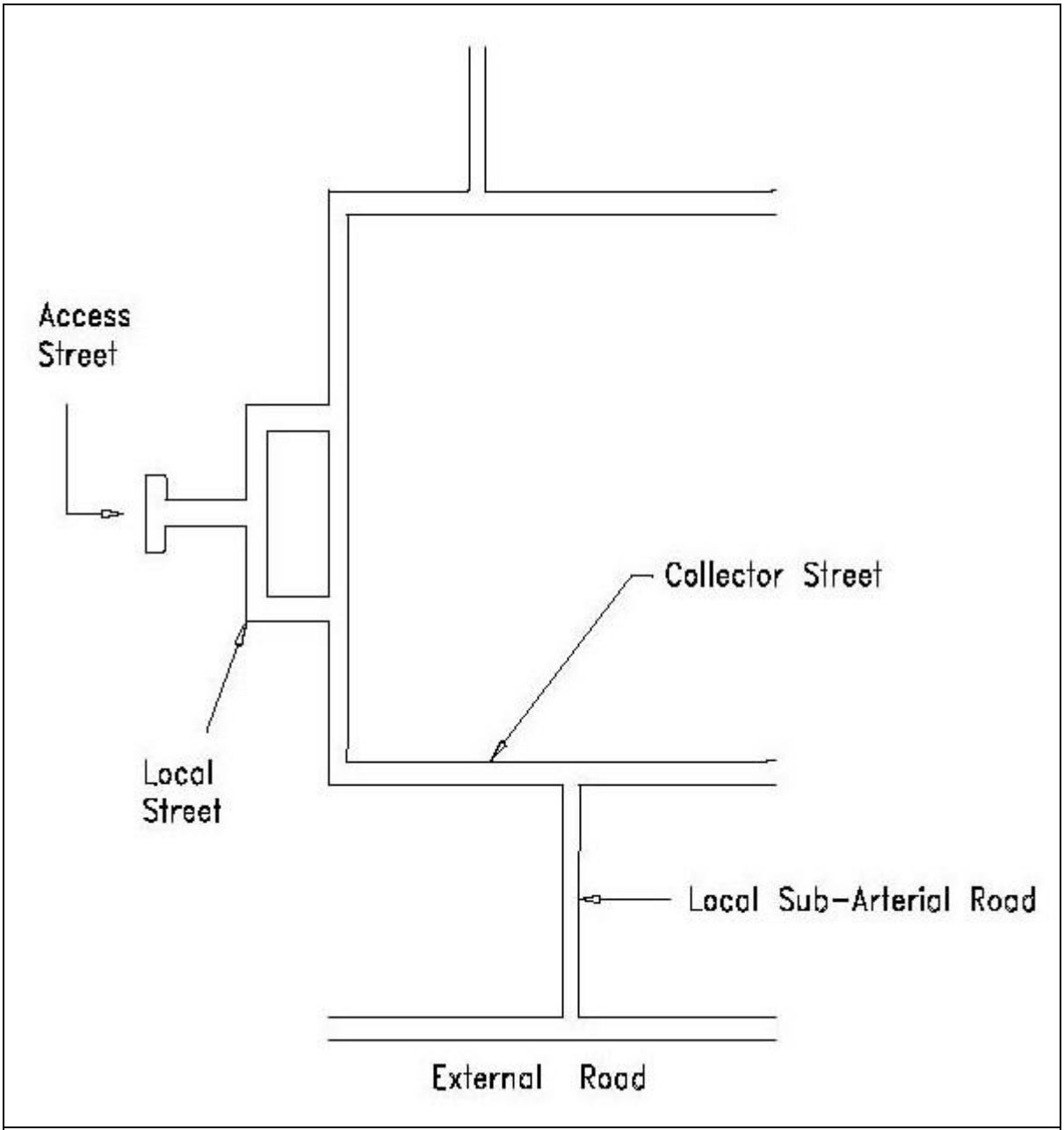
Requirement: Design the network so that the predominant function of the road is conveyed to all road users. Each class of road in the network serves a distinct set of functions and a hierarchical road network is essential to maximise road safety, residential amenity and legibility. Refer to the **Typical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

Traffic management at network level: Conform to Austroads AGTM04.

Access management categories: Conform to Austroads AGTM05.

Traffic management objectives: Conform to Austroads AGTM06.

Road function and traffic hierarchy: Conform to Austroads AGTM08.



Typical road hierarchy diagram

Road classification

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

Functional classification of urban roads: To Austroads AGRD02 Table 2.3.

Functional classification of rural roads: To Austroads AGRD02 Table 2.2.

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

Emergency access

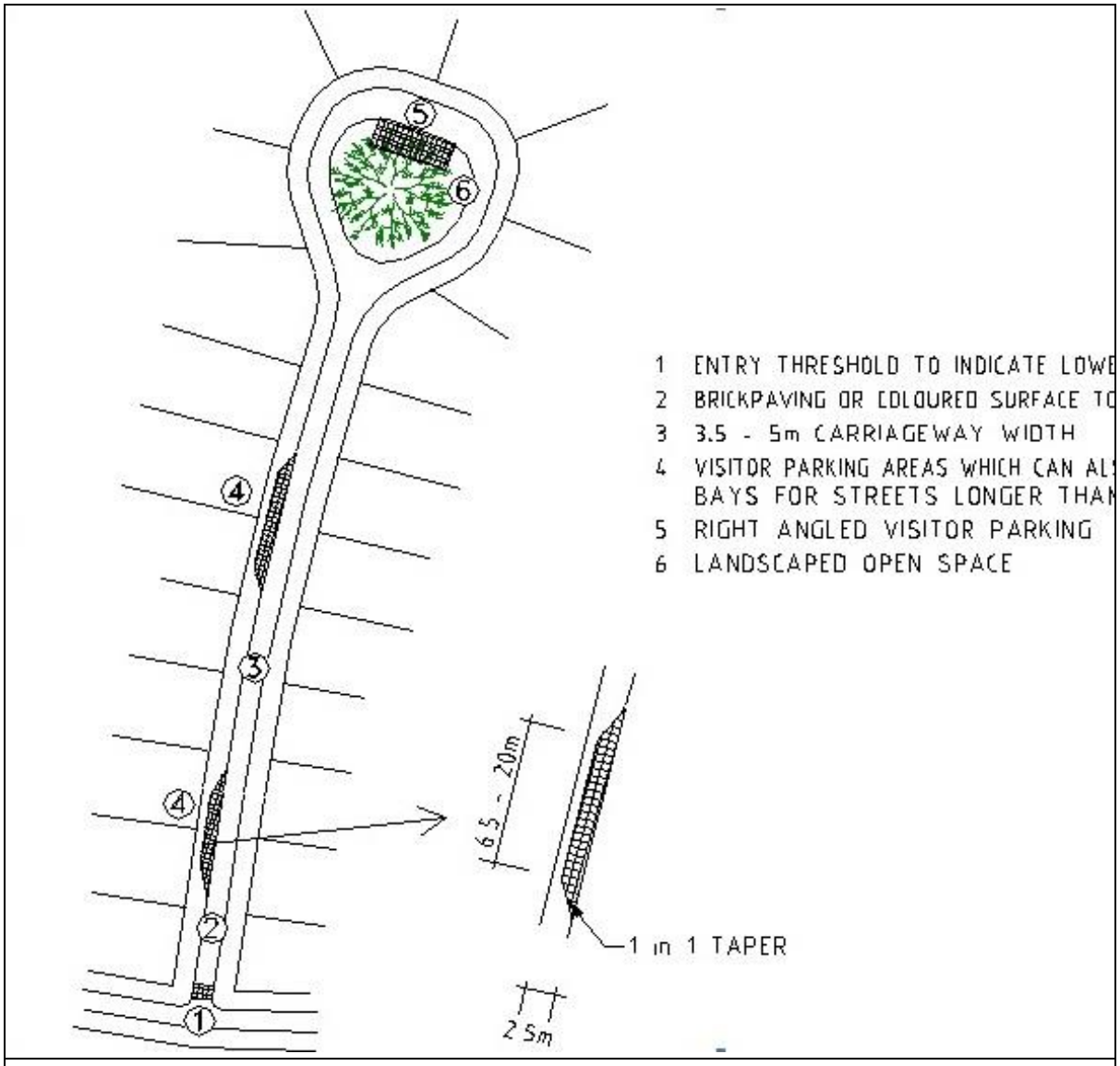
Requirement: Provide at least two access routes for emergency access for each street type in all subdivisions.

Traffic calming: Provide calming geometry to conform with Austroads AGTM08.

Access street

Road hierarchy: Lowest order road.

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



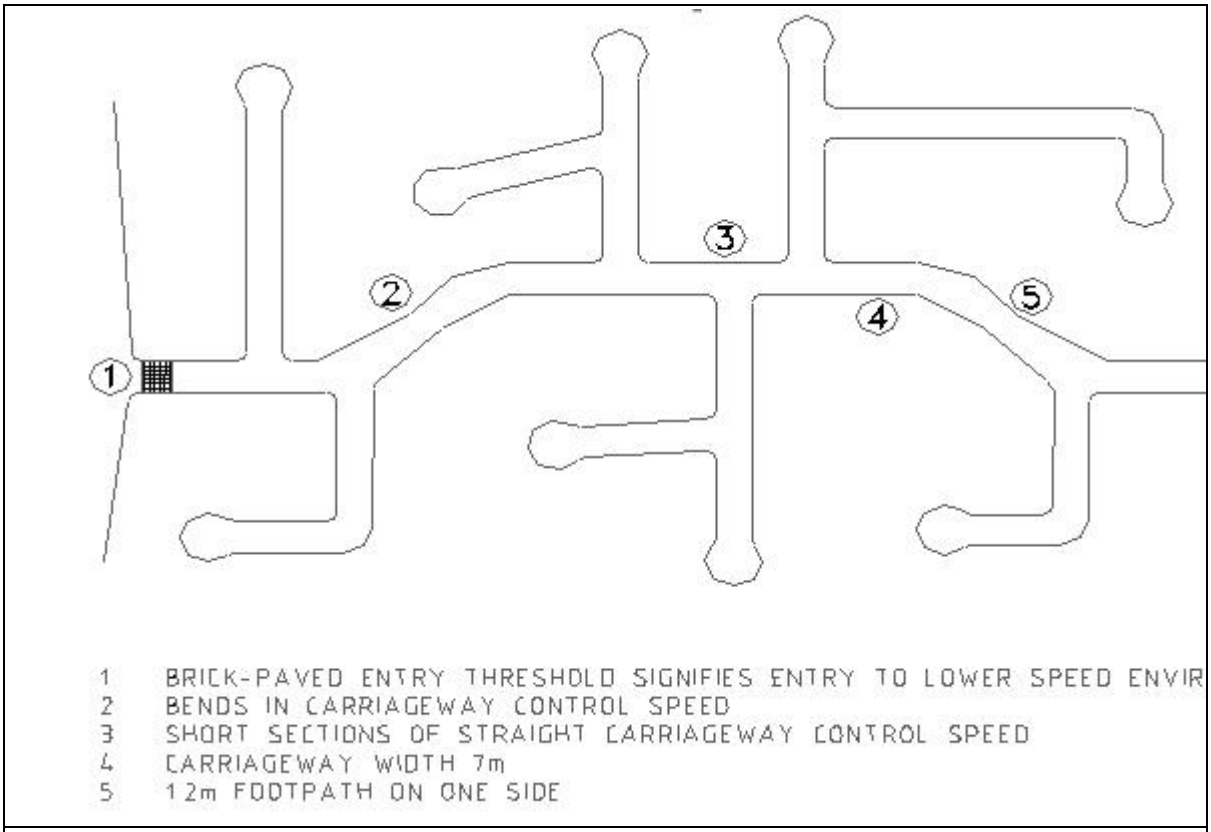
Typical access street layout

Local street

Road hierarchy: Second lowest order road.

Function: A local residential street, balancing the status of the street in terms of access with residential amenity functions. Resident safety and amenity are dominant but to a lesser degree than

access streets. Typically, local streets link access streets with collector streets. Refer to the **Typical local street layout**.

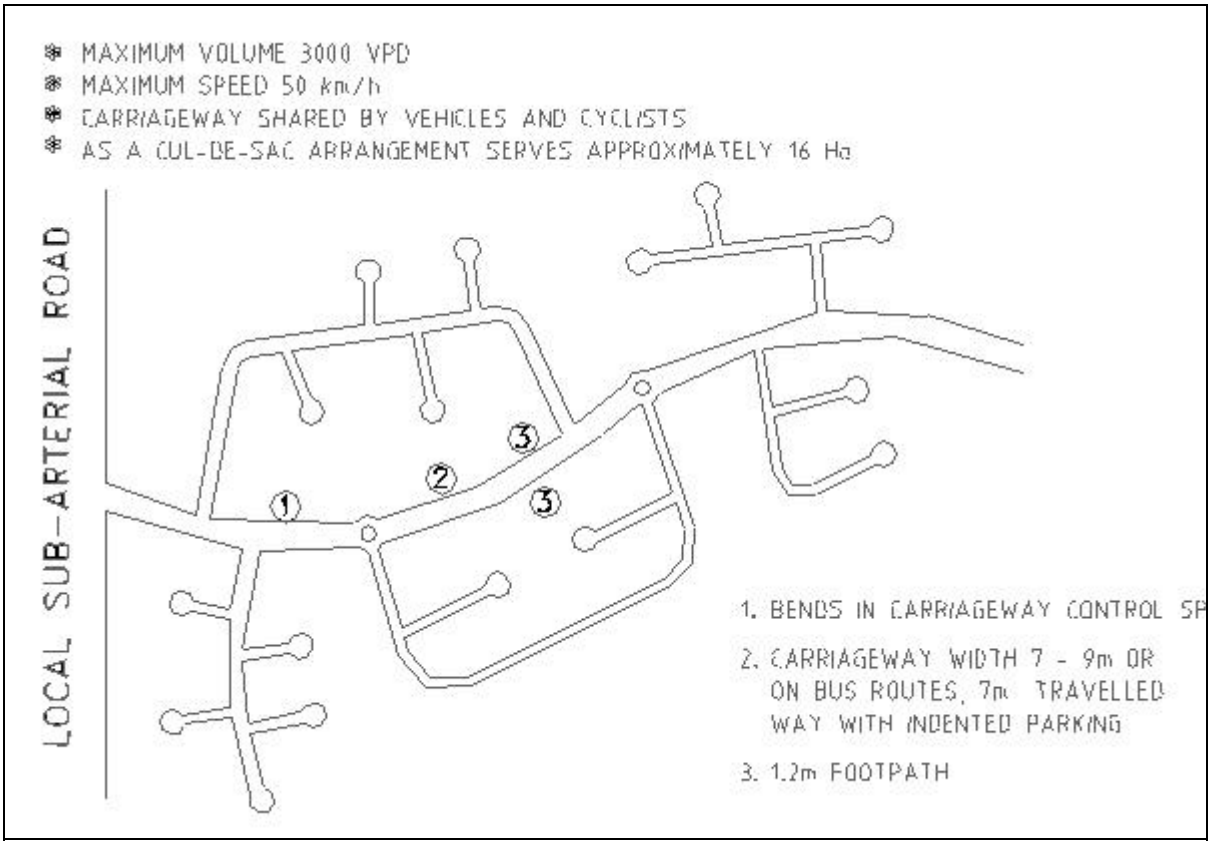


Typical local street layout

Collector street

Road hierarchy: Third lowest order road.

Function: Residential but also carries higher volumes of traffic collected from local streets and connects to local sub-arterial roads for community transport and business access. There is a reasonable level of residential amenity and safety through restrictions of traffic volumes and speeds. However, amenity and resident safety do not have the same priority as in access streets or local streets. Refer to a **Typical collector street layout**.

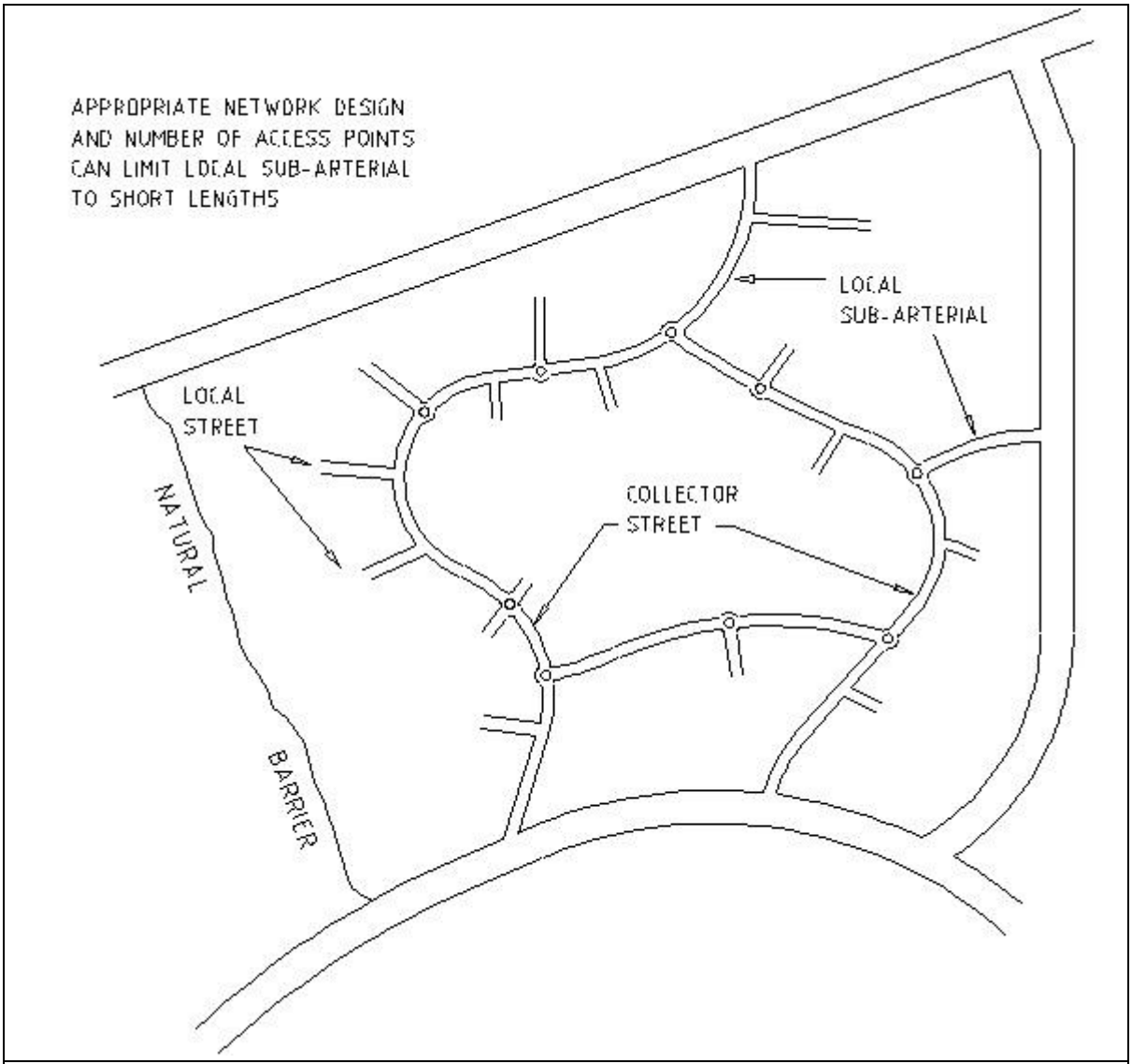


Typical collector street layout

Local sub-arterial road

Road hierarchy: Highest order road within a residential development.

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



Local sub-arterial road layout

1.5.1 Cul-De-Sac

The kerb line radius of a cul-de-sac shall not be less than:

- Residential - 9.5 metres (13.3m at property boundary)
- Industrial - 15 metres (18.8m at property boundary)

Alternative treatments of cul-de-sacs, such a “T” and “Y” heads, may be considered in consultation with Council’s Engineer. Generally any “T” or “Y” heads will require a minimum carriageway width of 8m.

Downhill cul-de-sacs should generally be avoided. Where they are unavoidable however, then special provision shall be made to take drainage through easements or drainage reserves. It will be necessary to give special consideration to the design of kerb longitudinal profiles for a cul-de-sac draining to the head.

Drainage of the low point in the head shall be provided via pipelines through easements or within pathways. It is essential that provision be made for overland flow for events which exceed pipeline

capacity or to allow for blockages of the downstream line. The locations of easements or pathways may not be flexible and regrading may be necessary to ensure safe overland flow.

1.5.2 Footpath Paving and Pathways

Footpaths shall be provided generally in accordance with Council's DCP. Notwithstanding the guidelines and reference documents provided in this specification the following should apply when designing footpaths:

(a) Located as indicated in Council's DCPs from the property boundary;

(b) Minimum width of 1.2 metres and a minimum thickness of 100 mm with SL72 steel reinforcement;

(c) Maximum crossfall of 4% and a minimum crossfall of 2% towards the road pavement;

(d) Signposting and pavement marking to be provided in accordance with AS 1742.1 to allow for the safe and convenient use of the facility;

(e) Minimum headroom of 2 metres and minimum formation width of 2 metres;

(f) Hinged joints shall be placed directly opposite any proposed tree and 1.2 metres either side of the tree if the tree is within 1.5 metres of the footpath. Minimum panel length is 1 metre.

For typical section of footpath refer to Council Standard Drawings and AUSTROADS guidelines.

Footpaths are to be provided as per Council's DCP. In areas adjoining public reserves, across vehicular crossings and abutting to roll top kerb the minimum thickness shall be increased to 125 mm. Where houses are constructed with the construction of the footpath, this thickened dimension may be applied to the driveway area only.

Additional footpaths will be required in public reserves to complete a footpath system in accordance with a layout to be approved by Council.

Low level and high level footpaths are to be avoided, but where this is impossible, provision must be made for satisfactory vehicular access to each lot in accordance with AS/NZS 2890.1

In areas where footpaths are located adjacent to drainage reserves, reverse crossfall shall be provided at sag points in the road longitudinal section.

2 PRE-DESIGN PLANNING

2.1 GENERAL

Planning stages

General: Plan and design road network to Austroads AGRTP. Carry out the following planning studies:

- Need study: A study to identify the requirements for new or upgrading the existing road network.
- Reconnaissance study: A qualitative study to identify all possible routes and feasibility of each route.
- Corridor study: A quantitative and qualitative study to select the preferred route.
- Route study: A graphical development of plans for all possible location of routes of the proposed development.

Geometric design elements

General: The geometric road design comprises of the following:

- Selection of the following road network elements to be incorporated in the design:
  . Cross section (e.g. widths of lanes, shoulders, medians and verges).
  . Horizontal curves.
  . Vertical curves and gradients.
  . Intersections.
  . Merge/diverge areas.
- Sizing of selected road network elements.
- Linking the road network elements into a three-dimensional sequence.

2.2 PLANNING

Road hierarchy

Requirement:

- For new areas: Make sure each class of route reflects its role in the road hierarchy by its visual appearance and physical design and is distinct from established areas with a pre-existing road pattern.
- Functional classification: Routes differ in alignment and design according to the volume of traffic they are intended to carry, the desirable traffic speed, and other relevant factors. Most road authorities have developed a functional hierarchy.

Integrated design principles

Requirement: Integrate design principles in the development of the road network to improve operational efficiency, road safety, public amenities while minimizing environmental impacts of noise, vibration and pollution.

Requirement: Consider the following in integrated design planning:

- Transport and community needs.
- Integrate natural patterns and design in response to topography and landform.
- Design roads so that their appearance signifies their function and their intended speed posting.
- Improve the legibility.
- Provide a self-reliant and minimal maintenance natural landscape.
- Integrate noise control in road network design.
- Avoid adverse visual impacts

Preparation for design: For design development inputs conform to Austroads AGRD08.

Legibility

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

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

2.2.1 Planning Standard

The road layout and width shall conform to that shown in Shellharbour City Council's Development Control Plan and / or as specified in the development consent. The precise location of any proposed roads are subject to the detailed site assessment carried out during the subdivision application process.

In areas not covered by a Development Control Plan the layout and width will be determined by Council on their merits.

2.3 CONSULTATION

Council and other authorities

Council consultation: Before starting design, liaise with the Council's officer(s) for the following:

- Roadway layout and traffic management.
- Council's transport policy.
- Stormwater and subsurface drainage.
- Landscaping.
- Requirements for road naming and addressing

Other authorities: Consult with and seek approval for the development from the following government authorities:

- State roads authority.
- State and local planning authorities.
- State and federal environmental agencies.
- Rail authorities if the proposed project crosses the rail network.
- Regional catchment management authority.
- Water authorities.
- Other utility authorities.

Public consultation

Requirements: Undertake public consultation with the community and the other stakeholders in conformance with the Council policy.

Utilities services plans

Existing services in the development area/precinct: Liaise with the utility authorities affected by the scheme and if required, obtain service plans from the authorities of the proposed development area for above ground and below ground services.

Requirements for utility services: To SOCC.

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

3 DESIGN CRITERIA

3.1 DESIGN DOMAIN

General

Requirement: Adopt a design domain approach to Austroads AGRD02 clause 2.

3.2 ROAD NETWORK DESIGN CRITERIA

Routing

General: Provide routing as follows:

- Avoid through routes in the internal road system that are more convenient than the external road network in conformance with Austroads AGTM04 and Austroads AGTM08.
- Design and locate the external road network to provide routes that are more convenient for potential through traffic within the network.
- Provide access to major roads at intervals of no more than 1.5 km, of adequate capacity to accommodate through network movements.

Road links

General: Provide for road links as follows:

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

Traffic flow

Traffic flow and speeds: Make sure that the traffic design for flow and speeds on any road are compatible with the residential functions of that road.

Traffic management in Activity centres: Conform to Austroads AGTM07.

Traffic impacts assessment: Conform to Austroads AGTM12 clause 4.

Transport provisions

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

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

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

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

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

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

Road naming and addressing

Road Layout: Provide for road naming and addressing as follows:

- Indicate the proposed ‘datum’ (in accordance is AS/NZS 4819 -5.7) of each road as the end where access to that road is most common or is planned occur.
- For staged developments, road names and address numbers should be assigned in terms of the completed development.
- The proposed named extents of each road shall apply from one end of the road to the other i.e. the point where the road finishes or it intersects with another road.
- The design of the road network and intersections shall have consideration to road naming and addressing
- Network design and proposed names to be compliant with requirements of AS/NZS 4819 – Rural and urban addressing, the Council’s ‘Naming and Addressing Policy’ and the NSW Addressing User Manual (AUM).

3.3 DESIGN PARAMETERS

Location

Road network location: Select urban or rural.

Traffic volume and composition

Requirements: Determine the following traffic characteristics to Austroads AGTM03.

- Traffic volume: Determine the volume of traffic to be carried by the road by conducting traffic studies and surveys to Austroads AGTM03.
- Roadway capacity.

- Level of service.
- Roadway conditions: Affect the roadway capacity and level of service depending on type of road and environment, traffic lane and shoulder widths, design speed, horizontal and vertical alignment.
- Terrain conditions: Generally classified as level, rolling and mountainous.
- Traffic composition: Generally classified as passenger cars, trucks and buses.
- Vehicle characteristics: Vehicle types and length or axle configurations.

Traffic lanes: Capacity analysis, level of service and design traffic volumes are used to determine the number of traffic lanes required.

Road classification

Requirement: Determine the functional road classification of the network to be designed in conformance to the **Hierarchical road network.**

Vulnerable road users

Pedestrians, cyclist and motorcyclists: Provide safe and convenient passage to vulnerable road users to Austroads AGRD03 clause 2.2.4 and Table 2.1.

Design speed and operating speed

Requirement: Identify the operating speed for existing roads and select the design speed for both existing and planned lengths of the road.

Alignment controls

Requirement: Identify any mandatory and discretionary controls for the proposed alignment.

Design vehicle

Requirement: Determine the type of vehicles that will be operating on the road network to establish the traffic lane widths, road geometry and intersection layout.

Apply Austroads ARGD04 Table 5.1 2017 and Table 4.2 of Australian Design Vehicles and Turning Path Templates Guide (2013).

Use of roads as emergency aircraft runway strip

Requirement: In an emergency in remote areas, roads may be designed to operate as emergency aircraft runway strips to Austroads AGRD03 Appendix B.

Environmental considerations

Requirement: Evaluate the environmental considerations including topography, existing public utility services, visual intrusion, noise, vibration and pollution in the road design to Austroads AGRD03 clause 2.2.9.

Noise reduction: Consider vertical alignment adjacent to intersections and/or sensitive areas (e.g. schools, hospitals) to minimize braking noise.

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

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

Fauna friendly roads

Wildlife currently occurring within Shellharbour City Councils future greenfield subdivision areas at risk of local extinction resulting from urbanisation include Swamp Wallabys, Wombats, Bandicoots, Echidnas and Eastern Long Neck Turtles.

RMS (2011) *Draft Wildlife Connectivity Guidelines* details principles and measures to managing wildlife connectivity and minimising roadkill.

The principles highlight the importance of considering wildlife connectivity early in the planning process.
Mitigation measures include;

- Underpasses such as culverts bridges and viaducts;
- Overpasses such as road tunnels or connected canopy; and,
- Usually incorporate fencing to minimise roadkill and direct fauna.

Greenfield subdivisions proposed within or adjoining the Terrestrial Biodiversity layer in the SCC 2013 LEP must consider wildlife corridors and mitigation measures as detailed in RMS (2011) to maintain corridors and minimise roadkill in road layout design and construction methods.

Heritage considerations

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

Access management

Requirement: Provide safe and appropriate access for the movement of traffic between the proposed road and the adjacent land.

Drainage

Drainage methods: Select the appropriate drainage methods to the *0043 Subsurface drainage (Design)* and *0074 Stormwater drainage (Design)*.

Utility services

Location: Locate the utility services in the road reserves such that there are minimum service relocations in case of future upgrades or growth in or around the proposed development.

Topography

Site specific features: Design the road with the terrain rather than against it and carry out the geotechnical investigation of the site to Austroads AGRD07.

Barriers and Fences

The road safety barriers shall be provided and designed in accordance with Austroads publication *Guide to Road Design Part 6: Roadside Design, Safety and Barriers*.

The barriers or fences for pedestrians and cyclists shall be installed and designed in accordance with Austroads publication *Guide to Road Design Part 6A: Pedestrian and Cyclist Paths*. The type and colour of the fencing shall be in galvanised heavy-duty fencing shall be used.

3.4 DESIGN SPEED

General

Design parameters: Use design speed as the basic parameter in road design as it is dependent on the functional classification of the road, topography, land use and abutting development and desired speed of drivers.

Operating speed on urban roads

Requirement: Conform to the following:

- Speed limits: To Austroads AGTM05 Table 5.4.
- Typical urban operating speeds: To Austroads AGRD03 Table 3.1.

Operating speed on rural roads
Criteria: Determine the minimum design speed value for other elements for Council Works on the concept of a speed environment as outlined in Austroads AGRD03 clause 3.4.

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

Desired speed
Existing rural roads: For restoration projects on existing rural roads, measure the operating speed from the suitable section of the existing road. Measure the desired speed directly as the 85th percentile speed on long straights. Also account for any increase in operating speed due to improved cross section and ride quality.

New rural roads: Select the desired speed from Austroads AGRD03 Table 3.3.

Operating speed model
Model: Determine the operating speed using the operating speed model to Austroads AGRD03 clause 3.6 to predict the operating speed of cars along the length of the road.

Vehicle speed
Requirement: Determine the acceptable vehicle speed for the particular section of road to Austroads AGRD03 clause 3.2.5.

Operating speed for temporary works
Requirement: Determine the operating speed for temporary roads to Austroads AGRD03 clause 3.8.

Hazard reduction
Low speeds: Adopt a low design speed to discourage speeding. Avoid vertical or horizontal curves on low design speed roads to minimise the risk of creating a potentially dangerous section of road.

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

Road safety barriers: Assess and design road safety barriers to AS/NZS 3845.1.

3.4.1 Design Speeds to be Adopted

Generally, the following design speeds shall be adopted:

- Collector Roads 60km/h
- Local Streets and / or Community Title Roads 50km/h
- Cul-de-sac, Access Streets and Community Title Roads 40km/h

It should be noted that vehicular speeds are limited by road intersections as well as changes in vertical and horizontal alignment. The adopted design speed may vary subject to the assessment by Council's Engineers. RMS determine signposted speeds.

3.5 CROSS-SECTION

Road reserve characteristics
Cross section: Provide for all road functions including the following:

- Safe and efficient movement of all users (including emergency vehicles and operation of buses on connector streets)
- Provision for parked vehicles. Give particular attention to access for disabled persons in conformance with the *AUS Gov Act No. 135 - Disability Discrimination Act 1992*.
- Access to public transport.

- Buffer from traffic acoustic nuisance for residents.
- Provision of public utilities and WSUD devices.
- Streetscaping.
- Requirements of *AUS Gov Act No. 135 - Disability Discrimination Act 1992.*

Operational aspects: Conform to the following:

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

Design life: To Austroads AGRD01 Table 3.1.

Type of cross-section

Design life: To Austroads AGRD03 Table 4.1.

Traffic lanes

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

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

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

Urban arterial road widths: To Austroads AGRD03 Table 4.3.

Single carriageway rural road widths: To Austroads AGRD03 Table 4.5.

Divided carriageway rural road widths: To Austroads AGRD03 Table 4.6.

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

Crossfall

Pavement crossfalls: Crown the roads on centreline. Provide crossfall to drain the carriageway on straights and curves and to provide superelevation on horizontal curves.

Pavement crossfall on straights: To Austroads AGRD03 Table 4.2 (excluding asphalt)

The typical crossfall of road pavements shall be 3%. Any proposal to have road pavement crossfall in excess of 4% or less than 2% will generally not be accepted.

Offset crown lines: In urban areas there are many factors that force departure from the recommended crossfalls. All roads shall be designed to have a crown on the centre of the road. In areas where there is a site constraint, an offset crown may be permitted subject to approval of Council's Engineer. Any shifting of the crown shall be towards the high side of the road and not be closer to the kerb line than 3.5 metres. Where necessary, Council may also consider an offset crown to be provided at intersections.

The difference in level between the road alignments can be taken by offsetting crown lines or by adopting one way crossfall. Adopt sustained crossfalls with a minimum of 4% and a maximum of 6%.

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

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

Precedence of crossfall over grade: Conform to the following:

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

Shoulders

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

- Structural: Provide lateral support to the road pavement layers.
- Traffic: Provide an initial recovery for an errant vehicle, emergency use, a refuge for stopped vehicles and space for cyclists.

Shoulder width: Provide the following:

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

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

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

Shoulder crossfall: Provide shoulder crossfall to Austroads AGRD03 clause 4.3.5.

For rural roads the design of road shoulders shall be carried as follow:

	For roads with AADT (1) ≤1000	**For roads with AADT (1) >1000**	**For roads with discretionary stopping for cars and trucks**	**Section of road shoulder adjacent to a barrier centreline**
Width of shoulder	Minimum 2.0 m	Minimum 2.0 m	Minimum 3.0 m	Minimum 3.0 m
Width of sealing	first 1.0 m	full width	full width	full width
Minimum sealing	two coat hot bitumen spray seal	two coat hot bitumen spray seal	two coat hot bitumen spray seal	two coat hot bitumen spray seal
Line marking	120mm wide edge line markings	120mm wide edge line markings	120mm wide edge line markings	120mm wide edge line markings
Crossfall (%)	3.0 – 4.0	3.0 – 4.0	3.0 – 4.0	3.0 – 4.0

(1) Annual Average Daily Traffic

Note:

The road base course layer shall extend at least to the nominated width of shoulder and shall have the thickness in accordance with the pavement design (See Section 4.5 of 0042 Pavement Design Specifications) but not less than 150mm.

Verge

General: Design the verge to perform the following functions:

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

Minimum width: To Austroads AGRD03 Table 4.9.

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

The following design requirements for the road verges shall be complied with:

a) Road verges shall be designed to have sufficient width to accommodate footpaths, cycleways / shared paths, kerb ramps, public utilities, street lighting, landscaping, street trees and traffic regulatory signage. Wherever possible, utility services should be located in common trenches.

b) The width of the verge at intersections shall be designed to ensure adequate sight lines and sight distance has been provided within the road reserve. Sight lines shall be checked to ensure that they do not encroach onto privately owned land.

c) Road verges shall be formed so as to extend 0.5 metres past the property boundary into the adjacent allotments (berms) to enable fences to be constructed at road level.

d) All road verges shall be cleared full width and extend minimum 0.5 metres inside the lot boundaries, or to a sufficient width to include cut and fill batters.

e) The grass road verge shall be 4% sloping down toward the kerb and be laid in such a way to ensure the finished level of the grass after settlement is not below the finished level of the adjacent footpath and/or kerb. There shall be no localised depressions. (See Council's Standard Drawing).

Verges and property access

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

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

Crossfalls in footpath paving: < 4% to Austroads AGRD06A.

Longitudinal grade: Conform to the following:

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

Driveway profile: Conform to the following:

- Provide a vehicular driveway centreline profile for the property access.
- Check the design using critical car templates in accordance with AS2890.
- Design driveway profiles so that vehicles can use the driveway satisfactorily.

Laybacks and vehicular crossovers: Roads shall be designed and located to ensure that vehicular access can be readily obtained to every allotment of a development.

Council requires that satisfactory vehicular access can be provided for every lot, taking into account the following:

- Physical constraints
- Sight distances
- Access, verge and allotment grading
- Street design / layout
- Minimum depth of cover requirements to underground services
- The functional road hierarchy of the road being accessed.

Layback and vehicular crossovers shall be designed in accordance with Shellharbour City Council's *Detailed requirements for a driveway or vehicle crossover* and Council Standard Drawings.
For all new subdivisions and developments where new kerb and gutter construction is required, new laybacks shall be provided for each allotment with barrier kerb. Any other type of developments will require a separate Vehicle Crossover Application form to be lodged and approved by Council.
The location of layback and vehicular crossover shall be wholly within the frontage of each allotment.
Any redundant layback and vehicular crossover shall be removed from the development site and restored to full kerb and gutter together with turfing of the adjoining footpath verge area.
Major drainage carried in roads must not be allowed to enter properties via the vehicular access.

Batters

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

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

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

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

Batter slopes: To Austroads AGRD03 Table 4.11.

Road shoulders shall be graded to extend at least 0.5m into adjacent lot and match the grade of the verge. The design of batter slopes shall be in accordance with the following table.

Where the desirable maximum slopes cannot be achieved, variances up to the absolute maximum slope may be permitted subject to approval by Council's Engineer. Where variances in slope are approved, provision shall be made to ensure the stability of the batters. Notwithstanding the above, access to each lot shall be available at natural surface level at the proposed building line with a maximum grade and changes of grade in accordance with AS2890.

It should be noted that Council will not support the construction of a retaining structure to support the road reserve. However, where the absolute maximum slope detailed above cannot be reasonably attained, the retaining structure supporting the road reserve may be considered by Council subject to the following:

a) Full engineering details of the proposed structure, including elevation, typical cross-section and structural certification by a qualified structural engineer shall be submitted to Council.

b) Safety barriers for roads and road embankments designed in accordance with Austroads and RMS requirements have been provided to protect errant vehicles.

c) All retaining structures shall be located wholly outside the road reserve.

d) Appropriate easements for support over the batters/ the retaining structures, burdening the affected lot and benefitting Council shall be provided. The width of the easement will be subject to assessment by Council's engineer and the cost of creating easements for support shall be borne by the applicant.

Benches: Provide benches for high batters > 10 m vertical height or batters on unstable ground. Provide benches as shown in Austroads AGRD03 Figure 4.14.

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

Roadside drainage

General: Provide appropriate drains to remove water from the road and its surroundings and to maintain road safety and pavement strength to Austroads AGRD03 clause 4.6.

- Table drain: Provide a dish drain, or similar structure along the invert of table drains, seal the outer edges of the pavement, the shoulder verges and the drain lining where scour is likely to occur to Austroads AGRD03 Figure 4.16. Provide the following slopes:
  . Side slopes: < 4H:1V.
  . Desirable slope: 6H:1V.
- Catch drains: Provide catch drains to prevent overloading of the table drain and scour of the batter face at least 2 m from the edge of cuttings to minimise possible undercutting of the top of the batter.
- Median drains: Provide median drains with side slopes 10H:1V to reduce the chance of vehicle overturning. Provide a depressed median of minimum 10 m width. Place the invert of the median drain below subgrade level to facilitate drainage of pavement layers.
- Kerb and gutter: Provide kerb and gutter to perform the following:
  . Collect and convey surface drainage to a discharge point.
  . Delineate the edges of the carriageway.
  . Separate carriageways from areas dedicated to footpath users.
  . Support the edge of the base course of the pavement.
  . Reduce the width of cut by substituting an underground drainage system in place of table drains.
- Kerb type: Select the kerb type from the following:
  . Barrier.
  . Semi-mountable.
  . Mountable.
  . High profile barrier kerbs.
- Kerb placement: Conform to the following:
  . Provide barrier kerb for lightly trafficked Local roads, adjacent to parking lanes and parking areas and bus bays to reduce the risk to pedestrians.
  . Provide layback kerb on minor roads to allow for off-road parking and for continuous access to property.
- Kerb location: Place kerb and gutter with the clearance between the face of the kerb and edge of the traffic lane to Austroads AGRD03 Table 4.14.

- Kerb and gutter in rural roads: Provide kerb and gutter on both sides of roads and piped drainage in all rural residential subdivisions.
- Concrete kerb and gutter are to be constructed along all new and existing urban roads to which a development has frontage and access.

- The kerb type (standard integral 150 mm or roll top kerb) is dependent on the road classification as shown in section 1.5 or the relevant DCP and is to be in accordance with Council Standard Drawings.

- Standard integral 150 mm kerb shall be provided adjacent to public open space and reserves.

- Laybacks in 150 mm standard integral kerb are to be constructed in accordance with Council Standard Drawings.

- Provision shall also be made for future roof and stormwater disposal from each allotment by providing one outlet at the lowest point in the kerb. A 150 mm by 50 mm Galvanised steel box section must be provided for all kerb types to accommodate stormwater disposal.

- Kerb ramps shall be provided at all intersections in accordance with the Council Standard Drawing.

- Any variations to the above shall be approved at the discretion of Council's Engineer.

- Laybacks and kerb ramps shall be provided in conjunction and concurrently with the kerb and gutter where possible.

- For subdivision developments, provision shall also be made for future stormwater disposal from each allotment by providing one outlet at the lowest point in the kerb. The outlet shall be an approved galvanised steel section fabricated stormwater kerb adaptors to match the kerb profile for the full height of the kerb.

Scour protection

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

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

Medians

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

Median type: Select raised or depressed type to Austroads AGRD03 Figure 4.21.

Median width: Minimum urban median width to Austroads AGRD03 Table 4.15.

Median slopes: Provide median slopes to Austroads AGRD03 Table 4.16.

Median transitions: Provide appropriate transition to safely merge and diverge vehicles to Austroads AGRD03 Figure 4.25.

High occupancy vehicle (HOV) lanes

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

- Shoulder width: 3.5 m.
- Intermittent bays: Provide bays with appropriate length tapers to provide safe movement of vehicles.

- Provide access to public transport in conformance with the AUS Gov Act No. 135 - Disability Discrimination Act 1992.

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

- To Austroads AGRD03 Table 4.22.
- Minimum width between the kerbs:
  . If bicycle lanes are provided: 15 m.
  . If bicycle lanes are not provided: 11.6 m.
- Width of kerbside bus lanes: To Austroads AGRD03 Table 4.23.

On-street parking

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

Road reserve parking: Provide adequate parking within the road reserve for visitors, service vehicles and any excess resident parking.

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

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

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

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

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

On-street parking dimensions: Conform to the following:

- AS2890.5
- Combined spaces for two cars:13.0 m x 2.5 m.
- Truck parking: 20 m x 2.8 m with adequate tapers at both ends to allow parking manoeuvres determined to Austroads AP-G34.

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

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

Angled parking space widths: To AS 2890.5 Table 2.2.

Off-street parking

Standards: To AS/NZS 2890 (all), Austroads AGTM11 and Austroads AGRD06B.

Service roads and footpath

General: Provide service roads for access to the abutting property or control access to the arterial road from the abutting property.

Minimum service road lane width: To Austroads AGRD03 Table 4.26.

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

Minimum service road carriageway width for roads with low traffic volumes: To Austroads AGRD03 Table 4.27.

Operating speed: 40 to 60 km/h.

Outer separator width: To Austroads AGRD03 Table 4.28.

Urban border: Consider urban borders comprising a pedestrian path and nature strip to Austroads AGRD03 Table 4.28.

Typical urban border slopes: Conform to the following:

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

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

- Standard: To Austroads AGRD06A.
- Minimum desirable width: 1.2 m.
- Crossfall: Varies from flat to 2.5%.

Bus stops

New bus stops: In conformance with the requirements of the AUS Gov Act No. 135 - *Disability Discrimination Act 1992* and other road authorities and transport agency disability standards which outline the requirements of the access paths, manoeuvring areas, ramps, waiting areas, surfaces and tactile ground surface indicators.

Urban bus stops: To Austroads AGRD03 Figure 4.51.

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

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

Minimum length of bus stopping area: 15 m.

Width of pedestrian footpath behind a bus shelter shall be a minimum 1.5m or 2.5m for shared paths.

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

Indented bus bay: The indented bus bay shall be designed in accordance with Section 4.12.2 and Figure 4.51 of Austroads publication *Guide to Road Design Part 3: Geometric Design (2016)*.

3.6 SIGHT DISTANCE

General

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

Sight distance parameters

General: To Austroads AGRD03 Table 5.1 and the following:

- Driver reaction time: Adopt reaction time of 2.5 seconds for all roads. If 1.5 seconds and 2 seconds reaction times are required, arrange approvals from the State Road Authority.

Stopping sight distance

General: Conform to the following:

- General: To Austroads AGRD03 clause 5.3, measured from an eye height of 1.15 m to an object height of 0.20 m.
- On sealed roads: Car stopping sight distance to Austroads AGRD03 Table 5.5.

Sight distance on horizontal curves

General: Conform to the following:

- On horizontal curves: To Austroads AGRD03 Figure 5.4 which shows the relationship between horizontal sight distance, curve radius and lateral clearance to the obstruction.
- On horizontal curves with roadside barriers: Provide minimum shoulder widths and manoeuvre times for sight Austroads AGRD03 Table 5.7.

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

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

3.7 COORDINATION OF HORIZONTAL AND VERTICAL ALIGNMENT

Horizontal and vertical alignment coordination

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

Requirement: Conform to the following:

- Avoid the use of minimum radius horizontal curves with crest vertical curves.
- Contain the crest vertical curves within horizontal curves to enhance the appearance of the crest by reducing the three-dimensional rate of change of direction and to improve safety.
- Provide the same design speed of the road in both horizontal and vertical planes.
- Avoid sharp horizontal curves at or near the top of a crest vertical curve.
- Consider three dimensional combined horizontal and vertical stopping sight distance and minimum sight distance.
- Provide a horizontal curve to indicate the change in direction before introduction of vertical curve in both directions of travel.
- Be aware that a short vertical curve on a long horizontal curve or a short tangent in the grade-line between sag curves may adversely affect the road's symmetry and appearance.

Aesthetic consideration: Conform to the following:

- Provide horizontal curves slightly longer than the vertical curve, so that the curves fits with the terrain and are coincident.
- Provide long horizontal curves to short curves so that:

. The overtaking opportunities are not reduced.
. Small deflection angles avoid the appearance of a kink.
. Best appearance is provided for deviations around obstructions.
. The far tangent point is beyond the driver's point of concentrated vision for curves located at the end of long straights.

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

3.8 HORIZONTAL ALIGNMENT

General

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

- For low and intermediate speed rural roads and minor urban roads, where it is difficult to overcome the physical restrictions of curve radii, introduce curvature of a lower standard than the design speed of the project to Austroads AGRD03 Table 7.1.
- Provide tangents of suitable length as frequently as the terrain permits to facilitate overtaking manoeuvres.
- Determine the horizontal alignment from the design speeds for a particular street within the road hierarchy (see **Design Speed**).
- Drivers react to restrictive horizontal alignment by slowing to an appropriate speed, hence the desired maximum design speed is maintained by deliberately designing a restrictive horizontal alignment.
- The minimum horizontal deflection angle for which a curve is needed is 1.0 degree. Where possible the radii of the curve shall be maximised to reduce the necessity for centreline shift and widening of the carriageway. The minimum radius of horizontal curves for various deflection angles shall be: -

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

- Where the deflection angle is 90° and travel speed is not an issue, the size of the horizontal curve is to be related to the turning requirements of a Single Articulated Vehicle (19.0m) / Heavy Rigid Vehicle (12.5m) such as a removalist van and garbage truck.
- All curves of less than 180 metres radius shall be widened and provided with plan transition at the junctions with the tangents. This applies particularly to curves which tend to reduce the speed of traffic flow and those with crests within their length.

Horizontal curves

Types of horizontal curves: Conform to the following:

- Compound curves: Provide a smaller curve preceding a larger curve. Avoid diminishing radii at steep downgrades.
- Reverse curves: Do not use reverse curves unless there is sufficient distance between the curves to introduce full superelevation of the two curves without exceeding the standard rate of change of crossfall for a particular design speed.
- Transition curves: Introduce transition curves to join the straight and circular curves to provide smooth travel of vehicles within the traffic lane.

. Transition the horizontal curves with the transition length based on the superelevation runoff length for the recommended combination of speed, radius and superelevation.
. Avoid transition curves for large radius horizontal curves and where operating speed is less than 60 km/h.
. Provide transition paths for trucks, where lane width is no more than 3.5 m.

Horizontal curves and tangent lengths

Speed/radius relation: Conform to the following:

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

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

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

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

Side friction and minimum curve size

Recommended side friction factors: To Austroads AGRD03 Table 7.5.

Minimum radii for horizontal curves based on superelevation and side friction: To Austroads AGRD03 Table 7.6.

Maximum allowable deflection angles without horizontal curves: To Austroads AGRD03 Table 7.7.

Superelevation

Criteria: Determine the superelevation by considering the following:

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

Minimum radius of curves: Determine from the following:

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

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

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

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

High design speed: Conform to the following:

- Maximum superelevation for urban roads of higher design speeds: 6%.
- Maximum values of superelevation for different road types: To Austroads AGRD03 Table 7.8.
- Avoid any increase in the longitudinal grade leading to excessive crossfall at intersections.
- While it is desirable to superelevate all curves, limit adverse crossfall to 3%.

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

Plan transitions

Transitions: Conform to the following:

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

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

Crossfall changes: Avoid abrupt changes in crossfall, which can cause discomfort in travel and create a visible kink in the kerb line. Conform to the following:

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

Curves with adverse crossfall

General: Avoid adverse crossfall greater than 3% except for curves with an operating speed of no more than 70 km/h in constrained areas and for intersection turns and roundabouts.

Minimum radii with adverse crossfall: To Austroads AGRD03 Table 7.12.

Adverse superelevation: Provide adverse superelevation at the following:

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

Pavement widening on horizontal curves

Widening: Provide pavement widening on curves to Austroads AGRD03 Table 7.13 to maintain lateral clearance between vehicles taking into account the following factors:

- Radius of the curve.
- Width of lane on a straight road.
- Vehicle length and width.
- Vehicle clearance.

Kerb returns

The design of kerb returns is necessary for all road junctions to ensure a smooth trafficable surface around the return and where necessary to locate low points for drainage purposes.

The minimum kerb line radius and splay of corner for all roads shall be in accordance with the following.

Minimum Kerb Line Radii and Splay Corners

DEVELOPMENT TYPE	MINIMUM KERB LINE RADII (1)	MINIMUM SPLAY OF CORNER
Urban	9.0 m (2)	4.0 m x 4.0 m
Collector	12.0 m	5.0 m x 5.0 m
Commercial	12.0 m	5.0 m x 5.0 m
Industrial	12.0 m	5.0 m x 5.0 m

(1) On bus routes the geometry of the kerb return must be varied to allow for the larger turning circle.

(2) The entry and exit kerb line radii into cul-de-sacs shall be 16 metres in Urban and Rural areas and 30 metres in Industrial and Commercial areas.

Any variation to the above radii must be approved by Council's Engineers and should accommodate the intended vehicular movement using **AUSTROADS** templates. The specified minimum kerb radii and minimum splay corners may be subject to amendment according to intersection treatments and associated traffic control devices. Should such be identified for an intersection, then both radii and splays will be designed in accordance with the intersection treatment design

Where reduced kerb returns are specified due consideration must be given to the following:

(a) The provision of kerb levels (on the nominal kerb lines) at tangent points, quarter points and wherever necessary to ensure accurate construction of junctions and turning heads;

(b) Offsets to all crests and low points to be shown on the kerb profile;

(c) The kerb return profile is to be generally designed by adopting the grades of the approach and exit kerbs to the return, by quartering the length of the return and by computing kerb

3.9 VERTICAL ALIGNMENT

General

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

Vertical controls

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

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

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

Vertical curves of the form of simple parabolas shall be provided at all changes of grade.

Every effort should be made to provide vertical curves as long as possible for improved appearance, however, surface drainage should be maintained in proximity to sag points.

The design of vertical curves shall be in accordance with Austroads publication *Guide to Road Design Part 3: Geometric Design* and the following:

1. Where the change of grade is less than that shown below, the centreline grading shall be "eased" over a symmetrically located distance of 10 metres. This distance may be reduced to 5 metres for cul-de-sac, access streets and community title roads.

Street / Road Type	Grade Change (%)
Local	1.0
Collector	0.9
Distributor	0.6
Industrial	0.6
Rural	0.6
Laneway / Cul-de-sac	1.0

2. The minimum length of a sag vertical curve shall:
   - comply with sight distance requirements;
   - provide minimum headlight sight distance;
   - based upon the riding comfort, in which the vertical acceleration shall not exceed 0.05g (desirable) and 0.10g (absolute minimum); and
   - comply with following minimum lengths of vertical curves requirements

Street / Road Type	Minimum Curve Length (m)	Minimum Curve Length at Road Junctions (m)
Local	25	6
Collector	35	12
Distributor	50	20
Industrial	35	12
Rural	35	12
Laneway / Cul-de-sac	25	6

Note: Minimum length of vertical curves given above are for straight alignments; longer curves will be necessary where roads also have horizontal curvature

3. The use of short sections of straight grade between vertical curves (sawtooth effect) is undesirable for appearance and should be avoided;

4. The tangent point of a vertical curve in the side road should be located at, or behind, the kerb line of the through road; and

5. Vertical curves on kerb returns must be treated in such a manner as to make construction practical.

Vertical clearances

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

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

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

Underground services

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

- Gas mains.
- Water mains.
- Stormwater drains.

- Sewer mains
- Telecommunication cables.
- Underground electrical cables.
- Road authority assets, e.g. traffic signals and street lighting.

Longitudinal gradient

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

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

Maximum grade: To Austroads AGRD03 Table 8.3.

Intersections: Conform to the following:

- Longitudinal grade of the minor street on the approach to an intersection: < 4%.
- Design actual gradient dependent on the type of terrain.
- Interrelate the design of the road alignments and the grades used.
- Avoid a steep grade on a minor side street if vehicles have to stand waiting for traffic in the major road.

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

The minimum and maximum permissible grade of the roads shall be provided as follow:

Minimum/Maximum/Absolute Longitudinal Grades **(1)**

ROAD TYPE	MINIMUM	DESIRABLE MAXIMUM	ABSOLUTE MAXIMUM
Major Collector Roads	1.0%	12.0%	15%
Collector Roads	1.0%	12.0%	15%
Industrial	1.0%	12.0%	15%
All other Urban Residential Roads	1.0%	17.0%	20%
Rural Roads	1.0%	17.0%	20%

(1) To occur over a maximum distance of 100 metres on a straight alignment.

Vertical curves

Criteria: Design vertical curves in conformance with the following:

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

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

- For kerbed roads: Limit the maximum length of sag curves with less than 0.3% grade to 30 m.
- Maintain a minimum grade of 0.5% in the kerb and gutter by warping of road cross sections at sag points.
- Make provisions for draining both the road surface and the subgrade.
- To minimise discomfort due to rapid changes in vertical acceleration when passing from one grade to another, limit the vertical acceleration generated on the vertical curve to the following:
  . For desirable riding comfort: 0.05 g.
  . For minimum riding comfort: 0.10 g.

where g is the acceleration due to gravity.

Sight distance on sag curves: To Austroads AGRD03 clause 8.6.5.

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

3.10 AUXILIARY LANES

General

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

Types of auxiliary lanes

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

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

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

Cross-section

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

Shoulder width: 1 m.

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

3.11 INTERSECTIONS

Design criteria

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

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

Urban and rural intersections: To Austroads AGRD04 Table 4.1 and Table 5.1.

Road users' considerations: To Austroads AGRD04 Table 3.2.

Design criteria: To Austroads AGTM06.

Intersection turning movements

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

Intersection types

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

The basic forms of an intersection may include the following:

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

Location

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

- "T" junctions shall be adopted in preference to four-way intersections. Where staggered "T" junctions are to be provided, the roads shall be spaced a minimum distance of 2 x stopping distance for the travel speed along the through-road (2.0 second reaction time).
- Where intersections are in a configuration deemed likely to cause traffic problems, Council's Engineer may require provision of turn treatments, construction of traffic islands / medians, or other traffic management facilities to provide traffic control and safety.
- Streets intersection: Preferably at right-angles and not less than 70°.
- Landform: Allowing clear sight distance on each of the approach legs of the intersection.
- Minor street: Intersect the convex side of the major street.
- Vertical grade lines at the intersection: Conform to the following:
  . Provide a desirable grade of 3% with a maximum of 5%.
  . Allow for any direct surface drainage.
- For a left turn, where two minor side streets intersect a major street in a staggered pattern, provide a minimum centreline spacing of 40 m.

Splay corners shall be provided at all intersections as follow:

- 4m x 4m – Laneways, Cul-de-sacs, Local roads, Collector roads
- 5m x 5m –Collector roads, Distributor roads, Industrial roads and Rural roads
- All sight lines shall be checked to ensure that they are located in the road reserve and do not encroach onto privately owned land.

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

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

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

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

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

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

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

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

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

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

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

Sight distance

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

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

Type of turn treatments

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

- Basic turn treatment (Type BA):
  - . Rural basic (BA) turn treatment: To Austroads AGRD04A Figure 4.1.
  - . Rural basic left-turn treatment for minor roads: To Austroads AGRD04A Figure 8.2, width minimum length of widened parallel shoulder to Austroads AGRD04A Table 8.1.
  - . Urban basic (BA) turn treatment: To Austroads AGRD04A Figure 4.2.
- Auxiliary lane turn treatment (Type AU): Provide short lengths of auxiliary lane to improve safety on high speed roads where an arterial road meets with sub-arterial, collector or local roads. Provide the following turn treatments as appropriate:
  - . Rural auxiliary lane turn treatments: To Austroads AGRD04A Figure 4.5.

  - Urban auxiliary lane turn treatments: To Austroads AGRD04A Figure 4.6.
  - Urban auxiliary left-turn treatment – Short turn lane (AUL(S)) major road: To Austroads AGRD04A Figure 8.10 with setting out details of the left turn geometry to Austroads AGRD04A Table 8.4 and with minimum kerb radii for low speed environment to Austroads AGRD04A Table 8.3.
- AUR right turn treatments: Generally, not as safe as a channelised treatment at unsignalised intersections. Do not use, unless approved by State Road Authority.
- Channelised turn treatment (Type CH):
  - Rural channelised (CH) intersection turn treatment: Layout to Austroads AGRD04A Figure 4.7 and design details to Austroads AGRD04A Figure 8.5 and Figure 8.6.
  - Urban channelised (CH) intersection turn treatment: Layout to Austroads AGRD04A Figure 4.8 and design details with a high entry angle left-turn island to Austroads AGRD04A Figure 8.12 and Urban CHL with acceleration lane to Austroads AGRD04A Figure 8.13.

Staggered T-intersections: Rural staggered T intersections may be 'right to left' or 'left to right' type to Austroads AGRD04A Section 4.11. Consider traffic volumes and available width in design selection. Provide staggered T-intersections by:

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

3.12 ROUNDABOUTS

General

Design criteria: To Austroads AGRD04B Section 4 and Austroads AGTM06 Section 4. If alternative criteria are proposed, submit alternative criteria for consideration.

Requirement: Provide the following:

- Functional design: To achieve safety of all users and traffic performance.
- Entry width: To provide adequate capacity.
- Adequate circulation width: Compatible with the entry widths and design vehicles (e.g. buses, trucks, cars).
- Central islands: To Austroads AGRD04B Table 4.1 with a size sufficient only to give drivers guidance on the manoeuvres expected.
- Deflection of traffic to the left on entry: To promote gyratory movement.
- Adequate deflection of crossing movements to ensure low traffic speeds.
- A simple, clear and conspicuous layout.
- Design so that the speed of all vehicles approaching the intersection will be less than 50 km/h.
- Landscape and street furniture: To Austroads AGRD04B Section 8.3.

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

3.13 TRAFFIC CALMING

General

Local Area Traffic Management (LATM) Scheme may be required as a condition of development consent and / or results from road safety audit report. Alternatively, applicants may be required to design and install these devices where appropriate by Council's engineer.

The location and design details of LATM Scheme shall be shown on the engineering construction plans and approved by the Shellharbour Local Traffic Committee.

Design criteria: Calming devices (e.g. thresholds, slow points, speed humps, chicanes and splitter islands) to AS 1742.13 and Austroads AGTM08.

LATM Type: Select the type of local area traffic management devices from Austroads AGTM08 Table 7.1.

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

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

Critical dimensions.

Dimensions: Conform to the following:

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

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

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

Bus routes

Criteria: Conform to the following:

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

Bus route criteria table

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

3.14 SIGNAGE AND PAVEMENT MARKINGS

All proposed signage and pavement markings shall be designed to conform *AS1742 Manual of Uniform Traffic Control Devices*, *AS1906 Retro-reflective Materials and Devices for Road Traffic Control Purposes*, Austroads, RMS and Council's requirements and shown on the engineering construction plans. This include signposting design for cycleways and shared pathways.

Street name signs shall be designed in accordance with Council Standard Drawings and shall be erected at all street intersections. The street name, house numbers and colour of sign are to be ascertained from Council and the sign location is to be shown on the Engineering Drawings.

All signage shall have anti-graffiti coated surface.

3.15 ROAD CROSSINGS

All conduit trenches shall be at a grade of not less than one (1) percent and shall be clearly located on relevant engineering construction plans.

3.16 PARTIAL ROAD WIDTH CONSTRUCTION

The provision of half road constructions is discouraged and significantly influenced by site specifics, development staging/layout and funding considerations. To be able to consider any combination of these influences within a single approach in dealing with half road constructions is prohibitive. Therefore, Council does not encourage the construction of half width roads as part of subdivision developments.

In situations where site specifics and development staging/layout necessitate that pavement construction be carried out, the applicant will cover all costs associated with the design of the design and construction of the full road width excluding the drainage and parking lane infrastructure requirements adjacent site.

Where partial road construction is necessitated an AC pavement will be provided to a minimum distance of 1 metre past the carriageway edge line (opposite the site) with a suitable shoulder width of 2.5m to allow vehicle to stop and remain clear of the carriageway.

3.17 STAGED ROAD CONSTRUCTION

Where roads are constructed in stages of a subdivision, a temporary single coat flush sealed turning area suitable for 12.5m long heavy rigid vehicles and a permanent type barricade shall be designed and constructed at the end of that stage to warn motorists of the dead-end and prevent their passage beyond.

The temporary turning area shall be constructed entirely within the subject land.

The permanent type barricades shall be made of guide posts with eye reflectors. The distance between two guide posts should be less than two (2) metres. Adequate sight distance to the barricade shall be provided. The barricades shall be removed only upon completion of the adjoining stage.

The engineering construction plans submitted to Council shall show the details of temporary turning area and permanent type barricades.

3.18 STREET LIGHTING

The Lighting of residential roads and public places must comply with AS/NZS1158 Lighting for Roads and Public Places. Where possible energy efficient LED luminaires must be used.

To address public safety from a criminal standpoint street lighting must be assessed using the NSW Police 'Safer by Design' or Crime Prevention through Environmental Design (CPTED) principles and protocols. The development proposal must demonstrate how public safety and risk will be managed.

The lighting of subdivisions must comply with the following:

- For residential roads in areas having underground reticulation of electricity the minimum lighting category should be P4; this implies utilizing columns at about 55-metre spacings;
- For sub-arterial or principal roads which connect arterial or main roads to areas of development within a region, or which carry traffic directly from one part of a region to another part the minimum lighting requirement should be either V5 or P3 and in accordance with the standard; and
- Compliance with Endeavour Energy document 'General Terms & Conditions for the Connection of Public Lighting Assets'.
- The determination of lighting category's for roads will be at the discretion of Council and applied generally in accordance with AS 1158.

The appropriate levels for street lighting need to be identified by Council's Manager Subdivision Development. In order for this to be identified, proposed schemes showing the limits of the proposed works showing proposed traffic management devices and other relevant information be forwarded to Council's Traffic Investigation Unit so that an accurate assessment can be undertaken to ensure compliance with Council's Street Lighting Guidelines and Australian Standard AS/NZS 1158 in its various parts. The appropriate street lighting categories will be forwarded to the applicant by way of a Design Brief Checklist to enable street lighting designs to be prepared for Council's approval and acceptance.

To further assist the designer, designs should also be prepared in line with Endeavour Energy document SPJ 4004 Network Connections Contestable Works General Terms and Conditions Section 6 - Public Lighting Assets.

Where street lighting is to be provided within the central median islands, barrier kerb is to be provided.

Public Domain Lighting must consider sustainable options.

4 DOCUMENTATION

4.1 GENERAL

Design process

Design development process: Develop a flow chart to capture the design process, include processes such as the brief and scope development, investigative studies and analyses, consultation, selection of design parameters/design inputs, design reviews, major design decisions made or design outputs, approvals and critical dates.

Design review, verification and validation: Provide design documentation to Austroads AGRD08.

Related design documentation requirements

Drainage and run-off: To the *0074 Stormwater drainage (Design)* and *0043 Subsurface drainage (Design)* work-sections.

Earthworks, contours, cut and fill: To the *0021 Site regrading* work-section.

Footpaths, pathways and cycleways: To the *0044 Pathways and cycleways (Design)* work-section.

Pavement structure: To *0042 Pavement design* work-section.

Approvals

Requirement: Document any prerequisite for approval of the development advised by the following authorities:

- Council for:
  - . Construction staging and traffic management.
  - . Landscaping and verge design.
  - . Access provisions.
  - . Tree protection and vegetation clearing.
  - . Stormwater drainage control.
- Planning and water resources department: For general land use, salination prevention measures, existing water bodies that may be affected, and areas of heritage significance.
- The EPA: For other general environmental impact requirements.
- Utilities authority: For any public or private utility affected by the development.
- Rail transport authority: For crossings and rail conflicts.

Authority audits: Include first party, external or third-party audits, for design process or design products, required by the relevant authority.

4.2 DRAWINGS

Drawing sheets

Requirement: Provide separate sheets for the following:

- Cover.
- Key/locality plan and legend.

- Plans: extents of roads to be named including the proposed datum point, general intersection configuration and any proposed one-way streets
- Longitudinal sections.
- Cross-sections.
- Structural details.
- Standard drawings.

Minimum requirements: Complete the relevant checklist in Annexure B of the *0010 Quality requirements for design* work-section for the development. Make sure required items are included in the design documentation.

Drawing presentation

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

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

Drawing scales: Conform to the following:

- Plans:
  . Generally: Minimum 1:500.
  . Rural plans: Minimum 1:1000.
- Longitudinal sections:
  . Horizontal: Minimum 1:500.
  . Vertical: Minimum 1:100.
- Cross-sections: 1:100.

Requirement: Provide the following drawings, describing the geometric road layout for the development:

- Survey(s): Showing contours, original and proposed terrain, locations of existing and new roads. If required, include finished grades on a digital terrain model.
- Plans: Showing alignments of existing and new roads, access treatments, drainage structures, edges of pavement, roadside barriers and flares, clearing and grubbing limits, critical dimensions, cut/fill toes, utility conflicts, objects/items that are to be relocated or removed, fencing, and limits of construction.
- Ground profiles: Showing proposed grades, vertical curve data, horizontal alignment schematic, superelevation, existing and proposed culvert locations, surcharge and preload areas, and original ground profile.
- Typical sections drawings: Showing lane and shoulder widths, clear zone requirements, excavation and embankment slopes, stripping, and special treatments.
- Lane and geometrics (vertical and horizontal): Showing access movements, intersection movements, design vehicles (and turning templates), design speed, approaches and transitions, vertical clearances, and critical lane dimensions.
- Signing and pavement marking drawings: Showing new sign locations, schedule of signs required, sign removals and relocations.
- Construction staging drawings: Showing detours if required, any required cross-sections.
- Utility relocation drawings.
- Landscaping drawings: Showing verge treatments.
- Environmental drawings: Showing sensitive zones, limits and setbacks from environmental features.
- Supporting design documents.

Supporting design documents

Design reports

Requirement: Provide a report including the following:

- Geotechnical field data.
- Noise studies.
- Environmental and archaeological studies.
- Development connectivity: Include details of links and place functions.
- Strategies for achieving target operating speeds.

Environmental impact statement: Include details of potential impacts and measures adopted for minimising the impact.

Design calculations

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

Assumptions: Include any data used in the design calculation.

Specifications

Construction documentation: Prepare technical specifications using the AUS-SPEC Construction work-section *Templates* from the National Classification System workgroups 02, 03, 11, 13.

Design certification

Certificate: Provide a signed and dated design certificate as evidence that a suitably qualified professional has reviewed all the design documents, including program and plans for the development, and can verify that the geometric road layout requirements for the development meet the Council and statutory requirements.

4.3 WORK-AS-EXECUTED

Work-as-executed documents

Work-as-executed drawings: Provide an additional set of final construction drawings for the purpose of recording the work completed by the Contractor in accordance with the ADAC specification, which is available on Council's website.

5 ANNEXURE

5.1 ANNEXURE - REFERENCED DOCUMENTS

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

AS 1742		Manual of uniform traffic control devices
AS 1742.13	2009	Local area traffic management
AS 2890		Parking facilities
AS/NZS 2890.1	2004	Off-street car parking
AS/NZS 2890.2	2002	Off-street commercial vehicle facilities
AS 2890.5	1993	On-street car parking
AS/NZS 2890.6	2009	Off-street parking for people with disabilities
AS/NZS 3845		Road safety barrier systems and devices
AS/NZS 3845.1	2015	Road safety barrier systems
AS/NZS 4819	2011	Rural and urban addressing'
Austroads AGRTP	2009	Guide to road transport planning
Austroads AGRD		Guide to road design
Austroads AGRD01	2015	Introduction to road design
Austroads AGRD02	2015	Design Considerations
Austroads AGRD03	2016	Geometric design

Austroads AGRD04	2017	Intersections and crossings - General
Austroads AGRD04A	2017	Unsignalised and signalised intersections
Austroads AGRD04B	2015	Roundabouts
Austroads AGRD06A	2017	Paths for walking and cycling
Austroads AGRD06	2010	Roadside design, safety and barriers
Austroads AGRD06B	2015	Roadside environment
Austroads AGRD07	2008	Geotechnical investigation and design
Austroads AGRD08	2009	Process and documentation
Austroads AGTM		Guide to traffic management
Austroads AGTM03	2017	Traffic studies and analysis
Austroads AGTM04	2016	Network management
Austroads AGTM05	2017	Road management
Austroads AGTM06	2017	Intersections, interchanges and crossings
Austroads AGTM07	2009	Traffic management in activity centres
Austroads AGTM08	2016	Local area traffic management
Austroads AGTM11	2017	Parking
Austroads AGTM12	2016	Traffic impacts of developments
Austroads AP-C87	2015	Austroads glossary of terms. 2015 edition.
Austroads AP-G34	2006	Austroads design vehicles and turning path templates (Includes CD)
AUS Gov Act No. 135	1992	Disability Discrimination Act
SOCC Guide	2009	Guide to codes and practices for streets opening
Geographical Names Board (NSW)		NSW addressing user manual
Australian Design Vehicles and Turning Path Templates Guide	2013	

0042 PAVEMENT DESIGN

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide design and documentation for pavement and surfacing materials; including types, layer thicknesses and configurations; so that the pavement performs to its designed functions and requires minimal maintenance under the anticipated traffic loading for the required design life.

1.2 CROSS REFERENCES

General

Requirement: This is not a self-contained work-section, conform to the following work-section(s):

- *0010 Quality requirements for design*.
- *0043 Subsurface drainage (Design)*.
- *IPWEA Greenspec – Specification for Supply of Recycled Material*

1.3 STANDARDS

General

Road design: To Austroads AGRD01 and Austroads AGRD02.

Design considerations: To Austroads AGRD02 Table 3.1.

Pavement structural design: To Austroads AGPT02.

1.4 INTERPRETATION

Abbreviations

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

- CBR: California bearing ratio.
- DCP: Dynamic Cone Penetrometer.
- ESA: Equivalent standard axle.
- HVAG: Heavy vehicle axle group.
- HV: Heavy vehicle.

Definitions

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

- Asphalt: A mixture of bituminous binder and aggregate with or without mineral filler, produced hot in a mixing plant, which is delivered, spread and compacted while hot.
- Asphalt pavement: A pavement, the predominant structural strength of which is provided by asphalt layers.
- Bound granular materials: Granular or subgrade materials to which a binder has been added to improve structural stiffness.
- Flexible pavement: A pavement which obtains its load-spreading properties from intergranular pressure, mechanical interlock and cohesion between the particles of the pavement material.
- Granular materials: Granular materials with no significant capacity to resist tensile stresses.
- Initial seal: An application of a sprayed seal to a prepared basecourse which has not been primed. It is intended to adhere to the base, whilst providing a temporary wearing course for traffic.
- Modified granular material: Granular materials to which small amounts of stabilising agent have been added to improve their performance without causing a significant increase in structural stiffness.
- New pavement: A combination of a base and surface course placed on a subgrade to support the traffic load and distribute it to the road bed for flexible pavements or rigid pavements.

- Oxidation of bitumen: A binder which becomes hard and brittle as a result of chemical attack by oxygen in the presence of heat and sunlight.
- Reconstruction: Treatments requiring full removal and replacement and/or improvement of the existing pavement structure including subbase, base course, and surface course.
- Rehabilitation: Resurfacing, stabilisation, restoration and rehabilitation work undertaken to restore serviceability and to extend the service life of an existing road. This may include partial recycling of the existing pavement, placement of additional surface materials, or other work required to return an existing pavement, including shoulders, to a condition of improved structural or functional adequacy.
- Reliability: The reliability of the pavement design performance process is the probability that a pavement section designed using the process will perform satisfactorily over the traffic and environmental conditions for the design period (life), that it will outlast its design traffic before major rehabilitation is required.
- Rigid pavements: A pavement composed of concrete or having a concrete base course.
- Seals:
  . Double/double: Two applications of binder and two applications of aggregate.
  . Single/single: A single application of binder and a single application of aggregate.

Edit the **Definitions** subclause to suit the project or delete if not required. List alphabetically.

2 PRE-DESIGN PLANNING

2.1 GENERAL

Data collection

Requirement: Determine the scope and data collection methods required based on the following:

- Whether pavement design is for new or existing pavement(s) and whether rehabilitation, reconstruction or construction of new pavement is required.
- Whether design decisions are required at the network or project level.
  . Network level: Requires information to manage the road system and make long term decisions for the pavement.
  . Project level: Requires site specific information to determine materials and economic requirements and develop construction plan and specification.

Field testing: Identify the field testing/materials sampling requirements for each road segment and the associated traffic management requirements.

Site investigation: Assess climate, topography, land use, drainage, hazards, road geometry and any future changes for the site environment.

2.2 EXISTING PAVEMENT CONDITION EVALUATION

Data collection

Requirement: Collect the following information for pavements requiring rehabilitation, to assess the existing pavement condition and the rehabilitation actions required:

- Traffic lane pavement condition (e.g. distress, smoothness, surface friction, and deflections).
- Shoulder pavement condition.
- Past maintenance activities.
- Pavement design features (e.g. layer thicknesses, shoulder type, joint spacing, and lane width).
- Geometric design features.
- Layer material and subgrade soil properties.
- Traffic volumes and loadings.
- Climatic conditions.
- Other miscellaneous factors (e.g. utilities and clearances).

Condition assessment

Data collection and assessment methods: Assess pavement condition as appropriate for the development, including through the following methods:

- Information from records: Gather information from records and as-constructed documents to provide information on the pavement history (including maintenance history and original design input data such as soil properties, climatic conditions, and traffic input) and features.
- Pavement condition/distress survey: Identify the following through detailed visual inspection(s):
  . Distress type: e.g. ravelling, bleeding, rutting, roughness and skid resistance.
  . Distress/condition grading: The level of distress severity, the degree of deterioration for each distress type.
  . Distress amount: The relative area (percentage of the project) affected by each combination of distress type and severity.
- In depth field investigation: If required, after gathering information from records and carrying out a distress survey on pavements affected, carry out in depth field investigations to determine the cause of distress for determining rehabilitation strategies. This may include detailed measuring and testing, such as coring and sampling, smoothness measurement, deflection testing, skid resistance measurement, drainage tests, and measuring vertical clearances on the project under evaluation. Pavement properties to measure include the following:
  . Structural adequacy, pavement strength evaluation.
  . Functional adequacy including foundation movement.
  . Surface and subsurface drainage adequacy.
  . Material durability.
  . Shoulder condition.
  . Variation of pavement condition.
  . Surface, base and subgrade condition.
  . Surface and subsurface drainage review.

2.3 ROAD ASSESSMENT FOR THE DESIGN OF NEW PAVEMENTS

Data collection

Requirement: Collect information for determining design requirements for new pavements as follows:

- Soil investigation to establish soil properties and characteristics to be used in the pavement design such as soil strength, applicable modulus (stiffness) and matrix stability.
- Site factors that affect the pavement structure or adjacent works.

Soil survey investigation

Requirement: Obtain clearances from landowners and authorities (including utility authorities) to access site locations for sampling and testing to determine the following:

- Soil type/classification across the road bed alignment.
- Estimation of characteristics and properties of soils.
- Estimated soil characteristics and properties, and potential geometric road layout to predict problematic areas, materials and conditions.
- Establish a testing plan for the road bed soils.
- Establish geotechnical lab testing of existing licensed Council or private quarries including basalt quarries.
- Use seismic testing to determine depths and extent of suitable gravel and ease of mining rippability with a D8 dozer. (Hardness above D8 rippability requires drilling and blasting).

Site factors

Requirement: Carry out reconnaissance of areas that affect the proposed pavement structure or adjacent works to determine the following:

- Physical layout and alignment: Assess geometrics and terrain features to determine drainage characteristics, side slope stability and cut/fill requirements, and terrain steepness that may contribute to shrinkage cracking.
- Hydrology: Identify water sources to determine drainage conditions and patterns.
- Topography: Assess development site topography to determine cut/fill, stability and drainage requirements.
- Vegetation: Identify vegetation close to the roadway edge where mitigation measures for shrinkage cracking may be required.
- Geology: Identify soil minerology, presence of rock, potential for sulphur acid soils and evaluate general support potential from surface survey(s).

Other factors

Requirement: Collect the following design input data:

- Traffic volume.
- Traffic operating speed.
- Historical performance of previous designs and construction.
- Road functional classification.
- Project budget.

2.4 CONSULTATION

Council and other authorities

Council consultation: Before starting design, liaise with the Council's officer(s) for the following:

- Roadway layout and traffic management.
- Council's transport policy.
- Stormwater and subsurface drainage.
- Landscaping.

Other authorities: Consult with and seek approval for the development from the following government authorities:

- State roads authority.
- State and local planning authorities.
- State and federal environmental agencies.
- Rail authorities if the proposed project crosses the rail network.
- Regional catchment management authority.
- Water authorities.
- Other utility authorities.

Public consultation

Requirements: Consider consultation with the community and the following stakeholders:

- Affected and adjoining landowners.
- Road users.

Utilities services plans

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

Development design team

Integrated development planning: Liaise with members of the development design team preparing the design of the following:

- Layouts of lots, roads, cycleways and pedestrian pathways.
- Stormwater and subsurface drainage systems.

- Services installations.

Rehabilitation pavement design: Coordinate between the design, construction and maintenance engineers to reinforce the design intent and provide feedback on project constructability, maintainability and performance.

3 GENERAL DESIGN CRITERIA

3.1 GENERAL

Design objective

Requirement: Design pavement structure to meet the following:

- Required design life and traffic loading.
- Maximum economic value, safety and serviceability requirements over the pavement design life.
- Adequate for its load carrying capacity.
- Appropriate to subgrade strength, climatic conditions and environmental factors.
- Materials for the subgrade, subbase, base and wearing surface.
- Have minimal deterioration over pavement design life.
- Have minimal disruption to the adjoining land use.
- Fit into the built environment visually.

Pavement rehabilitation and reconstruction: Develop design options to repair existing pavement distress and prevent future problems.

Noise control: Integrate control measures in the development design.

Light traffic roads or minor roads: Consider that in comparison to roads with other traffic loadings, light traffic roads:

- Are more susceptible to the effects of the environment.
- Have higher variation in subgrade and moisture conditions.
- Have lower traffic speeds in urban locations.
- Are more susceptible to significant pavement damage resulting from a small number of passages of heavily overloaded vehicles.

3.2 REHABILITATION PAVEMENT DESIGN

Project evaluation

Pavement condition assessment: After carrying out data collection to **PLANNING**, **Existing Pavement condition evaluation** to establish the condition of the in-place pavement, evaluate feasible options for repairing the existing distress to maintain pavement service life and prevent the premature reoccurrence of the distress.

Pavement evaluation and treatment design: Conform to Austroads AGPT05 for investigation of existing sealed road pavements and design of pavement treatment.

Project analysis

Engineering and economic analysis of strategies: Conduct analysis of the feasible options as follows:

- Engineering analysis: Consider present and future traffic loads, climate, testing of local pit gravels blended with basalt gravels to achieve required strength and plasticity for pavement materials. Check a range of geotechnical test criteria required for bitumen surface sealing.
- Examine local gravel with opposite characteristics with a view to getting blended gravel with a high MDD density and high CBR%. With these blend test with the adding of small amounts of stabilents such as lime to see if high CBR% and low plasticity Index can be manufactured with cheap local materials.

- Examine as another option a local gravel blended with a small % say 20 to 30% of commercial basalt quarry by product such as DG20 or DGS30. Use the same testing as the two local gravels abovementioned with the same objectives.
- Economic analysis: Based on life cycle costs, consider service life, initial capital cost, maintenance costs, user costs, and future rehabilitation requirements, including traffic management.

Option selection for design implementation: Select the rehabilitation option that best meets the project based on economics, budget constraints, traffic service, climate, and engineering requirements.

3.3 DESIGN OF NEW PAVEMENTS

Pavement design procedure

Design variables: After carrying out data collection to **PRE-DESIGN PLANNING**, **Road assessment for the design of new pavements** to define design criteria for acceptable pavement performance, design pavement as follows:

- Determine the design input variables and carry out subgrade evaluation.
- Pavement type: Select pavement type based on the design variables and subgrade evaluation for the pavement performance required. Determine material properties and properties for the structural design.
- Surfacing (wearing course) treatment: Select treatment based on required skid resistance, traffic abrasion, and site climatic conditions (and its effect on surface disintegration).
- Pavement thickness: Determine the thicknesses of subbase, base and surface course for the performance required.
- Shoulder design: To *0041 Geometric road design*.
- Drainage design: To *0074 Stormwater drainage (Design)* and *0043 Subsurface drainage (Design)*.

3.4 DESIGN INPUTS

Project scope and project base design factors

Scope: Determine the extent of pavement design required for the development for the project, budget and project delivery timeline.

Project design factors: Determine the following base criteria of pavement design for the development:

- Project objectives: Level of service, project reliability, pavement design life, structural capacity, and level of maintenance and rehabilitation.
- Usage: Required levels of usage, including traffic volume, traffic loading, future trends and functional road classification to Austroads AGRD02 Table 2.2 and Table 2.3.
- Environment constraints: Planning regulations, use of recycled materials, air, noise, water pollution, erosion and sediment control.
- Safety: Levels of service required including skid resistance, ride quality, road geometry and visibility in wet and dry conditions.
- Pavement properties required: Required functional and structural performance, pavement type, composition and future maintenance practices.

Development/precinct design factors: Consider the following development related issues when designing the road pavement:

- Land use and zoning areas.
- Transport and community needs.
- Re-use of heritage infrastructure items.
- Protection of sites with aboriginal heritage significance.
- Road hierarchies based on different speed and functional requirements.

Design input variables

Pavement design influencing factors: Consider the following input variables for urban and rural roads:

- Design traffic.
- Project reliability.
- Subgrade and pavement material.
- Construction and maintenance considerations: To Austroads AGPT02 Section 3.
- Environment: To Austroads AGPT02 Section 4 including climatic conditions.

3.5 DESIGN TRAFFIC

Traffic loading

Standards: To Austroads AGPT02 Sections 7 and 12.

Requirement: Design road pavement so that the pavement width and geometry allows vehicles to operate safely at an acceptable speed. Make sure the pavement strength is suitable for the heaviest of the design vehicles and is able to withstand the cumulative effects of the passage of all vehicles.

Traffic data

Pavement design: Include all traffic data and assumptions for calculating design traffic. Consider traffic loading beyond the width of the trafficked lanes.

Minimum pavement design life (period)

General method: Determine the design life to suit the design traffic conditions, as appropriate for the road pavement, to function without major rehabilitation or reconstruction, based on the following minimum design life for the pavement type:

- Flexible, unbound granular: 40 years.
- Flexible, containing one or more bound layers: 40 years.
- Rigid (concrete): 40 years.
- Segmental paving: 30 years.

Factors to consider: Consider the following when determining pavement design life:

- Importance of the road.
- Likelihood of a future realignment.
- Likelihood that major future upgrading will be required to improve the road capacity.
- Likelihood that factors other than traffic such as reactive subgrades, consolidation of imported fills or compressible soil strata will cause distress requiring major rehabilitation or reconstruction.
- Likelihood of existing fixed levels of kerb and gutter, clearance under overhead structures constraining the selection of rehabilitation treatments.

Equivalent standard axles (ESA)

Requirement: Calculate design traffic in equivalent standard axles (ESAs) for the design life of the pavement. Take into account the present and predicted commercial traffic volumes, axle loadings and configurations, commercial traffic growth and street capacity.

Predicted volume: Use the cumulative growth factor (CGF) from Austroads AGPT02 Table 7.4, based on the annual growth rate and design period for future traffic growth provisions.

Interlocking concrete segmental paving: For design traffic up to 10^6 ESA, replace ESA's with the number of commercial vehicles exceeding 3 tonne gross to CMAA PA02. For higher traffic volume, calculate ESAs for the development.

Design traffic volumes

HVAG volumes for lightly trafficked urban streets: To Austroads AGPT02 Table 12.2.

ESA for non-urban streets: To **Design ESA's 40-year design life table**.

Design ESA's 40-year design life table

Street type	Design ESA's – 40-year design life
Rural residential	3×10^5
Commercial and industrial	5×10^6

Additional requirements

Additional traffic allowance: Calculate and assess the following:

- Proportion of heavy vehicle traffic generated by waste collection and subdivision development construction.
- Heavy vehicle load factors incorporating average number of HVAG per HV and average number of ESA per HVAG for flexible pavements.

3.6 PROJECT RELIABILITY

Desired project reliability levels table

Road type	Project reliability
Access lane	90%
Access place	90%
Access street	90%
Connector street	90%
Arterial road	95%

3.7 CONSTRUCTION AND MAINTENANCE

Considerations

Construction and maintenance factors: Consider the following for the pavement type, base and subbase materials, and the wearing surfacing required:

- Extent and type of drainage: To the *0074 Stormwater drainage (Design)* and *0043 Subsurface drainage (Design)* work-sections. Also consider pavement base and subgrade material selection for permeability.
- Surfacing type.
- Use of boxed or full width construction: Where pavement materials are expensive or wide verges and flat batters are used, it may be more economical to adopt boxed instead of full width construction. If boxed construction is required, provide measures to prevent excessive moisture collecting in the pavement during its service life.
- Equipment available to the contractor: Make sure the pavement type selected is compatible with the available equipment.
- Use of staged construction: If required, consider fatigue cracking which may occur with bound layers and whole of life costs.
- Use of stabilisation: If required (e.g. to provide a working platform), allow for subgrade material with CBR value of 15% minimum.
- Pavement layering considerations: To reduce the chances of rutting in heavily trafficked asphalt surfaced pavements.
- Transverse variations in pavement design.
- Use of Strain Alleviating Membrane Interlayers (SAMIs): To reduce reflective cracking.
- Aesthetic, environmental and safety requirements: Consider issues such as skid resistance, noise, wheel spray and night-time visibility when selecting surfacing type.
- Social considerations: In heavily trafficked areas or for roads adjacent to commercial developments, rapid forms of construction may be required. This may affect pavement type and wearing surface selection, especially if pavements are used by pedestrians and cyclists, e.g. in terms of texture and colour.
- Construction under traffic: If required, select pavement types requiring deep excavations or long curing periods.

- Maintenance strategy: Consider traffic loading, future hazards and costs associated with future maintenance, e.g. to minimise disruption. For urban pavements, consider constraints on future overlays, e.g. due to kerbing levels.
- Acceptable risk: Consider design parameters appropriate for the road function and issues which may be encountered during construction.

3.8 ENVIRONMENT

Environmental considerations

Requirement: Consider environmental factors that affect the pavement performance (subgrade strength, pavement type and surfacing material selection) the effect of pavement design on the environment (water quality, air quality, flora, fauna, soil contamination, noise attenuation).

Moisture and temperature considerations

General: Consider moisture and temperature related factors that affect pavement performance, including freeze/thaw conditions.

Moisture related factors: To Austroads AGPT02 clause 4.2. Coordinate pavement design with the stormwater and subsurface drainage design for the development.

Temperature related factors: To Austroads AGPT02 clause 4.2.

- Oxidation of bitumen seals: Consider the oxidation effect of bitumen binder when exposed to air, heat and sunlight, that is it becomes hard and brittle. This process is accelerated by high temperatures and sunlight which leads to cracking of surface seals and asphalt surfaces.

Specific location effects considerations

Pavement selection: Consider the environmental effects on pavement performance in the following areas:

- Mine subsidence.
- Bushfire heat in bushfire prone areas.

4 SUBGRADE AND PAVEMENT MATERIAL DESIGN CRITERIA

4.1 SUBGRADE EVALUATION

Design considerations

Subgrade support design: Consider the following factors:

- Sequence of earthworks construction.
- The compaction moisture content and field density required for construction.
- Moisture changes during service life.
- Susceptibility to flooding.
- Subgrade variability.
- Do more DCP testing at closer intervals where variability occurs.
- The presence of weak layers below the subgrade design level.
- Stabilisation requirements.
- Dispersive soils.
- Plasticity parameters.
- Swell characteristics.
- Salinity.

Management of exposed dispersive soils

Dispersive soils: Consider the following:

- These soils are very susceptible to most forms of erosion, including raindrop impact, gully, and stream bank erosion.
- They are responsible for most of the turbidity in our local waterways.
- They can have low fertility and poor soil structure which reduces the ability to re-establish vegetation following disturbances.
- Wherever possible, avoid disturbance of dispersive soils. If this is not possible, consider the following management options:
  . Keep topsoil separate from subsoil when excavating.
  . Consider lime stabilisation.
  . Runoff management.
  . Revegetation.

Design approach

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

Mechanistic design approach: If adopted using the linear elastic theory for flexible pavements, the subgrade support measurement is based on the elastic parameters (modulus, Poisson's ratio).

Design CBR

Design CBR value: For the design, determine a subgrade CBR value at the density and moisture conditions which are expected to prevail in-service for each identifiable unit, defined by topography, drainage and soil type. CBR values can be gained from either field testing or laboratory testing. It is important that clay subgrades are compacted to the required density at moisture contents consistent with the moisture levels likely in the finished road. It is desirable that the selected subbase cover gravel is an impervious material to protect the clay subgrade from undesirable moisture incursions and variations causing strength loss and subgrade pavement failure causing potholes. See Austroads AGPT02 Figure 5.1 for an example of variation of CBR with dry density(t/m^3) for a clayey sand comparing moulding moisture content (%).

Subsurface drainage: If subsurface drainage is not proposed, allow for a CBR value with greater variability in subgrade moisture content during the pavement service life, that is a design moisture content above the optimum moisture content.

Calculation of design CBR

Methods of calculating CBR: Determine the CBR value based on either of the following methods:

- Field testing: To Austroads AGPT02 clause 5.5 where the support values from the in-situ subgrade soil conditions are expected to be similar to those of the proposed pavement.
- Laboratory testing: To Austroads AGPT02 clause 5.6 when subgrade support is to be determined from first principles.

If no information is available: Adopt the presumptive values for lightly trafficked roads to Austroads AGPT02 Table 5.4.

Summary of results

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

4.2 PAVEMENT TYPES

Pavement selection

Requirement: Select the most appropriate pavement type based on the road functional classification, estimated traffic volume, availability of materials and the site environmental properties.

Types of pavements

Pavement types: To Austroads AGPT01.

- Flexible pavements: Select from the following:
  . Granular pavements with sprayed seal surfacing.
  . Cemented granular bases with sprayed seal surfacing.
  . Granular pavements with thin asphalt surfacing.
  . Asphalt over granular pavements.
- Rigid pavement types: Select from the following:
  . Plain (jointed unreinforced) concrete pavements.
  . Jointed reinforced concrete pavements.
  . Continuously reinforced concrete pavements (CRCP).
  . Steel fibre reinforced concrete pavements.
- Concrete or clay segmental pavements
- Unsealed pavements.

4.3 REHABILITATION PAVEMENT DESIGN

Pavement evaluation and treatment design

Existing pavement: Conform to Austroads AGPT05 for existing sealed road pavements investigation and pavement treatment design requirements.

4.4 PAVEMENT MATERIALS

Pavement material types

Pavement materials: Select the pavement material to meet pavement performance required under the applied loadings.

Flexible pavement materials: Select from the following:

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

Rigid pavement materials: To Austroads AGPT04C.

Unsealed roads: To Austroads AGPT06.

Materials

Pavement materials characteristics: To Austroads AGPT02 Table 6.1.

Material types: Select from the following:

- Unbound granular: Crushed rock, natural gravel, soil aggregate and granular stabilised materials.
- Modified granular: Bitumen stabilised, chemically modified, Cement, lime, lime/fly ash or slag-modified materials.
- Cemented: Lime stabilised, Cement stabilised, Lime/fly ash stabilised, Slag-stabilised, Slag/lime stabilised.
- Asphalt.
- Concrete.

Blending of locally available materials: To TECHreport TR08.

Local pit gravels are no longer fit for purpose: Due to a lack of funds Councils are persevering with gravels that are no longer fit for purpose. The materials used are redundant without a range of stabilisation options, including better geotechnical testing and optimum density and CBR matching research with mechanical gravel blending and quality construction control.

Ideal objective: The aim is to build and maintain the roads for lower whole of life costs rather than focus on initial gravel costs. This has to be achieved with blending of local pit gravels with different

grading characteristics with a view to achieving a higher optimum density, higher CBR and complying Plasticity Index (PI). Ideally creation of an impermeable gravel is better for increased whole of life costs and lower maintenance costs.

There is a need to conserve natural aggregates and to use recycled concrete, bricks, tiles and asphalt to reduce the amounts of these materials going to landfill. This can be achieved by incorporating the use of these materials into new civil works and subdivision design.

Council can accept RMS compliant material at their discretion.

GreenSpec

the Institute of Public Works Engineering Australia (IPWEA) in conjunction with the EPA in 2010 released Specification for the Supply of Recycled Material, commonly referred to as Greenspec. The document provides a specification for the supply of recycled materials, primarily crushed concrete, brick and reclaimed asphalt.

Recycled materials can be used for the following uses;

- Road Base (Class R1/Class R2);
- Select fill (Class S) for use on subgrades to enhance strength or for raising site levels beneath paved surfaces and buildings;
- Bedding Material (Class B);
- Drainage Medium (Class D10/Class D20/Class D75);

Recycled materials must conform to the IPWEA Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage (2010).

The Supplier of recycled materials used in subdivisions must provide test certificates from a National Association of Testing Authority (NATA) accredited laboratory confirming that the material complies with the appropriate standards as outlined in the IPWEA Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage (2010).

EPA Resource Recovery Exemptions and Orders

The NSW EPA provides a list of current resource recovery orders (orders) and resource recovery exemptions (exemptions) in force in NSW for commonly recovered and reused wastes including;

- Reclaimed Asphalt Pavement;
- Recovered Aggregate;
- Recovered Glass Sand

Contractors can use an order and exemption without EPA approval however, all conditions of an order and exemption must be met for the reuse of recycled materials to be lawful.

Reclaimed Asphalt Pavement

Reclaimed Asphalt Pavement Material used should comply with Roads and Maritime Services (RMS) QA Specification 3153.

New subdivision should ensure infrastructure is in place to install solar charging stations for electric vehicles in (shopping centre carpark/public carparks).

4.5 PAVEMENT THICKNESS

Minimum pavement thickness

Requirement: Select pavement thickness and composition that is most economical for the required level of service for the anticipated traffic.

Pavement thickness (including surfacing): Conform to the following:

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

Final thickness of subbase and base layers: Conform to the following:

- Flexible pavement: Subbase 100 mm, base 100 mm.
- Rigid pavement: Subbase 100 mm, base 150 mm.
- AC to be minimum 50mm for roads and 100mm for roundabouts.

Subbase extent

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

Base extent

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

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

Un-kerbed roads: Extend the subbase and base layers at least to the required shoulder width.

Carparks

Load concentrations: Make provisions for areas likely to have traffic concentrations (and consequently load concentrations) within the carpark area (e.g. entrances/exits and at ramps).

Drainage

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

4.6 DESIGN TRAFFIC AND PAVEMENT THICKNESS

Unbound granular flexible pavements – bituminous surfaced

Pavement material: Unbound granular flexible pavements with thin bituminous surfacing, including those with cement or lime modified granular materials.

Pavement thickness: Allow for the pavement thicknesses as follows:

- Design traffic up to 10^6 ESAs: To Austroads AGPT02 Figure 12.2. Chart for low order traffic with Design traffic ESA against selected subgrade CBR giving output of total pavement thickness in mm.
- Design traffic above 10^6 ESAs: To Austroads AGPT02 Figure 8.4 Chart with high order traffic Design traffic ESA against selected subgrade CBR giving output of total pavement thickness in mm.

Flexible pavements containing bound layers – bituminous surfaced

Pavement material: Flexible pavements containing one or more bound layers, including cement stabilised layers or asphalt layers other than thin asphalt surfacing.

Pavement thickness: Use software designed for this purpose.

Rigid pavements

Pavement material: Rigid concrete pavements.

Pavement thickness: Allow for the pavement thicknesses as follows:

- Design traffic up to 10^6 ESAs: To CCAA T51, Austroads AGPT02 clauses 12.9.3 and 12.9.4, or use software designed for this purpose.
- Design traffic above 10^6 ESAs: To Austroads AGPT02 clause 9.4 or use software designed for this purpose.

Concrete segmental paving

Pavement material: Concrete segmental paving with various base courses including bound and unbound granular material.

Pavement thickness: To CMAA PA02 for design traffic up to 10^6 estimated commercial vehicles exceeding 3 T gross.

Clay segmental paving

Pavement material: Clay segmental paving with various base courses including bound and unbound granular material.

Pavement thickness: To *Think Brick Manual 01* for design traffic up to 10^6 ESAs.

5 SURFACING DESIGN

5.1 SURFACING TYPES AND PROPERTIES

Surfacing classification

Surfacing materials: Select from the following wearing surface material to meet surface characteristics and performance required for the road:

- Sprayed seal surfacing treatments.
- Bituminous slurry surfacing.
- Asphalt.
- Cement concrete.
- Concrete segmental pavers.
- Clay segmental pavers.

Sprayed treatments

Materials: Sprayed seal surfacing (a layer of binder sprayed onto the pavement surface with a layer of aggregate incorporated), including initial seals to Austroads AP-T310 or to the relevant state road authority's requirements.

Initial seal aggregate size: Allow for initial seals below all final sprayed surfacing treatment, bituminous slurry surfacing, and asphalt surfacing with aggregate sizes to suit traffic and climatic conditions and as follows:

- < 1200 vehicle/lane/day: 5 to 7 mm.
- > 1200 vehicle/lane/day: 7 to 10 mm.
- > 600 v/l/d and hot or wet conditions: 10 mm.

Double/double seals: Allow in locations with the following properties:

- When additional waterproofing is required.
- When the traffic noise from a single/single application is unacceptable.
- When a fine texture is required, such as in parking areas, residential streets or footpaths.
- In areas subject to high shear loading compared to single/single seals.

Double/double seal aggregates: Allow for the following aggregate sizes:

- 1st coat: 14 mm.
- 2nd coat: 7 mm.

Single/single seal: If bituminous slurry surfacing or asphalt surfacing is required as the finished surface, provide 14 mm or 10 mm thick single/single seals.

Bituminous slurry surfacing

Materials: A mixture of graded aggregates and bitumen emulsion produced as a slurry. Select from the following types:

- Slurry seal: Basic mixture, usually without a polymer modifier.
- Microsurfacing: Enhanced mixture, usually containing polymer.

Minimum thickness: 8 mm nominal compacted thickness.

Application locations: Allow as a thin wearing course to existing sound pavement as follows:

- Preventative maintenance.
- Corrective maintenance to restore surface texture.
- To correct ravelling and loss of fines.
- To fill minor surface cracks

Asphalt

Asphalt mix types: Select from the following mix types:

- Dense graded asphalt.
- Open graded asphalt.
- Stone mastic asphalt.
- Fine gap graded asphalt.

Application locations: Allow for mix as follows:

- Generally: Dense graded asphalt to Austroads AGPT04B.
- Open graded asphalt:
  . Light or medium traffic: With bitumen (binder) class 320.
  . Heavy or very heavy traffic: With polymer modified binders (PMB).
- Stone mastic asphalt:
  . Light or medium traffic: With bitumen (binder) class 320.
  . Heavy or very heavy traffic: With bitumen (binder) class 320 or multigrade.
  . Very heavy special application: With PMB.
- Fine gap graded asphalt:
  . Light or medium traffic: With bitumen (binder) class 320.

Minimum thickness: Design asphalt surfacing to provide the following nominal compacted layer thickness:

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

Concrete surface finishes

Finishes types: To Austroads AGPT03 Table 7.1.

Segmental pavers

Surfacing finish: Determined by the paver shape, colour and type.

Concrete segmental pavers: Design paving as follows:

- Type: Type A to CMAA PA05 clause 4.4.1.
- Thickness: To CMAA PA05 Table 3.
- Base course: To CMAA PA05 Design charts A, B or C and clause 6.3.

Clay segmental pavers: Design paving as follows:

- Thickness: To *Think Brick Manual 01* Table 3.
- Bedding and base course: To *Think Brick Manual 01* clause 4.2.3 and clause 4.2.4.

Paving pattern: Herringbone.

Edge restraint: Design paving so that all edges are constrained by kerbing, guttering or concrete edge strips.

5.2 SURFACING SELECTION

Parameters

Surface parameters: Design surfacing to meet the following wearing property requirements for the pavement:

- Longitudinal profile and roughness.
- Transverse profile and rutting.
- Skid resistance.
- Texture.
- Noise attenuation.
- Conspicuity of markings/reflectivity.
- Delineation.
- Water spray generation.
- Appearance.
- Pavement strength.
- Cracking.
- Resistance to shear forces.

Road classification and wearing course application

Wearing surface selection options: Allow for wearing surface as follows:

- Urban/rural residential streets: Access street and local street:
  - Initial seal plus double/double sprayed surface final seal.
  - Initial seal, plus single/single sprayed surface seal, plus bituminous slurry surfacing.
  - Initial seal, plus asphalt.
- Urban/rural residential streets: Collector and local sub-arterial:
  - Initial seal, plus single/single sprayed surface seal, plus bituminous slurry surfacing.
  - Initial seal, plus asphalt.
- Commercial and industrial streets:
  - Initial seal, plus asphalt.

Braking and turning zones

Surfacing options: Provide either bituminous slurry surfacing or asphalt surfacing with suitable binders at intersection approaches and cul-de-sac turning circles on residential streets with sprayed surface final seals, within the vehicle braking and turning zones. In braking zones, consider surfacing materials which provide additional wear and roughness properties.

6 DOCUMENTATION

6.1 STATUTORY DOCUMENTATION REQUIREMENTS

Approvals

Requirement: Document the conditions, advised by the appropriate authority, required to obtain approval of the development for the following:

- Council for:
  . Road geometric layout and pavement design.
  . Landscaping adjacent to the pavement.
  . Stormwater and subsurface drainage design affecting pavement design.
- The planning and water resources department for road and drainage layout.
- Utilities authority for any public or private utility affected by the development.

6.2 DRAWINGS

Drawing content

Requirement: Provide the following drawings, describing the pavement design for the development:

- Site plan/maps: Showing the location and extent of pavement subject to improvement and design. If required to determine rainfall requirements, catchment area maps.
- Typical cross-sections for standard pavement types: Showing pavement and surface treatment design, including for any special or unusual pavement treatment, with the following details:
  . The number of lanes.
  . The pavement structure and reinforcement.
  . Material types and layer thicknesses, including thicknesses for subbase, base and wearing course.
  . Shoulders, kerbs, gutters and drainage.
- Joint layout plan and details.
- Shoulder design.
- Construction staging plan.

6.3 SUPPORTING DESIGN DOCUMENTS

Design reports

Requirement: Identify and describe the design proposal and the basis for pavement selection. Include all data and assumptions used for designing the pavement, including geotechnical information, traffic information, rainfall data, hydrographs, and other environmental considerations.

Existing pavement condition: Provide report with distress details and rehabilitation or reconstruction proposals, include all analyses, data and other considerations used to design the pavement.

Rehabilitation pavement design: Document the design intent in the project plans and specifications to provide the contractor a clear and concise project proposal. To facilitate preventative maintenance in the pavement management process, include pavement performance information.

Economic analysis: Include all calculations and assumptions related to the economic analysis (e.g. capital cost analysis, life cycle (whole of life) cost analysis, total annual cost per kilometre, maintenance and rehabilitation activities, capital recovery and current worth factors). Illustrate how the economic analysis was performed.

Other information: Include details of any unusual factors affecting the design or have influenced the pavement selection process (e.g. construction staging, high stress locations, Council requests, unusual traffic volumes, traffic count summary sheets).

Calculations

Requirements: Submit all assumptions (e.g. traffic factor calculations, thickness calculations, thickness nomographs and related charts, temperature location map), subgrade test results, and design calculations with the pavement design. Illustrate how the pavement thickness was determined.

Subgrade stability chart: If the soil condition is found to be fair or granular, include the subgrade stability chart used in the analysis. Also include details of any unusual soil conditions that affect the pavement design (e.g. laboratory test results).

Specifications

Construction documentation: Prepare technical specifications using the AUS-SPEC Construction work-section *Templates* from the National Classification System workgroups 02, 03, 11, 13.

Design certification

Certificate: Provide a signed and dated design certificate as evidence that a suitably qualified professional has reviewed all the design documents, verifying that the designed road pavement for the development site meet the Council and statutory requirements.

Pavement design

When the development requires construction of new roads and pavements or reconstruction of existing road pavement where traffic loading have been increased, a formal pavement design report shall be submitted to Council for approval prior to issue of construction certificate for subdivision works or approval under Roads Act - S138 Application.

The pavement design report shall comply with the following requirements:

1. Qualified person (Geotechnical Engineer)
   The pavement design report be prepared by a registered N.A.T.A. laboratory based on sampling and testing of the subgrade materials taken from the site and shall include details of the pavement design and results of the subgrade testing (including test holes to a depth not less than 1 metre below design subgrade levels and 4 day soaked CBR's).

2. Location and frequency of sampling and testing
   The testing authority responsible for the subgrade investigation must be fully satisfied that the location and depth of the test samples have been accurately surveyed to ensure that the sample represents a material which will remain in place when the subgrade is exposed. To this end, location, identification and sampling of subgrade materials shall be carried out in accordance with *AS1726 Geotechnical Site Investigations*. In general, the location and frequency of sampling and testing shall consider the following:

   a. In similar subgrade conditions sampling shall be carried out at intervals not greater than 50 meters;
   b. In variable subgrade conditions the above intervals will need to be reduced accordingly;
   c. Sufficient soil sampling and testing must be undertaken to ensure that all soil types represented in the subgrade are properly identified and tested for pavement depth requirements; and
   d. At least two (2) samples shall be taken from each road subgrade unless approved otherwise by Council's Engineer.

3. Design subgrade CBR
   Where the design subgrade CBR is less than 3, the subgrade shall be chemically stabilised to a minimum depth of 150mm, with the pavement design based on a CBR of 3.

4. Minimum design life
   A minimum design life of 50 years shall be used to determine the flexible and rigid pavement thickness respectively.

5. Equivalent Standard Axles (ESA)
   The pavement design shall generally be based on the assessed subgrade strength and the Traffic Loading Criteria (Equivalent Standard Axles (ESA)) given in the following table. Special consideration shall be given to the design of pavements where specific loading criteria (e.g. turning) is likely, for example, roundabouts, single lane carriageways, cul-de-sac etc.

Street/ Road Type	AADT	Design Traffic Loading (ESA) (N)
Access Place	0 – 300	1×10^5
Access street	0 – 1500	5×10^5
Collector	3000 max	1×10^6
Major Collector	Above 3000	2×10^6
Industrial / Commercial		5×10^6

6. For N values equal to or less than $5x10^5$ ESA
   Pavements should be designed using the general principals of the Austroads publication *Guide to Pavement Technology – Part 2 Pavement Structural Design* Chapter 12 and *Pavement Design for Light Traffic: A supplement to the Austroads Pavement Design Guide.*

7. For N Values greater than $5x10^5$ ESA
   Pavements should be designed using the general principles of the Austroads publication *Guide to Pavement Technology – Part 2 Pavement Structural Design*.

8. Minimum pavement thickness
   The thickness of the flexible pavements shall be provided in accordance with Shellharbour City Council's Engineering Construction Specification for Civil Works, which consist of:
   - Wearing Course
     - Minimum 50mm Asphaltic Concrete in one layer of AC10 except for roundabouts which shall be a minimum of 100mm Asphaltic Concrete
   - Base Course
     - Minimum 125mm of DGB20.
   - Sub-base Course
     - Minimum 150mm of DGS20 or DGS 40.

9. Pavement thickness variations
   If the changes of subgrade become evident during construction or due to spatial variations in the subgrade, pavement thickness calculations will subject to variation. Confirmation by a suitably qualified Geotechnical Engineer of preliminary subgrade conditions will be required following initial excavation. In deep cuttings, deep fills or other instances where testing of subgrade is possible only at the time of construction, a separate pavement design will be required during construction.

10. Alternate Designs
    Alternate designs may be submitted accompanied by supporting evidence from a geotechnical engineer as to the bearing capacity of the subgrade and the structural adequacy of the proposed pavement.

11. Water Sensitive Urban Design
    If Water Sensitive Urban Design (WSUD) features are proposed, considerations must be taken with the pavement design in areas adjoining these measures to avoid the potential effects of frequent water logging and the subsequent affectation of the adjoining pavement materials.

Pavement design report

All pavement design reports and certificate submitted to Council shall include the following:

a) An introduction including a description of the proposed development, the locality, the length or road sampled and tested and a general summary of the purpose of the report.
b) Field investigation, site geology and subsurface conditions summary.
c) Design Traffic Classification and Design CBR.
d) All tests and Borehole Log reports, indicating sampling location within soil profile and relative to design road surface.
e) All CBR Reports.

f) Pavement Thickness Design Recommendation based on Council's specification requirements.
g) A plan indicating sampling locations together with given road chainages, estimated extent of each soil type and the associated recommended pavement thicknesses.
h) The pavement design is to include the following certificate from the Geotechnical Engineer:

I certify that:
1. *This pavement design report has been prepared in full recognition of the likely existing subgrade conditions, the anticipated traffic loadings, the pavement materials to be used in the construction and the method of pavement construction.*
2. *The design has been undertaken in accordance with Austroads publication Guide to Pavement Technology Part 2: Pavement Structural Design*
3. *The engineering drawings include the relevant sub-surface drainage requirements to achieve the pavement design, and*
4. *The design complies with the relevant Specifications of Shellharbour City Council.*

Signed: _____ *Date:* _____
Name: _____
(Geotechnical Engineer)
Address: _____
NPER-3 Registration number (if applicable) _____

Recycled Materials see section 4.4 above for specifications as well as EPA exemptions and orders regarding the use of recycled materials including asphalt, aggregate and glass sand in composite paving as well as bedding and select fill.

6.4 WORK-AS-EXECUTED

Work-as-executed documents

Work-as-executed drawings: Provide an additional set of final construction drawings for the purpose of recording the work completed by the Contractor. Provide plans in digital dgf. format, A3 and A1 paper copies signed by a Civil Design or Surveyor certifier as Work as Executed.

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

7 ANNEXURE

7.1 SCORING SHEET FOR SEALING AN UNSEALED ROAD

Scoring sheet for Councils to seal or not to seal?				
Item No.	**Factor**	**Score Rating**	**Actual Score Example Only**	**Comments**
1	**No. of vehicles per day**			Higher VPD means faster wearing course erosion
2	50 to 99 VPD	0		

Scoring sheet for Councils to seal or not to seal?				
3	Vehicles per day 101 to 150	5		
4	Vehicles per day 151 to 200	10		
5	Vehicles per day 151 to 200	15	15	
6	Vehicles per day 201 and above	20		
7	**Heavy vehicles %**			Higher heavy vehicles equals more wear for weaker roads
8	% 0 to 5	0		
9	% 5 to 10	3		
10	% 10 to 15	5	5	
11	% greater than 15	7		
12	**Vertical grades %**			Gravel unsealed roads can be more difficult when steeper
13	% less than 8	0		
14	% 8 to 10	3	3	
15	% 10 to 20	5		
16	% more than 20	7		
17	**Horizontal alignment**			Sealed roads encourage more speed and require more sight distance on corners and vertical curves.
18	Standard	0		
19	Sub - Standard	4	4	
20	**Rainfall per annum**			Wetter climates require sealed all weather access.
21	less than 450mm	5		
22	more than 450mm	0	0	
23	**Defects in existing unsealed pavement**			Unresolved defects create customer complaints
24	No. of defects	0		

Scoring sheet for Councils to seal or not to seal?				
25	Defects unsealed -potholes slippery, ravelling corrugations, gouging	5	5	Defects may be resolved by blending of different gravel pits using the Paige Green / ARRB spreadsheet graph model. Resolving defects should be the first option before considering sealing.
26	**Available material CBR in local pit gravels**			Higher CBR strength pavements have lesser annual whole of life costs (in general).
27	- Pavement gravels CBR less than 50	0		
28	- Pavement gravels CBR greater than 70	5	5	
29	**Haulage distance to basalt quarry**			Acquiring basalt seal aggregates is higher cost the longer the haul distance
30	less than 100 Km	10		
31	100 to 200 Km	5	5	
32	more than 200 Km	0		
		Example only	42	**TOTAL Points**
	Score of less than 30			Sealing is not required
	Score of greater than 30 and up to 45			Sealing is desirable
	Score of greater than 45 or more			Sealing is required

This selection table can be used as a general guide however each Council will have different factors and weightings based on local conditions.

7.2 ANNEXURE - REFERENCED DOCUMENTS

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

Austroads AGPT		Guide to pavement technology
Austroads AGPT01	2009	Introduction to pavement technology
Austroads AGPT02	2017	Pavement structural design
Austroads AGPT03	2009	Pavement surfacings
Austroads AGPT04B	2014	Asphalt
Austroads AGPT04C	2009	Materials for concrete road pavements
Austroads AGPT05	2011	Pavement evaluation and treatment design
Austroads AGPT06	2009	Unsealed pavements
Austroads AGRD		Guide to road design
Austroads AGRD01	2015	Introduction to road design
Austroads AGRD02	2015	Design Considerations
Austroads AP-T310	2016	Selection and design of initial treatments for sprayed seal surfacings
CCAA T51	2004	Guide to residential streets and paths

CMAA PA02	2014	Concrete segmental pavements - Design guide for residential accessways and roads
CMAA PA05	2014	Concrete flag pavements - Design and construction guide
Think Brick Manual 01	2013	Clay paving manual
The following documents are mentioned only in the Guidance text:		
Austroads AGPT		Guide to pavement technology
Austroads AGPT07	2009	Pavement Maintenance
Austroads AGRD		Guide to road design
Austroads AGRD08	2009	Process and documentation
Austroads AP-R518	2016	Safe system roads for local government
Austroads AP-R488	2015	Safe system in the planning process
Austroads AP-T85	2007	Optimum use of granular bases: material selection for detailed performance evaluation
IPWEA (NSW)	2012	ROADguide: Road design and performance (Roads and Transport Directorate)
IPWEA NSW Greenspec	2010	Specification for the supply of recycled materials for pavements, earthworks (Roads and Transport Directorate)
IPWEA NSW IS-01	2009	Information sheet IS-01: Oxidation of bitumen seals (Roads and Transport Directorate)
IPWEAQ LORDG	2016	Lower order roads - Design guidelines
IPWEA PN 9	2015	Practice Note 9: Condition assessment and asset performance guidelines: Road pavements (visual assessment)
IPWEA PN 9.1	2016	Practice Note 9.1: How to: Assess road pavement condition: Road pavements (Visual assessment code) Suite
IPWEA PN 9.2	2016	Practice Note 9.2: How to: Integrate pavement assessments into AM planning: Road pavements (Visual assessment code) Suite
Vic Gov Recycled Products	2015	Recycled products in pavement construction: A business case for councils to use local recycled products in pavement construction (Sustainability Victoria)

0043 SUBSURFACE DRAINAGE (DESIGN)

1 GENERAL

1.1 INTRODUCTION

Work-section application

Description: This work-section is applicable to the design and documentation of subsurface drainage systems for new and existing road pavement and/or subgrade including:

- Subsoil and formation drains.
- Pavement drains.
- Drainage blankets.

1.2 RESPONSIBILITIES

General

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

Salinity prevention: In areas with salinity problems, design the subsurface drainage system to keep the groundwater table lower in the strata to avoid progressive deterioration of topsoil and upper layers soil condition caused by increased salinity levels from rising and/or fluctuating groundwater tables.

1.3 STANDARDS

General

Subsurface drainage systems design: To Austroads AGPT10.

Road drainage design: To Austroads AGRD05A and NATSPEC TECHnote DES 036.

1.4 INTERPRETATION

Abbreviations

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

- CBR: California bearing ratio.
- IFD: Intensity-frequency-duration.

Definitions

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

- Cleanout: A subsurface drainage inlet at the surface of the pavement, shoulder or surrounding ground surface. Also known as flush-out riser and inspection point.
- Drainage blankets: A drain comprising a blanket of free-draining material. Typically used where a pavement intercepts a subterranean water source with substantial flows or the nature of the water-bearing strata is such that interception by formation or pavement drain is not possible. It is generally considered to be a structural component of the pavement system.
- Drainage types:
  - Subsoil drains: Drainage below the ground surface which collects subsurface water throughout its length of ground water or seepage from the subgrade and/or the subbase in cuttings and fill areas.
  - Formation drains: Drainage systems designed to intercept water before it reaches the road/pavement structure. They are generally deeper than pavement drains and are usually remote from the pavement structure. Also known as cut-off drains.
  - Pavement drains: Drainage systems designed to remove water from the subgrade and pavement materials.
- Filter layers: Used to prevent the loss of permeability in drainage layers from clogging by fine soil particles infiltrating from the subgrade (underlying soil).

- Formation: The surface of the finished earthworks, excluding cut or fill batters.
- Permeable base: A free-draining bound layer, capable of draining both surface water and preventing water accumulation from the subgrade below. The flow of water through this layer is retarded only by the cross slope and any obstructions.
- Prefabricated geocomposite drain: A proprietary product typically consisting of a plastic core wrapped in geotextile material, functioning as a single or second stage filter. Also termed as geocomposite edge drain and strip filter drain. These drains can be installed in narrower trenches than traditional pipe drains.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Data collection generally

Moisture source: Identify possible sources of moisture to the pavement system, and how it can be stopped from reaching the pavement subsurface. Consider sources for investigation, including:

- Seepage, capillary suction or vapour movements from the water table (when in close proximity to subgrade/pavement).
- Seepage from ponded stormwater into embankment/pavement.
- Seepage from an aquifer or other groundwater flow.
- Infiltration from precipitation through pavement surface, including at joints, edges and cracks.
- Seepage from irrigated landscape features.
- Capillary moistures from verges.
- Leakage from water supply and drainage lines.

Quantify net flow by source: Determine net flow as a basis for design by including inflow from all possible sources.

Geotechnical investigations: Carry out geotechnical investigation to determine subgrade soil characteristics (such as permeability and soil water suction properties), permeability of materials around the pavement and ground water effects to inform selection of drainage units.

Scope of investigation

Scope: Determine scope of investigation required for the development, depending on the pavement construction requirements and following:

- Site conditions: For example, this may depend on the range of groundwater site conditions required to establish a predicted worst condition to use as a basis for design.
- Road functional classification and location: For example, this may affect the road in-service performance requirements.

Reconnaissance studies

Requirement: Examine and record site subsurface features including topography, geology, surface water, springs, erosion and vegetation. Features to take note of include the following:

- Physical conditions of nearby roads.
- Vegetation in wet environments, location and class of wetlands.
- Erodibility of the land, particularly if there is evidence of batter erosion, drain siltation and scour in table drains of existing roads.
- Regional geology, including possible groundwater recharge areas, pressures and grades.
- Texture, substructure, hydraulic conductivity, infiltration, and stratification of soils, subsoils and substrata.

Quantitative evaluation of drainage needs

Requirement: Prepare survey(s) of the site to provide quantitative data for the drainage design by taking measurements of parameters which affect site drainage conditions, including the following:

- Traffic loading: Including volume and weight.
- Net moisture inflow into the subbase layer: Taking the following into consideration:
- Climatic conditions such as rainfall and temperature at the site (e.g. over a period of 50 years).
  . Surface flow.
  . Groundwater table and conditions: Include sampling and testing.
  . Roadway geometry: For example, slope, length and aspect.
  . Pavement type and condition: For example, pervious or impervious and age.
- Factors that increase the potential for moisture related pavement damage: Take the following into consideration:
  . Traffic loads.
  . Subgrade type, strength and condition.
  . Pavement material.
  . Design features.
- Roadway geometry to inform drainage system selection and layout.
- Soil type.

Existing pavement

Drainage survey: Prepare a drainage survey to provide information on the pavement condition. Determine the extent of moisture related damage and critical factors that cause the damage.

2.2 CONSULTATION

Other authorities

General: List relevant public authorities who need to approve the design proposals, e.g. water fisheries environmental planning, wildlife coastal protection or Maritime Authorities.

Utilities service plans

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

Development design team

Integrated development planning: Liaise with members of the development design team preparing the design of the following:

- Works in or close to a watercourse.
- Layouts of lots, roads, cycleways and pedestrian pathways.
- Pavement design.
- Stormwater drainage.
- Services installations.

3 DESIGN CRITERIA

3.1 GENERAL

Design objective

Requirement: Design subsurface drainage system for the proposed development road pavements to meet the following objectives:

- To keep the base, subbase, subgrade, and other susceptible pavement materials from becoming saturated or exposed to constant high levels of moisture over time by:
  . Preventing moisture from entering the pavement structure, including infiltration from pavement layers, verges, shoulders, medians and lateral groundwater seepage.
- To avoid premature pavement failures.
- To avoid surrounding pavement layer with materials of a lower permeability.

- If pavement drain cannot be in direct contact with all pavements layers, design drainage system so that the flow path to subsurface drains passes through materials of increasing permeability.

Design process

Requirement: To ANNEXURE, **GUIDE OUTLINE OF THE DESIGN PROCEDURES FOR SUBSURFACE DRAINAGE SYSTEMS FOR PAVEMENTS** for the pavement type.

3.2 SELECTION OF SUBSURFACE DRAINAGE SYSTEM

System selection

Requirement: Select and design subsurface drainage system based on the data collected for the development site for the following factors:

- Road geometry.
- Climate data.
- Pavement materials.
- Apparent pavement distress and why it is occurring.

Roadway geometry

Requirement: Design subsurface drainage system to suit the geometry and path of water flow in pavements, based on the geometric design features of the pavement and other related subsurface drainage. Roadway design features (which affect the subsurface drainage system) to consider include:

- Longitudinal grades: If grading is less than 0.5%, grade subsurface drains independently.
- Transverse grades (including superelevation).
- Widths of pavement and shoulder surface, base and subbase.
- Slopes and depths of cuts and fills: Allow for cuts that can be properly drained and fills which are high enough to inhibit capillary rise and accommodate subsurface drainage outlets.
- Details of ditches and other surface drainage facilities.
- Traffic volume and weight expected on the pavement, including cumulative traffic loading expected on the pavement during its design life.

Design of permeable base: Use the true slope and length of the permeable layer.

Pavement design: Liaise with members of the development design team preparing the pavement design so that adequate cross and longitudinal pavement slopes are provided. This is so that infiltration into pavement structure is minimised as moisture can quickly drain from the pavement surface.

- Design features: Consider design features which reduce infiltration by minimising stress/traffic loads on longitudinal edges and cracking in pavements, for example, widened traffic lanes.

Climate data

Hydrological data: Determine precipitation and run-off based on frequency, intensity and duration of precipitation for the development site, using an appropriate rainfall IFD chart for the required ARI and duration.

Temperature fluctuations: Determine daily and seasonal temperature variation for the development area and allow for this in the pavement and drainage system design.

Pavement materials

Flexible pavement: Design pavement subsurface drainage system to maintain a water free subbase during the design life of the pavement structure considering the following factors:

- With the increase in traffic speed and volume, consider pavement pumping for pavements.
- Water accumulation under flexible pavements can lead to failure in the form of rutting and shoving.

Other factors

Factors to consider: Design pavement and subsurface drainage system based on the following factors for the development:

- Subgrade type.
- Functional classification: Pavements which carry high volume and heavy traffic have higher potential for moisture related damage.
- Design life: Subsurface drainage systems affect pavement performance and service life.
- Topography: This affects the longitudinal grade and cross slope of the roadway, and hence the removal of excess water.
- Life cycle cost: Cost of subsurface drainage system may be offset by increased service life and maintenance cost of pavement.
- Soil properties: Consider pavement subgrade strength, deformation, gradation, and permeability properties.
- Maintainability of the system and expected performance.

3.3 TYPES OF DRAINAGE SYSTEMS AND SYSTEM PROPERTIES

System types

Systems based on function: Select from the following drainage system types based on pavement moisture control requirements for the development:

- Groundwater control systems or formation drains: Drainage systems designed to remove and/or control the flow of groundwater. These systems are designed to intercept moisture before it reaches the pavement structure.
- Infiltration control systems or pavement drains: Drainage systems designed to remove water that seeps into the pavement structure (subgrade and pavement material).

Systems based on location and geometry: Select from the following drainage system types based on drain location, component and geometry requirements:

- Longitudinal edge drains: Located parallel to the roadway centreline, for both horizontal and vertical alignments. Collects water that infiltrates the pavement surface and drains water away from pavement outlets.
- Transverse and horizontal drains: Drains that run laterally beneath the roadway, generally at 90º to the roadway centreline but can be skewed.
- Permeable base: An open graded drainage layer with minimum permeability of 300 m/day.
- Drainage blankets: A permeable layer used to control both groundwater and infiltration. For example, it can be used to effectively control the flow of groundwater from cut slopes and beneath fills on the side of hills. NATSPEC TECHnote DES 036 provides more information with various options of providing subsurface drainage based on site conditions.
- Earthworks options: Widen cutting embankments to remove the topsoil. Cut with grader deeper table drains. Consider impediments such as environmental concerns with vegetation clearing and locations of road fence boundaries requiring widening of the road.

System performance

Requirement: Design pavement drainage system to meet the following performance criteria required for the development, derived from the data collection process:

- Required time-to-drain: For the permeable layer.
- Pipe size and outlet spacing requirements.
- The gradation for a graded aggregate separation layer or the opening size, permeability, endurance, and strength requirements for geotextile separators.
- The opening size, permeability, endurance, and strength requirements for geotextile filters, or the gradation of the granular filters (to be used in the edge drain).

System components

Elements: Allow for a subsurface drainage system consisting of the following:

- A permeable drainage layer, e.g. a permeable base/subbase or drainage blanket layer.
- A filter or separator layer between subgrade and permeable base/subbase.
- A collector system comprising of a longitudinal edge drain and, if required, interceptor drains.
- Outlet or discharge pipe (to carry water from pavement to the stormwater drain or surface ditch).
- Headwall and outlet marker to protect outlet pipes from damage.
- Where deeper surface table drains are required, make sure the depth is adequate, especially in flat rural areas.

Longitudinal edge drains

Network performance: Allow for drainage system with the hydraulic capacity required to handle water discharged from the permeable base to avoid weak links in the drainage system, allow for an increase in capacity for each element as the water moves towards the outlet.

Trench drains: Aggregate trench edge drains and geo-composite fin drains have low hydraulic capacity and are difficult to clean.

Pipe edge drains: Allow for drainage system that collects water which infiltrates the pavement surface and drains it away from the pavement through outlets. Select from the following types of system:

- Pipe drains in an aggregate filled trench.
- Pipe drains with porous concrete filled trench. Used in trafficked areas.
- Prefabricated geocomposite drains in a sand backfilled trench.
- Aggregate trench drain with geotextile wrappings.

Salinity mitigation

Outlets: Where possible, allow for discharge on the downhill side of the embankment or in the cut-fill area to reduce the risk of recharge to the subsurface water table.

Developments in salinity affected areas: Consider allowing for a separate drainage system for subsurface drains to discharge to a basin, where controlled release or desiccation treatment and removal can be facilitated as a maintenance operation.

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

Water quality targets: Allow for targets matching those of downstream watercourses. Provide advice on discharge operations and maintenance which is compatible with water quality targets and the requirements of the state land and water resource authority.

3.4 LOCATION, LAYOUT AND GRADE OF DRAINS

General

Standards: Conform to the following:

- To Austroads AGPT10 and Austroads AGRD05A for typical design details of the various types of drainage.
- To NATSPEC TECHnote DES036 *Need for subsurface drains on local roads* (includes diagram cross-section showing situations for each drain type).

Drainage layout: Design drainage systems to suit the three-dimensional geometric road layout. Identify conditions where water could be trapped by unusual geometrics, or where water may meander for long distances before reaching an outlet, including locations such as reverse superelevated curves, long sustained grades and sag vertical curves.

Subsurface drainage provision: To Austroads AGRD05A clause 8.6 for further details on locations of subsurface drains. Allow for subsoil drainage for the development in the following locations:

- Cut formations with depths to finished subgrade level 400 mm or more below the natural surface level.
- In locations of known hillside seepage, high water table, isolated springs or salt affected areas.
- Irrigated, flood prone or poorly drained areas.
- Areas with subgrades which are highly susceptible to moisture, including those with high plasticity or low soaked CBRs.
- Areas with pavement materials which are susceptible to moisture.
- Existing pavement areas where subgrade conditions show deterioration from excess subsurface moisture.
- At cut-to-fill transition areas.

Longitudinal edge drains

Pavement edge: Allow for drains along the following locations:

- In road sag points.
- On both sides of the pavement near any cut-to-fill line.
- On both sides of kerbed pavements.
- On both sides of the pavement where the crossfall is flatter than 0.02 m/m in superelevation developments.
- The high side of pavement where there is seepage, or where water may enter from batters, full-width pavement, service trenches or abutting properties.
- Joints between an existing pavement and pavement widening where depths or permeability may create moisture traps.
- On both sides of pavements for major arterial roads.

Medians: Allow for drains along the following locations:

- The low side of a dished median if the median drain invert level is less than 0.2 m below subgrade level of the adjacent pavement.
- The low side of a kerbed median if the cross slope is 10% or more.
- Sides of a median more than 2 m wide.
- Sides of a median with a fixed watering system.
- Centre of flat grassed medians without fixed watering systems and less than 6 m wide.

Transverse drains

Locations: Consider locating drains in the following locations:

- Approximately 5 m upstream of cut-to-fill lines.
- Along changes of pavement depth or permeability.
- At both ends of bridge approach slabs:
  . Immediately behind the bridge abutment, to the full depth of the abutment.
  . In the subgrade at the interface of the road pavement and the approach slab.
- At superelevation changes, to limit the length of the longest drainage path within the pavement to approximately 50 m.

Trench subsoil drainage

- Excavate subsoil drain trenches to below subgrade level. Extend pavement drains into or adjacent to the pavement layers to facilitate drainage of the pavement layers in addition to the subgrade.

Minimum trench width: 300 mm.

Minimum depth below finished subgrade level:

- In earth: 600 mm.
- In rock: 450 mm.

Level: Locate below the invert level of service crossings.

Subsoil drainage in pipe trenches: If pipe trenches are backfilled with sand or other pervious material, provide the following:

- 3 m length of 100 mm diameter agricultural pipes, butt jointed with joints wrapped with geotextile, or slotted PVC pipe of subsoil drain in the bottom of the trench immediately upstream from each pit or headwall.
- Seal the upstream end of the subsoil drain with cement mortar.

Discharge the downstream end through the wall of the pit or headwall.

Outlet pipes

Location: Locate pipe so that there is no interference (from topographical or geometric road layout features) with free gravity flow from the system. If there is interference from natural or man-made features, use longer spacing between outlets, sumps and pumping outlets.

Outlets: Join into gully pits or outlet headwalls.

Headwalls perform the following functions in subsurface drainage systems:

- Protect outlet pipe from damage from mowing.
- Prevent slope erosion.
- Aid in the location of outlet pipe for future maintenance operations.

Table drains: Locate pipes high enough on slopes of table drains so that there is free gravity flow.

Spacing: Allow for pipes at intervals suitable for conveying water received to a suitable and safe exit point.

Subsurface drain outlet through fill batters: Allow for unslotted plastic pipe of the same diameter as the main run.

Formation drains

Location: Consider providing in the following locations:

- Along both sides of cuts where the road is below the water table or where seepage is expected in wet weather.
- Transversely at any expected seepage areas, and further downstream if required. The transverse drains may be laid in a herringbone pattern to achieve the minimum grade.

Trench dimensions:

- Minimum width: 300 mm.
- Minimum depth: To suit the application and ground conditions of the development site.

Minimum outlet diameter: 150 mm.

Minimum grades: Allow as follows:

- Generally: 1.0% for corrugated pipes.
- Non-corrugated pipes: 0.5%.

Drainage blankets

Location: Allow for blankets underneath or as an integral part of the pavement structure where required to remove infiltrated water or groundwater from gravity and artesian sources.

Access to subsurface drains

Urban areas: Allow for drainage pits at the start and end of subsurface drains.

Rural areas: Consider allowing for flush-out riser inlets as intermediate access and outlets.

Inlet and outlet pits: Locate as follows:

- Clear of traffic lanes.
- Inlets in shoulders: Allow for a trafficable steel cover.
- Inlets: Do not locate where stormwater can enter the subsurface drainage system.
- Outlets: In easily accessible areas, visible from the road, and where road maintenance activities (e.g. grass cutting, cleaning of table drains) will not be hindered.
- Pit spacing: Maximum 150 m apart.

Minimum pit width: Allow as follows:

- Pit depth less than 1.5 m: 0.6 m.
- Pit depth more than 1.5 m: 1.05 m.

Cleanouts or flush-out risers: Allow as follows:

- Location: At the start of each subsoil drain line run and directly at the rear of kerb or at the edge of shoulder.
- Spacing: Maximum 120 m intervals.

3.5 MATERIALS AND SIZE OF DRAINS

General

Material selection: Allow for drainage materials compatible with the local conditions so that pipes and other components will not corrode, rust, disintegrate or be attacked by the chemical content of the soil, water or foreign matter.

Permeable base

Material performance: Allow for permeable base/subbase which intercepts and removes water that infiltrates the pavement structure quickly, preventing it from entering the lower pavement structure and causing weakness there. Design permeable base with the following properties:

- Sufficient permeability for the layer to drain within the design time period.
- Sufficient air void space to prevent pumping, and erosion of fines when the pavement is under heavy axle loads to prevent general pavement weakening.
- Stable enough to support the pavement during construction without causing premature distress of the surface layer.
- Provides stability and the required support for the pavement over its design life.
- Provides a dry base to minimise moisture related distresses in the layers above it, such as and stripping in pavements.
- Include drainage for water to flow away from the pavement structure, e.g. through longitudinal edge drains with outlet pipes.

Aggregates: Durable crushed, angular aggregate with few or no fines and good mechanical interlock.

Thickness: 100 mm or sufficient to overcome any construction variances and provide an adequate hydraulic conduit, to transmit the water to the edge drain.

Design criteria: Design permeable base based on the following:

- Estimated traffic load, especially where heavy vehicle volume is anticipated.
- Subgrade soil type.
- Pavement type.
- Pavement functional classification.

Drainage blankets

Properties: Consisting of specially graded aggregate layers to prevent clogging and erosion with the following features:

- A drainage outlet for the water collected to drain water away from the pavement structure.
- Shall have one or more protective filter layers.

Aggregates: With high coefficient of permeability to remove water that infiltrates the pavement structure and to meet the outflow capability required.

Drainage pipes – properties

Pipe of longitudinal collector pipes: Dependent on outlet spacing.

Pipe drain features: Design pipes with the following features:

- Relatively high flow capacity.
- Easy to maintain.
- Supported at edges of pavement so that they are not damaged when drain is installed.
- So that the material adjacent to the drain is sufficiently permeable to allow free water to reach the longitudinal drain.
- Protected at exit points from hazards such as debris deposit, birds and other animals, e.g. through a combination of screens.
- Designed to be displaced outwards.

Drainage pipes – material, size and application

Perforated pipes: To AS 2439.1.

Corrugated polyethylene:

- Size: Minimum 90 mm.
- Class: Class 1000 subject to traffic, construction and maintenance vehicles.

Smooth PVC-U: Allow where longitudinal gradients are flatter than 0.5%.

- Size: 100 to 300 mm diameter

Concrete: Allow where groundwater flows require diameters are not available in plastic pipes.

- Size: 300 to 750 mm.

Smooth plastic slotted and unslotted pipes: Allow where subgrade gradients are flatter than 0.5%.

- Unslotted pipes: Allow for conveying flows beneath pavement to outlet or as collector pipe.

Perforated corrugated steel: May be allowed for formation drains where soil and water are not highly corrosive.

Cleanouts and outlets: 100 mm diameter unslotted pipe.

Pipe class: Select pipe class based on expected live loading at the surface.

PVC-U pressure pipe and fittings: To AS/NZS 1477.

- Intra-pavement drains: Allow for slotted PVC-U pipes with wall thicknesses to AS/NZS 1477 for the crush rock subbase loading.

Prefabricated geo-composite drains and fittings:

- Type: Rigid or flexible.
- Rigid geo-composite drain: To ASTM D7001-06.
- Load bearing: Select the appropriate drain based on its load bearing characteristics.

Filter material

General: To *1171 Subsurface drainage (Construction)* for grading details and specifications for all filters.

Separator or filter materials: Allow for granular materials/aggregate or geotextile fabric to supplement the subsurface type selected, using one of the following combinations:

- Granular single stage filter.
- Wrap geotextile under pipe and along sides of the trench before backfill of aggregate. Wrap material around aggregate and pipe.
- Geotextile first stage filter with coarse granular second stage filter.
- Fine granular first stage filter with geotextile second stage filter.
- Fine granular first stage filter with coarse granular second stage filter.

Material performance: Select filter material with the following properties:

- More permeable than the surrounding material but fine enough to support the material and prevent penetration by the surrounding soils.
- Stable under flow so that it does not segregate during placement and piping or wash into perforations, inlets or joints in drainage pipes.
- Permeable enough to carry anticipated flow, so that the base course can drain within the designed period.
- Strong enough to provide a work platform during construction of permeable base.
- Able to protect permeable base from contamination by fines from underlying layers.

Areas with soils known to be stable: Determine if under adverse conditions, jointed or fissured materials are stable enough to dispense with filter material.

Filter material selection: To *ARRB ARR 368*.

Geotextile

Application: Allow where subgrades have a high percentage of fines.

Material performance: Allow for geotextile fabric with enough strength to survive the construction phase and pore openings sized to retain the larger soil particles, from one of the following categories (of manufacture):

- Woven.
- Non-woven.
- Composite.
- Knitted.

Filtering capability: Select fabric with pore openings sized to retain larger soil particles to facilitate soil bridging action, whilst at the same time allow smaller soil particles to pass through the geotextile without clogging the fabric. Consider fabrics with permeability several times greater than that of the subgrade.

Compatibility with pipes and soils: Select fabric based on the following criteria:

- Equivalent opening size (EOS).
- Retention (piping) based on soil grain size.
- Permeability.
- Clogging, including by salt and soil.
- Survivability.
- Durability, including tensile strength, and exposure to alkali or acidic soils and spilt fuels.

Backfill

Material selection: Select filter material for trench backfill (for subsoil, formation and pavement drains) based on the permeability of the pavement layers and/or subgrade and the expected moisture flow rate.

3.6 MAINTENANCE REQUIREMENTS

Inlets

Location: Allow for access to the upstream end of the pipeline.

Openings in stormwater pits: Locate high enough so that surface run-off does not enter pavement drainage pipe.

Separate openings: If required, locate so that they do not interfere with other maintenance operations. Do not locate where surface run-off can enter.

Outlets

Inspection: Consider allowing subsurface drainage to flow into permanent stormwater pits or concrete culvert end walls, at a level above the normal stormwater flow, to minimise inspection requirements. This allows both systems to be inspected at the same time.

Area around the outlet: Allow for paving to prevent scouring and grass growth, and to facilitate outlet visibility.

Outlet pipe: Allow for pipes with sufficient strength to bear maintenance plant.

Access points

Maintenance access points: Locate at the start of a pavement drainpipe run and at intervals of 100 m to 140 m.

Access type: Allow for pits, risers or outlets.

Connection of the drainage system to the stormwater system: Allow for the following:

- Entry points not less than 100 mm above the invert level of the stormwater pipe, to prevent pavement drainpipe from silting up with stormwater debris and prolonged flooding of the pavement drainage system.
- Risers: Constructed by bending flexible plastic pipe or by using the curved length of pipe or T-fittings.
- Rigid pipes: If required, use curved lengths of pipe or special T-fittings.
- Pits rather than risers: For easy access.
- Pit and riser location: Locate in unsealed shoulders, drain inverts or on batter faces

Markers

General: To *1171 Subsurface drainage (Construction)* for details on construction materials for powder coated metal steel post box sections.

Requirement: Allow for markers for future outlet identification by maintenance personnel. Allow for markers immediately adjacent to inlet and the outlet. Stencilled letters black on white background.

4 DOCUMENTATION

4.1 STATUTORY DOCUMENTATION REQUIREMENTS

4.2 APPROVALS

Requirement: Document any prerequisite for approval of the development advised by the following authorities:

- The EPA for salinity mitigation measures.

- Utilities authority for any public or private utility affected by the development.

4.3 DRAWINGS

Drawing content

Requirement: Provide the following drawings, describing the subsurface drainage design for the development:

- Drainage layout plans: Showing the proposed location of all subsurface drains with the following details:
  - . All drain types clearly defined, including formation drains.
  - . Flow paths, pipe length.
  - . In relation to the geometric road layout.
  - . Pipe/drain sizes and inverts.
  - . Pits, pit sizes, outlets and access points.
- Cross sections (transverse and longitudinal) of drains in relation to the pavement structure with the following details:
  - . The nominal depth and width of the trench.
  - . The location of the kerb/gutter or edge of pavement.
  - . Pipe type, diameter and class.
  - . Pipe gradient.
  - . Velocity, actual discharge and pipe capacity.
  - . Extent of backfill.
  - . Invert levels and finished surface level.
  - . Formation drain details.
- Large scale design details of drains, e.g. edge drains, pipes, trenches and cleanouts.
- Supporting design documents.

Supporting design documents

Design reports

Requirement: Provide a design report incorporating the design criteria/assumptions, drainage needs analysis, calculations, computer studies, and references supporting the design and maintenance

Maintenance program: Include in the report a recommended maintenance program covering the following procedures:

- Routine inspections and monitoring.
- Routine preventive maintenance.
- Spot detection of problems.
- Repair.

Specifications

Construction documentation: Prepare technical specifications using the AUS-SPEC Construction work-section Templates from the National Classification System workgroups 02, 03, 11 and 13.

Design certification

Certificate: Provide a signed and dated design certificate as evidence that a suitably qualified professional has reviewed all the design documents, verifying that the designed drainage system for the development site meets the Council's development consent conditions. Use Council's standard certificate (if available) or the template provided in the *0010 Quality requirements for design* work-section.

4.4 WORK-AS-EXECUTED

Work-as-executed documents

Work-as-executed drawings: Provide an additional set of final construction drawings in A3 and A1 paper forma for the purpose of recording the work completed by the Contractor.

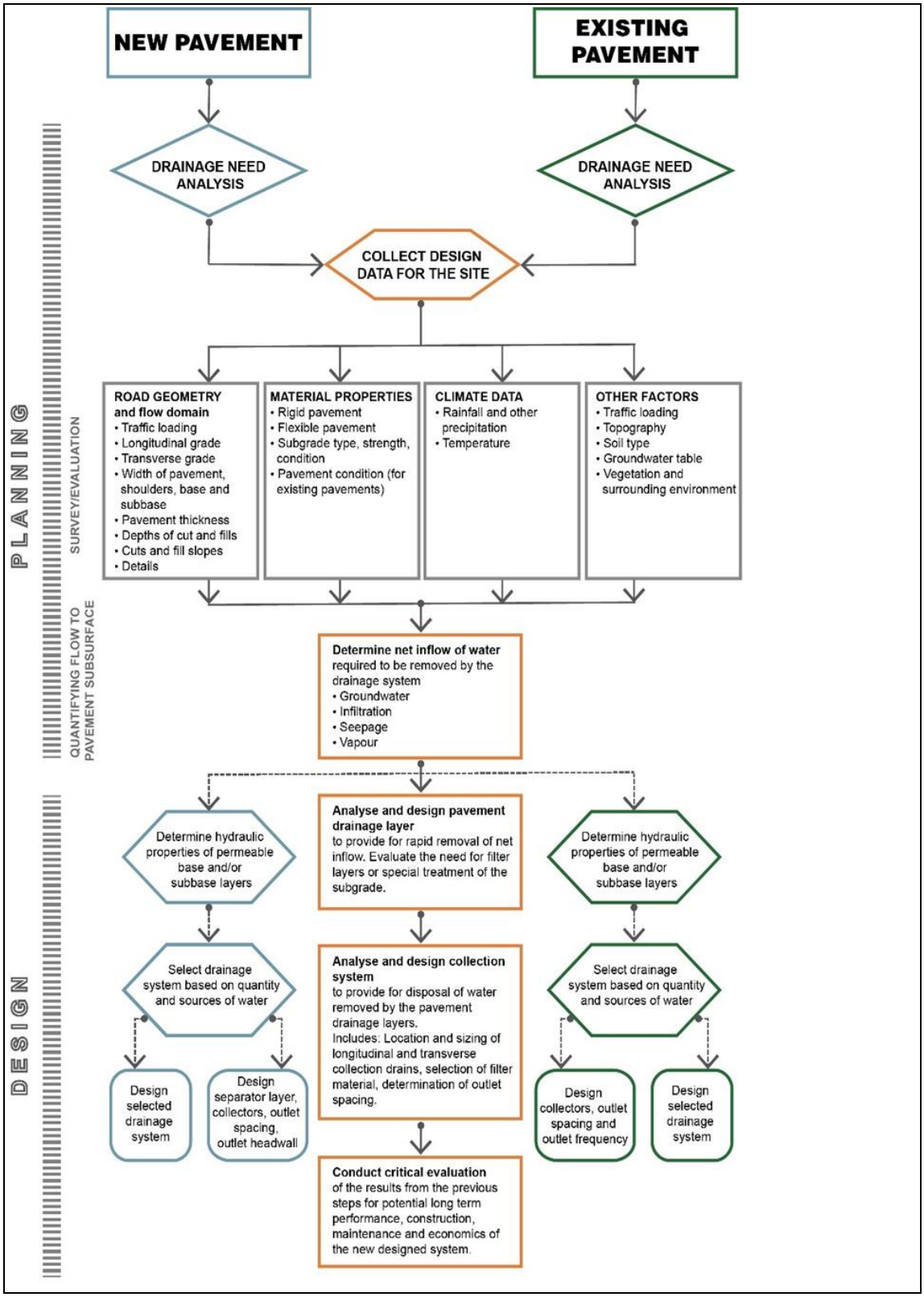
Drawing/Data format: Requested digital information conforming to the ADAC (Asset Design and As Constructed) standard for describing asset and work-as-executed plans which is available on Council's website. www.adac.com.au

Final certification of completed works

Completed works: Provide one copy of the plans for final certification and inspections specified by the drainage designer.

5 ANNEXURE

5.1 GUIDE OUTLINE OF THE DESIGN PROCEDURES FOR SUBSURFACE DRAINAGE SYSTEMS FOR PAVEMENTS



5.2 ANNEXURE - REFERENCED DOCUMENTS

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

AS/NZS 1477	2017	PVC pipes and fittings for pressure applications
AS 2439		Perforated plastics drainage and effluent pipe and fittings
AS 2439.1	2007	Perforated drainage pipe and associated fittings
ARRB ARR 368	2006	The collection and discharge of stormwater from the road infrastructure
Austroads AGPT		Guide to pavement technology
Austroads AGPT10	2009	Subsurface drainage
Austroads AGRD		Guide to road design
Austroads AGRD05A	2013	Drainage – Road surface network, basins and subsurface
NATSPEC DES 036	2017	Need for subsurface drainage on local roads
ASTM D7001-06	2011	Standard specification for geocomposite for pavement edge drains and other high-flow applications

0044 PATHWAYS AND CYCLEWAYS (DESIGN)

1 GENERAL

1.1 INTRODUCTION

Work-section application

Description: This work-section is applicable to design and documentation requirements for cycleways and pathways. It is not applicable to paths and cycleways in complex intersections, roundabouts or railway crossings.

1.2 RESPONSIBILITIES

General

Requirement: Provide design and documentation for cycleways and pathways that are connected, accessible and easy to maintain.

1.3 STANDARDS

Design

General: To Austroads AGRD06A and AS 3727.1.

Cycleways: To Austroads AP-G88.

Walking tracks: To AS 2156.1 and AS 2156.2.

1.4 INTERPRETATION

Abbreviations

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

- ARRB: Australian Road Research Board.
- CBR: California bearing ratio.

Definitions

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

- Bicycle path (cycleway): A path or path section intended for the exclusive use of cyclists, generally referred to as an exclusive bicycle path.
- Footpath (pathway): A public way reserved for the movement of pedestrians, motorised wheelchairs and personal mobility devices.
- Gradient: The longitudinal slope of a road or path, usually represented as a ratio of one metre rise to the horizontal distance (e.g. 1:50) or expressed as a percentage (e.g. 2%).
- Ramp: An inclined access way that has a constant gradient anywhere between 1:14 and 1:20.
- Separated path: A path divided into separated sections one of which is designated for the exclusive use of cyclists and an alternate section for other path users.
- Shared path: A paved area particularly designed (with appropriate dimensions, alignment and signing) for the movement of cyclists and pedestrians.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Scheme and planning development

Initial appraisal: Determine the scheme requirements in compliance with the Council's objectives, strategy/policy and planning documents. Factors to consider in the appraisal include the following:

- The urban structure of the development.
- Population density.
- Terrain.

- Provision hierarchy of roads, paths, cycleways (shared or segregated) and links.
- Existing transport/infrastructure routes/network and location of centres.
- Existing levels of use, public demand and user profile.
- Community priorities.

Site assessment: Examine the physical conditions along potential routes and their surrounds to test, inform and prioritise options under consideration. Record the assessment information for the following:

- Record of baseline information.
- Identifying potential problems, especially those that may affect the scheme viability.
- Identifying key design issues for pedestrians and cyclists.
- For future auditing and justification of the scheme.

Existing physical conditions: Physical conditions to consider in the site assessment include:

- Gradient.
- User flows and frontage activity (development activity adjacent to the path, e.g. commercial buildings).
- Route continuity which may affect length of route corridor and path/road transitioning requirements.
- Surface type and condition, level of lighting, vegetation and stormwater drainage.
- Identify possible conflicts with services such as sewer, water and optical fibre for vibration problems.
- Width of routes and clearances to other services.

2.2 ENVIRONMENTAL INVESTIGATION AND PLANNING

Existing building structures

Records: Obtain drawings of existing structures along and adjacent to the planned routes in the development area/precinct.

Dilapidation reports: Inspect existing structures along and adjacent to the planned routes in the development area/precinct. Prepare a report on the condition of the structures affected by the development, including photographic records of any defects.

Existing vegetation

Requirement: Assess existing vegetation, to establish the following:

- Vegetation for retention.
- Vegetation for relocation.
- Vegetation for removal.

Potential environmental impacts

Requirement: Check the development area/precinct for potential environmental impacts such as the following:

- Heritage items.
- Preservation of visual values.
- Endangered species requiring protection.
- Wildlife habitat.

Details of potential impacts: If there are potential impacts, provide details of the issues and proposed control measures for minimising the impact and protecting the surrounding environment before starting design. This may be in the form of an environmental impact statement (EIS), to be included in the Design report. Refer to Conditions of Consent.

Heritage items

General: List heritage items of Aboriginal or non-Aboriginal significance, including natural and man-made features. Verify details with the state heritage register, national parks and wildlife services and other local, state or federal heritage authorities.

2.3 CONSULTATION

Council and other authorities

Council consultation: Liaise with the Council's staff for the following:

- Roads and traffic management.
- Landscaping.
- Stormwater drainage.

Other authorities: Consult with and seek approval for the scheme development from the following state government authorities:

- Service authorities such as water, gas, electricity, Telstra. Optus using Dial Before You Dig.
- Fisheries (where crossing of or adjacent to a designated waterway).
- Wildlife, coastal protection or maritime authorities.

Other stakeholders

Stakeholder involvement: Engage with interested parties such as local community groups early in the design. As appropriate for the scheme, consult the following parties:

- The police, via Traffic Committee.
- Local residents and businesses.
- Current users of the land.
- Disability/access officers within the local authority.
- Cycle and pedestrian user groups.
- Local environmental and amenity groups.

Public consultation

Public engagement: Once a basic scheme has been developed, undertake public consultation.

Utilities services plans

Existing services in the development area/precinct: Liaise with the utility authorities affected by the proposed development and if required, obtain service plans from the authorities of the proposed development area for above ground and below ground services.

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

3 DESIGN CRITERIA

3.1 GENERAL

Statutory requirements

General: Identify any known specific requirements of utility or other regulatory bodies. Seek concurrence with the State Road Authority if the cycleway fronts a State road.

3.2 LOCATION OF PATHS

Required path properties

Requirement: Locate the pathways and cycleways to meet the following criteria for the development:

- Connectivity: Including measures such as accessibility (for people with disabilities to programs, services and activities), distance and directness, reliability, and connection to infrastructure and key destinations.

- Comfort and perception of safety: Compliance with regulations and codes, and minimisation/elimination of potential threats.
- Convenience: Easy and safe access without delay and barriers.
- Demand and level of service: Travel patterns, current and potential future walking and bicycling activity. Observe wear desire line tracks for existing pedestrian traffic.
- Environmental impact minimisation: Including impact on air quality, water, wetlands, noise and wildlife habitat.
- Equity: Accessibility without discrimination.
- Safety: To minimise potential accidents and maximise security.
- Visibility: If paths can be easily identified or located.

Possible path locations

Requirement: Consider the following locations in the development:

- Along river frontages.
- Within foreshore areas.
- Through parklands.
- Along railway reservations.
- Connections to public transport.
- Abutting bridges.
- Within the reservations of public roads which have direct access to property.

Design considerations

Factors for determining path locations: Consider the following when locating pathways and cycleways:

- Horizontal alignment and sight lines: Locate paths to provide good sight lines along the whole length of the path for safe travel, including adequate sight distance across the inside of curves and under overhead obstructions.
- Vertical alignment: The gradient along paths (especially for cyclists) should be as flat as possible, as steep downgrades are potential hazards for cyclists travelling at high speeds.
- Align paths to allow cyclists to travel safely at their chosen speed in the cyclists designated reserve.
- Horizontal curvature: Avoid sharp horizontal curves at the bottom of steep downgrades.
- Crossfalls and drainage: To minimise ponding.
- Adequate clearances: For example, between opposing traffic, between the cyclist operating spaces and potential hazards such as pedestrian conflicts.
- Access for emergency service and maintenance vehicles at path entrances.
- Landscaping and planting.

Location of pathways and cycleways: Select from the following:

- Adjacent to property boundary.
- Adjacent to the kerb.
- At any intermediate point, e.g. 1.5 m behind the kerb.

To Austroads AGRD06A Table 5.1 provides further guidance on the choice of path alignment in road reserves.

3.3 PATH AND CYCLEWAY FEATURES

General

Path Design Life: Adopt a design life in excess of conventional periods to reduce future maintenance costs. If this is adopted, consider the effect on the capital cost.

Maintenance factors which may affect the path design:

- Assess whether pathways need to be cut for future services or crack control.
- Assess whether the path needs reinforcing steel including dowelling between shrinkage sawcuts.

- Assess compliance with standard Council drawings for Kerb ramp details, crossover kerb details and similar interface with road carriageways.

Cycleway types

General: Select the cycleway from the following:

- Off-road cycleways: Include shared use bicycle/pedestrian pathway, separated pathway or exclusive cycleway.

Common pathway types

General: Select the pathway from the following types:

- Exclusive pedestrian pathways.
- Shared use bicycle/pedestrian pathways.

Pathway/cycleway features table

Feature	**Shared path**	**Separated paths**	
		Pathway	**Cycleway**
Minimum path width	2.5 m	1.2 m	2.0 m
Minimum vertical clearance*	2.5 m	2.0 m	2.5 m
Crossfall	≤ 2.5%**	≤ 2.5%**	Sealed surfaces: 2 to 4%
			Unsealed surfaces: 5 %
Gradient	1:14 – 1:20 to AS 1428.1	1:14 – 1:20	≤ 5%
* Including tree branches, underpasses, doorways, signs and other overhead structures ** It is assumed that the surfaces for these paths will be sealed to accommodate wheelchair access.			

The cycleway/shared path shall be 125mm thick concrete with SL72 reinforcement mid depth. In addition, the following requirements shall also be complied with:

a) In order to determine whether a safety fence barrier is required, distance between the cycleways / shared paths and the top of batters shall be shown on the engineering construction plans. Safety fence barriers are to be designed in accordance with Austroads publication *Guide to Road Design Part 6A: Pedestrian and Cyclist Paths*.

b) The construction details of path terminal treatments (e.g. ramps, bollards, U-rails etc), end of journey facilities (e.g. seats, bicycle parking area etc) shall be shown on the engineering construction plans.

c) The bicycle parking area shall be design in accordance with AS2890.5 *Parking Facilities – On-street Parking*.

d) No drainage pit shall be provided within the cycleways / shared paths.

e) Signage (regulatory and directional) and pavement markings of cycleways / shared paths shall be designed in accordance with RMS publication *NSW Bicycle Guidelines* and AS1742.9 *Manual of Uniform Traffic Control Devices – Bicycle Facilities* and shown on the engineering construction plans.

Other pathway/cycleway features

Minimum radius for horizontal curves for cycleways and shared pathways: Allow for the following:

- Without superelevation: To Austroads AGRD06A Tables 5.6.
- With superelevation: To Austroads AGRD06A Table 5.7.

Stopping sight distance for cycleways and shared pathways: To Austroads AGRD06A clause 5.7.

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

Minimum lateral clearances for cycleways: Allow for the following clearances between opposing bicycle operating spaces and cyclist operating spaces and potential hazards:

- Relatively flat paths: 0.5 m between the edge of cycle path and obstacle.
- Recreation paths with speed ≤ 20 km/hr: 0.4 m between opposing bicycle operating spaces.
- Paths for commuting and major recreational activity: 1.0 m between opposing bicycle operating spaces.

Landscaping and stormwater drainage

Requirement: Locate, design and construct path and associated stormwater drainage measures to minimise future maintenance. Design considerations include the following:

- Measures to minimise debris washing onto paths.
- Locating paths adjacent to watercourses to prevent inundation, to minimise slippery surfaces.

Water sensitive urban design (WSUD)

Requirement: Include WSUD into the project, this provides for preventing pollutants/sediments draining into waterways.

Safety

Safety measures: Include the following in the development scheme:

- For safety issues such as bollards, handrails, grab rails, tactile indicators or kerb ramps: To Austroads AP-R287.
- For terminal design: Consider speed restrictions for busy, shared paths for pedestrian safety to Austroads AGRD06A clause 7.5.2.
- For maximum operating speed recommendations for bicycles: To Austroads AGRD06A clause 5.2.

Pedestrian walking speed: Allow for walking speed of 1.0 to 1.2 m/s.

Ramp and footpath landings table

Type of path	Longitudinal gradient	Landing requirement
Ramp and footpaths with gradients > 1:20	1:14	Every 9 m
	1:20	Every 15 m
Footpath[1]	1:20	Every 15 m
	1:33	Every 25 m
	Flatter than 1:33	No landing required
[1] Ground level adjacent to footpaths: ≤ 25 mm of the footpath level.		

Disabled access

Compliance: To AS 1428.1, Council's policy on access and mobility and the *AUS Gov Act No. 135 - Disability Discrimination Act 1992*.

Warning tactile ground surface indicators (TGSIs): Provide at the top and bottom of ramps and stairs and to AS/NZS 1428.4.1.

Provision at structures

Uninterrupted movement: Facilitate continuous cyclist and pedestrian movement at proposed and existing structures, including at bridges and underpasses, roads or railways.

Signage and pavement marking

Signposting: Provide signposting to indicate destinations and potential hazards.

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

Pavement design

Structural design: To Austroads AGPT02, Section 12.

Control of cracks: To CIA Z15.

Grates and covers: Flush with the adjacent path.

3.4 PATH FACILITIES

Facilities

Requirement: Include in the development scheme, design proposals for the following facilities, including at common cyclist and pedestrian destinations:

- Street furniture including seats, bins, drinking fountains and telephones.
- Information stands/direction signs.
- Bicycle wheeling ramps.

Lighting and lighting support structures

Generally: To AS/NZS 1158.3.1 and AS 1798.

Underpasses: To AS/NZS 1158.5.

3.5 MATERIALS

Environmental considerations

Trees policy: When designing and selecting the path and surrounding materials, consider the Council's existing or planned tree planting requirements to minimise future maintenance and environmental impact. Factors to consider include the following:

- Location of vegetation, distance from the path.
- Type of vegetation and their root system requirements to minimise branch trimming and pavement deformation and cracking, e.g. loose materials may be used to allow root system expansion.
- Path surface slip resistance.

Subgrade

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

Pavement

Pavement type: Select the pavement type from impermeable, permeable or a combination of those.

Maintenance considerations

Requirement: Nominate low maintenance materials for path surface, pavements and street furniture to suit the exposure conditions and durability requirements of the development.

Other criteria

Requirement: Include other material requirements for other associated structures such as retaining walls, fences, safety barriers, signposts, traffic poles and light poles. Consider the Council's maintenance policy and the ecological footprint of the materials selected. If using plantation timber or certified hardwood, see www.forestrystandard.org.au for information on AFS certification to AS 4708.

4 DOCUMENTATION

4.1 STATUTORY DOCUMENTATION REQUIREMENTS

Approvals

Requirement: Document any prerequisite for approval of the development advised by the following authorities:

- State Road authority: Gain concurrence from the State Road Authority where the path is in the pedestrian way adjacent to a State highway carriageway.
- Relevant transport authority where pathway/cycleway connects and/or intersects with a public transport facility.
- Utilities authority by information from Dial before you Dig.

4.2 DRAWINGS

Drawing content

Requirement: Provide the following drawings to describe the development:

- Locality plan.
- Site plans showing cycleways and pathways at 1:500 scale.
- Part plans at 1:200 scale, showing merging details of new cycleways and pathways with existing roads.
- Longitudinal sections at the following scales:
  - Horizontal section: 1:500.
  - Vertical section: 1:50.
- Cross sections at 1:100 scale. Provide transition tables if crossfalls vary.
- Design traffic loading and design CBR value for the natural subgrade material.
- Details of typical cross sections including pavement materials, pavement layer depths, edge details and details of any retaining walls, batters, fences and drainage works at 1:20 scale.
- Typical details of expansion joints, contraction joints and joints to existing pavements. Show details of additional joints at drainage pits, light poles and bollards.
- Details of handrails, bollards, street furniture, light poles and traffic signalling posts at 1:10 scale.
- Traffic management plan for the construction stages.

4.3 SUPPORTING DESIGN DOCUMENTS

Design reports

Requirement: Provide a design report covering the following:

- Design criteria adopted for the development design.
- Site investigation reports supporting the design.
- Any additional requirements including, Traffic management plan not covered by drawings.

Specifications

Construction documentation: Prepare technical specifications using the AUS-SPEC Construction work-section templates from the National Classification System workgroups 02, 03, 11 and 13.

Design certification

Certificate: Provide a signed and dated design certificate as evidence that a suitably qualified professional has reviewed all the design documents, including program and plans for the development, and can verify that the designed cycleways and pathways for the development site meet the Council and statutory requirements.

4.4 WORK-AS-EXECUTED

Work-as-executed documents

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

Drawing/Data format: Request digital information conforming to the ADAC (Asset Design and As Constructed) standard for describing asset design and work-as-executed plans, which is available from Council's website. www.adac.com.au

Final certification of completed works

Completed works: Provide one copy of the plans for final certification and inspections specified by the designer.

5 ANNEXURE

5.1 ANNEXURES - REFERENCED DOCUMENTS

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

AS/NZS 1158		Lighting for roads and public spaces
AS/NZS 1158.3.1	2005	Pedestrian area (Category P) lighting - Performance and design requirements
AS/NZS 1158.5	2014	Tunnels and underpasses
AS 1428		Design for access and mobility
AS 1428.1	2009	General requirements for access - New building work
AS/NZS 1428.4.1	2009	Means to assist the orientation of people with vision impairment - Tactile ground surface indicators
AS 1742		Manual of uniform traffic control devices
AS 1742.9	2018	Bicycle facilities
AS 1742.10	2009	Pedestrian control and protection
AS 1798	2014	Lighting poles and bracket arms - Recommended dimensions
AS 2156		Walking tracks
AS 2156.1	2001	Classification and signage
AS 2156.2	2001	Infrastructure design
AS 3727		Pavements
AS 3727.1	2016	Residential
AS 4708	2013	Sustainable forest management – Economic, social, environmental and cultural criteria and requirements
Austroads AGPT		Guide to pavement technology
Austroads AGPT02	2017	Pavement structural design
Austroads AGRD		Guide to road design
Austroads AGRD06A	2017	Paths for walking and cycling
Austroads AP-G88	2017	Cycling aspects of Austroads Guides
Austroads AP-R287	2006	Pedestrian-Cyclist conflict minimisation on shared paths and footpaths
CIA Z15	2011	Cracking in concrete slabs on ground and pavements
AUS Gov Act No. 135	1992	Disability Discrimination Act

0061 BRIDGES AND RELATED STRUCTURES

1 GENERAL

1.1 INTRODUCTION

Work-section application

Description: This work-section is applicable to design and documentation requirements for the following structures:

- Road traffic bridges.
- Pedestrian bridges including bicycle and wheelchair access.
- Structures other than bridges associated with bridge construction e.g. culverts, retaining structures, sign supporting structures and noise barriers.
- Structures providing public safety, e.g. safety barriers, safety rails, protection screens and street lighting poles.
- Temporary works.

1.2 RESPONSIBILITIES

General

Requirement: Provide design and documentation for the bridges and related structures covered by this work-section.

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

Performance

Draw attention to any specific requirements of other regulatory bodies.

1.3 STANDARDS

General

Bridge design: To the AS 5100 series, Austroads AGBT-SET series and RMS DC B30-DC B381 series.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Concept design

Design investigations: Inspect the site and carry out necessary design investigations.

Checklists: Complete the following before commencement of detailed design:

- Action checklist for preparation of bridge design concept: To Austroads AGBT04, Appendix B.
- Matters for resolution before design commences: To AS 5100.1 clause 6.

Geotechnical investigation and survey

Heritage considerations

Requirement: Provide a plan for management of heritage assets.

Protection of existing infrastructure

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

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

Groundwater control: Identify potential effects of dewatering during construction.

2.2 SUBSIDISED SCHEMES

Funding

Government grant funds: If the works form part of a contract attracting Government grant funds, identify items which do not meet the project objectives and the requirements of the various authorities for the least Net Present Value (NPV) but may become the preferred option for construction.

If the works form part of a contract attracting Government grant funds, include the requirements here.

2.3 CONSULTATION

Council and other authorities

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

Public consultation

Requirements: Undertake public consultation on design in conformance with Council policy.

Utilities services plans

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

3 DESIGN

3.1 DESIGN CRITERIA

Waterways and flood design

Design: To AS 5100.1 Section 11.

Geometry

Design: To AS 5100.1 Section 13.

Road layout: Conform to *0051 Geometric rural road design - sealed* or *0052 Geometric rural road design - unsealed*.

Aesthetics

Design guidance: Austroads AGBT04 Appendix C.

Maintenance considerations

Rehabilitation and strengthening of existing bridges: To AS 5100.8.

Construction considerations

Provisions for traffic: Conform to *1101 Traffic management*.

Design loads

General: To AS 5100.2.

Serviceability

General: To AS 5100.2.

Environmental constraints

Erosion and sedimentation control: To *0022r Control of erosion and sedimentation (Design)*.

3.2 ROAD TRAFFIC AND PEDESTRIAN BRIDGES

General

Design guidance: To AS 5100 and AS 1742.

Design life maintenance
Requirement: Design for low maintenance.

Procedures for planned maintenance: To AS 5100.

Design life maintenance:

- Timber: To AS 5100.9 Section 3.
- Steel: To AS 5100.6 Section 3.
- Concrete: To AS 5100.5 Section 2.

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

Material types:

- Timber: To AS 5100.9 Section 2.
- Steel: To AS 5100.6 Section 2.
- Concrete: To AS 5100.5 Section.3.

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

Drainage
General: Conform to *0074r Stormwater drainage (Design)*.

Freeboard
Design: Provide freeboard to suit local conditions and expected amount and size of debris.

Public utilities
General: If public utilities are required, conceal from public view, where possible.

3.3 PROVISIONS FOR PEDESTRIANS AND CYCLISTS ON ROAD BRIDGES

Walkways and cycleways
Standard: To AS 5100.1 clause 13 and Austroads AGRD06A.

Traffic management: AS 1742.9.

Disabled access
Standard: To AS 1428.1 and AS/NZS 1428.4.1.

3.4 OTHER STRUCTURES

Buried corrugated metal structures
Standard: To AS/NZS 2041.1 and Austroads AP-T196.

Soil-supporting structures
Standard: To AS 5100.3.

Culverts
Standard: To AS 5100.2 Section 11 and AS 5100.3 clause 9.

Noise barriers
Standard: To AS 5100.1 Section 17 and AS 5100.2 clause 25.

3.5 STRUCTURES USED FOR PUBLIC SAFETY

Barriers and rails

Standard: To AS/NZS 3845.1, AS 5100.1 Appendix A and AS 5100.2 Sections 12, 25 and Appendix A.

Pedestrian and cyclist path barriers: To AS 5100.1 clause 16.

Omitting safety barriers: Conform to AS 5100.1, clause 10.5.2. Specify flood depth indicators and signposting.

Lighting and lighting support structures

Standard: To the AS/NZS 1158 series, AS 1798 and AS 5100.2.

Design: Provide for street lighting on bridge approaches and crossings.

Protection screens

Standard: To AS 5100.1.

4 DOCUMENTATION

4.1 GENERAL

Approvals

Requirements: Document the approval conditions advised by the appropriate authority which contribute to the basis for the design of the bridge(s) and related structures.

Design reports

Concept design: Provide a design report including the following:

- Design criteria.
- Design options.
- Recommended solution.
- Recommended construction procedures.
- Recommended maintenance procedures.

Detailed design: Provide a design report including the following:

- Design criteria.
- Detailed design calculations.
- Structural design models.
- Reference documents supporting the design, such as hydrological, geotechnical, vibration study and fatigue study reports.
- Construction sequence.
- Maintenance schedule.

Design certification

Requirement: Provide a signed and dated design certificate.

Final certification of completed works

4.2 DRAWINGS

General

Requirement: Provide drawings and/or computer output defining the works and assumed operating and maintenance procedures.

Structural drafting

Standards: To AS 5100.5 Parts 1 to 9 and Austroads AGBT05.

Drawing content

Requirement: Provide drawings to include the following:

Work-as-executed drawings

Requirement: Provide an additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor in accordance with the ADAC specification, which is available on Council's website.

4.3 SPECIFICATIONS

Construction documentation

Requirement: Prepare technical specifications using the AUS-SPEC Construction work-section *Templates* from the National Classification System including workgroups 02, 03, 11 and 13.

5 ANNEXURE

5.1 ANNEXURE - REFERENCED DOCUMENTS

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

AS/NZS 1158		Lighting for roads and public spaces
AS 1428		Design for access and mobility
AS 1428.1	2009	General requirements for access - New building work
AS/NZS 1428.4.1	2009	Means to assist the orientation of people with vision impairment - Tactile ground surface indicators
AS 1742		Manual of uniform traffic control devices
AS 1742.9	2018	Bicycle facilities
AS 1798	2014	Lighting poles and bracket arms - Recommended dimensions
AS/NZS 2041		Buried corrugated metal structures
AS/NZS 2041.1	2011	Design methods
AS/NZS 3845		Road safety barrier systems and devices
AS/NZS 3845.1	2015	Road safety barrier systems
AS 5100		Bridge design
AS 5100.1	2017	Scope and general principles
AS 5100.2	2017	Design loads
AS 5100.3	2017	Foundations and soil supporting structures
AS 5100.5	2017	Concrete
AS 5100.6	2017	Steel and composite construction
AS 5100.8	2017	Rehabilitation and strengthening of existing bridges
AS 5100.9	2017	Timber
Austroads AGBT		Guide to bridge technology
Austroads AGBT04	2018	Design procurement and concept design
Austroads AGBT05	2018	Structural drafting
Austroads AGRD		Guide to road design
Austroads AGRD06A	2017	Paths for walking and cycling
Austroads AP-T196	2011	Guidelines for design, construction, monitoring and rehabilitation of buried corrugated metal structures

0074 STORMWATER DRAINAGE (DESIGN)

1 GENERAL

1.1 INTRODUCTION

Work-section application

This work-section is applicable to the design and documentation requirements for stormwater drainage systems for urban and rural areas. It covers hydrology and hydraulic design for all aspects of stormwater drainage system and includes Water Sensitive Urban Design and principles for stormwater harvesting and re-use.

Flood Studies and Floodplain Risk Management Plans adopted by Council and other relevant state agencies are available on Councils Website. Detailed flood level information for individual properties are available from Council on request.

It should be noted that the Design Coefficients defined in the Tables and Figures within this specification are applicable only to the Shellharbour City Local Government Area. It covers design aspects for the full range of municipal stormwater drainage assets with consideration to the Total Water Cycle Management philosophy for management of stormwater.

It is important to note that required design aspects are detailed in the Shellharbour City Council Drainage Design Handbook. Drainage Design works require full compliance with this specification as well as all ancillary and detailed design requirements in the Handbook.

1.2 RESPONSIBILITIES

General

Requirement: Provide design and documentation for stormwater drainage systems.

1.3 STANDARDS

General

Standard: Conform to the following:

- Rainfall and runoff: To ARR (2016).
- Water sensitive urban design: To EA ARQ.

1.4 INTERPRETATION

Abbreviations

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

- AEP: Average exceedance probability.
- ARI: Average recurrence interval.
- GPT: Gross pollutant trap.
- IFD: Intensity-frequency-duration.
- HGL: Hydraulic grade line.
- OSD: On-site detention.
- SQID: Stormwater quality improvement devices.
- WSUD: Water sensitive urban design.

Definitions

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

- Average exceedance probability: The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.

- Average recurrence interval: The average or expected value of the period between exceedances of a given rainfall total accumulated over a given duration. It is implicit in this definition that the periods between exceedances are generally random.
- Catchment: A topographically defined area drained by a stream where all outflow is directed to a single point.
- Catchment area of any point: The limits from where surface runoff will make its way, either by natural or man-made paths, to this point.
- Dual drainage: The major/minor approach to street drainage.
- Major system: The network of planned and unplanned drainage routes providing safe, well-defined overland flow paths for rare and extreme storm runoff events. It includes roads, natural channels, streams, culverts, community retention/detention basins and other facilities.
- Minor system: The gutter and pipe network capable of carrying and controlling flows from frequent runoff events. It includes kerb and channels, inlet structures, open drains and underground pipes and on-site detention facilities.
- Primary treatment SQID: Removal of the majority of gross pollutants and coarse-medium grained sediments by screening or sedimentation, e.g. GPT's, trash racks, sediment trap.
- Redevelopment site: A site that had (or was originally zoned to have) a lower density development than is proposed.
- Secondary treatment SQID: Removal of the majority of fine, medium and coarse grained sediments, as well as a significant proportion of the pollutants attached to sediments, by enhanced sedimentation and filtration, e.g. infiltration basins and wet ponds.
- Stormwater management plan: A plan to manage the stormwater quantity and quality within a catchment and protect receiving water features, such as the protection of existing waterways, lakes and wetlands.
- Sub-catchment: A topographically defined area drained by a tributary or branch drain of a primary stream, river or main draining catchment.
- Tertiary treatment SQID: Removal of the majority of sediments, attached pollutants and dissolved pollutants by sedimentation, filtration and biological uptake, e.g. constructed wetlands.
- Time of concentration: The time required for storm runoff to flow from the most remote point on the catchment to the outlet of the catchment or to the inlet of a drainage structure within the catchment.
- Treatment train: Sequencing of SQID's to optimise treatment performance.
- Trunk drains: Large capacity channels or conduits which carry runoff from local street drainage systems to receiving waters including natural or artificial channels, transitions and hydraulic structures, culverts and road crossings, naturally occurring ponds and lakes, artificial detention or retention storages.
- Water sensitive urban design: Design principles aimed at improving the sustainable management of the urban water cycle. It integrates the planning and design of urban water cycle, water supply, wastewater, stormwater and groundwater management, urban design and environmental protection.

2 PRE-DESIGN PLANNING

Stormwater management

Requirement: Integrate management activities at the catchment, waterway and local development level in conformance with the NWQMS Document 10 (Pending its Review) and the following:

- Restore existing stormwater systems.
- Minimise the impacts of stormwater from new developments.
- Hydrological: Minimise the impacts of urbanisation on the hydrological characteristics of a catchment including wet weather and low flows. Mitigate pre-development inappropriate flows where practical.
- Water quality: Minimise the amount of pollution entering the stormwater system and remove residual pollution by implementing stormwater management practices.

- Vegetation: Maximise the value of indigenous riparian, floodplain and foreshore vegetation.
- Aquatic habitat: Maximise the value of physical habitats to aquatic fauna within the stormwater system.
- Processes for management: Implement processes for management for the following as applicable:
  . Runoff.
  . Water quality.
  . Riparian vegetation.
  . Watercourse and aquatic habitat.
  . Urban bushland.
  . Bridges and culverts across waterways.

Water sensitive urban design: Plan and design stormwater drainage using WSUD principles including the following:

- OSD.
- Capture and use of stormwater as an alternative source of water to conserve potable water.
- Use of vegetation for filtering purposes.
- Water-efficient landscaping.
- Protection of water-related environmental, recreational and cultural values.
- Localised water harvesting for re-use.
- Localised wastewater treatment systems.

2.1 CONSULTATION

Council and other Authorities

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

Public consultation

Requirements: Undertake public consultation on design in conformance with Council policy.

Utilities service plans

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

Requirements for utility services: To the SOCC *Guide to codes and practices for streets opening*.

Calculations

Certified design calculations: Engage a qualified hydrologic and hydraulic design professional to perform all required calculations.

Major structures

Certified structural design: Engage a professional engineer for all bridges, major culvert structures and specialised structures in conformance with *0010r Quality requirements for design - Sealed roads*.

3 DESIGN CRITERIA

For design criteria, methodologies and references please refer to Councils Drainage Design Handbook.

Design objectives

Requirements: Design stormwater drainage for the development with the following objectives:

- A high level of safety for all users;
- Acceptable levels of amenity and protection from the impact of flooding;
- Control of surface flows to prescribed velocity/depth limits.
- Control of surface flows to minimise the effect on pedestrians and traffic in more frequent stormwater conditions.
- Retention of the natural stormwater system where possible and as required by other statutory authorities;
- Efficient conveyance of stormwater and surface runoff from public and private property to ensure public safety and property protection;
- Controlled rate of stormwater discharge to reduce downstream flooding and environmental impacts by making maximum use of open spaces and other available areas to detain drainage;
- Ensure that the design capacity of downstream drainage systems are not compromised;
- Ensure that the stormwater drainage design has considered infrequent floods greater than the
- design flood. i.e. up to the PMF;
- Minimise construction and maintenance costs and avoid the need for future property acquisition;
- Protection of the environment from adverse impacts of development by stabilising the landform, controlling erosion and maintaining/ enhancing regional water quality;
- Protection of aquatic biota and riparian vegetation;
- Meet water quality objectives and incorporate the principles of Water Sensitive Urban Design; and
- Ensure low maintenance and economically sustainable in the long term in relation to operation, maintenance and replacement costs.
- Conformance with the Australian Rainfall & Runoff (ARR) major/minor system concept.
- A constant ARI for existing and reconstructed works.
- Reduced frequency of flooding of private and public buildings in flood-prone areas.
- Retention of incident rainfall and runoff consistent with the planned use of the area, within each catchment.
- Adoption of WSUD principles.

Control of erosion and sedimentation

Requirement: To *0022r Control of erosion and sedimentation (Design)*.

Design for stormwater harvesting and re-use

General: Design for re-use of locally generated roof water, stormwater.

Stormwater re-use scheme: Design the re-use scheme for ease of operation and maintenance. Consider the following when designing for collection, storage, treatment and distribution:

- End use requirements for water quality and quantity.
- Reliability of supply.
- Estimated demand for water with regard to peak flow.
- Assessment of water balance for sizing and storage.
- Storage requirements considering average annual volume and diversion flow rates.

- Treatment system based on:
  . Diversion flow rates before storage.
  . Distribution flow rates both before and after storage.

Roof water: Provide an integrated design with rainwater tanks, coordinate with the appropriate engineering consultation and conform to Statutory and local authority requirements.

Stormwater runoff: Design for the utilisation of stormwater runoff at the following scales:

- Allotment scale.
- Subdivisional/regional scale.

Stormwater collection

Requirement: Design the stormwater collection system to meet the following objectives:

- Extraction of sufficient water to meet the end use requirements without compromise to downstream aquatic eco systems.
- Ability to stop collection in the event that stormwater is contaminated by an incident within the catchment.
- Minimisation of the risk and/or impact of upstream flooding.

Stormwater storage

Requirement: Design the stormwater storage system to meet the following objectives:

- Storage of sufficient water to balance supply and demand.
- Minimisation of mosquito habitat (virus control), risks to public safety and risks to water quality in above-ground storage.
- Maximisation of dam safety.

Stormwater treatment

Treatment: Design appropriate stormwater treatment techniques to meet the following objectives:

- Minimisation of public health risks for the adopted public access arrangements.
- Minimisation of environmental risks.

Stormwater distribution

Requirement: Minimise the potential for:

- Contaminant inputs downstream of the final treatment facilities.
- Public exposure to untreated stormwater.
- Cross-contamination with mains water distribution networks or confusion with mains water supplies.

Irrigation: Design the irrigation system to the following requirements:

- Minimise run off, groundwater pollution and soil contamination.
- Minimise spray to areas outside the access control zone to reduce public health risks, if access control is adopted.
- Application rate of stormwater: Uniform for the irrigation scheme and less than the nominal infiltration rate to avoid surface runoff.

Durability

Design for the service life of the drainage system including the following:

- Thickness and type of base material of drainage structures including pipes and culverts.
- Life expectancy of the coating.
- pH and resistivity of water and backfill material.
- Presence of impurities including chloride, sulphate and aggressive CO_2 in the groundwater or soil.

Soil chemical testing: Determine as follows:

- pH level: Test backfill, soil and water to AS 1289.4.3.1.
- Resistivity: Test backfill, soil and water to AS 1289.4.4.1.
- Chloride, sulphate and aggressive CO_2 concentration: Test groundwater or soil extract to AS 1289.4.2.1.

4 DOCUMENTATION

4.1 GENERAL

Approvals

Requirements: Document the approval conditions advised by the Shellharbour City Council which contribute to the basis of the design of the stormwater drainage.

Design reports

Requirements: Provide a design report including the following:

- Design criteria.
- Site investigation reports supporting the design.

Calculations

Design: Provide a design report incorporating the criteria, computer studies, calculations and references supporting the design of the stormwater drainage.

Design certification

Requirement: Provide a signed and dated design certificate.

Final certification of completed works

Requirement: To be provided as necessary.

4.2 DRAWINGS

General

Requirements: Provide drawings and/or computer output defining the works and assumed operating and maintenance procedures.

Catchment areas plan

Catchment area drawings: Provide drawings showing the following:

- Contour interval: 1 – 2 m (closer if the area is very flat).
- Grade direction for kerb and gutter.
- General layout of the drainage system with pit locations.
- Catchment limits.
- Any other information necessary for the construction of the drainage system.

Scale 1:1000 or 1:5000.

Drainage system layout

Drainage system layout drawings: Provide drawings showing the following:

- Drainage pipeline location.
- Drainage pit location.
- Number and road centreline chainage.
- Size of opening.
- Drainage easements.
- Reserves and natural water courses.
- Location of buffer strips, vegetated swales and bioretention systems.

- Location and details of infiltration systems.
- Any other information necessary for the construction of the drainage system.
- If appropriate, combine with the road layout plan.

Scale 1:500.

Longitudinal section
Drainage system longitudinal sections: Provide drawings showing the following:

- Pipe size, class and type.
- Pipe support type to AS/NZS 3725 or AS/NZS 2032.
- Pipeline and road chainages.
- Pipeline grade.
- Hydraulic grade line.
- Any other information necessary for the construction of the drainage system.

Horizontal scale: 1:500.

Vertical scale: 1:50.

Open channels
Open channel cross sections: Provide drawings showing the following:

- The direction of the view of cross sections, normally downstream.
- Reduced levels to Australian Height Datum.
- Provide a data input file for the design flow rates.

Scale: 1:100.

Other documentation
Detailed drawings: Provide details including standard and non-standard pits and structures, pit benching, open channel designs and transitions to scales appropriate to the type and complexity of the detail being shown.

Submit hydrology and hydraulic summary sheets:

Computer data files and output: Submit final hydrological and hydraulic computer data files.

Landscape plans and planting plans: Provide for buffer strips, vegetated swales and bioretention systems.

Work-as-executed drawings
General: Provide an additional set of final construction drawings for the purpose of recording the work-as-executed by the contractor in accordance with the ADAC specification, which is available on Council's website.

4.3 SPECIFICATIONS

Construction documentation
Requirement: Prepare technical specifications using the AUS-SPEC Construction Templates from the National Classification System workgroups 02, 03, 11, 13.

4.4 ANNEXURE RESERVED

4.5 ANNEXURE - REFERENCED DOCUMENTS

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

AS/NZS 1254	2010	PVC (UPVC) pipes and fittings for storm and surface water applications
AS 1289		Methods of testing soils for engineering purposes
AS 1289.4.2.1	1997	Soil chemical tests - Determination of the sulphate content of a natural soil and the sulphate content of the groundwater - Normal method
AS 1289.4.3.1	1997	Soil chemical tests - Determination of the pH value of a soil - Electrometric method
AS 1289.4.4.1	2017	Soil chemical tests - Determination of the electrical resistivity of a soil - Method for sands and granular materials
AS 1926		Swimming pool safety
AS 1926.1	2012	Safety barriers for swimming pools
AS/NZS 2032	2006	Installation of PVC pipe systems
AS 2200	2006	Design charts for water supply and sewerage
AS/NZS 2566		Buried flexible pipelines
AS/NZS 2566.1	1998	Structural design
AS/NZS 2566.2	2002	Installation
AS/NZS 3500		Plumbing and drainage
AS/NZS 3500.3	2018	Stormwater drainage
AS/NZS 3725	2007	Design for installation of buried concrete pipes
AS/NZS 4058	2007	Precast concrete pipes (pressure and non-pressure)
AS 4139	2003	Fibre-reinforced concrete pipes and fittings
AS/NZS 5065	2005	Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
ANCOLD	2000	Guidelines on acceptable flood capacity for dams
Austroads AGRD		Guide to road design
Austroads AGRD05	2013	Drainage – General and hydrology considerations
Austroads AGRD05A	2013	Drainage – Road surface network, basins and subsurface
Austroads AGRD05B	2013	Drainage - Open channels, culverts and floodways
ARR	2016	A guide to flood estimation
EA ARQ	2006	Engineers Australia - Australian runoff quality: a guide to water sensitive urban design
SOCC Guide	2018	Guide to codes and practices for streets opening
NWQMS Doc 10	2000	Australian guidelines for urban stormwater management

8100 LANDSCAPING (DESIGN)

1 GENERAL

1.1 INTRODUCTION

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

1.2 LANDSCAPE PROCEDURE

Public Open Space

Public open space generally refers to all land that Council has the ongoing care and maintenance responsibility. This applies to areas of both passive and active recreation including road verges, nature strips, parks, reserves, rehabilitation areas, revegetation areas, riparian areas, conservation areas, drainage channels and sports fields and complexes etc.

Dedication of all landscape works for Council's maintenance and responsibility of public open space areas within subdivisions and other developments is to be handed over to Council at the completion of the establishment period for the landscaping works.

The standard maintenance and establishment period for the developer commences from the date of a satisfactory practical completion of all landscape works as per the following maintenance periods:

Street Trees, Road Reserves, Nature Strips	12-month maintenance liability period
Parks, Reserves, Drainage Reserves	12-month maintenance liability period
Rehabilitation Areas, Revegetation Ares, Riparian Areas, Conservation Areas	24-month maintenance liability period
Sports Fields and Complexes	36-month maintenance liability period

Prior to the dedication of any public open space area including road reserves to Council for the care and maintenance of the public open space areas, all hard and soft landscaping works (e.g. street trees, turf areas, park furniture, play equipment, park fixtures), must be in an undamaged, safe and functional condition. All landscape plantings must have signs of successful establishment showing signs of a healthy and vigorous growth.

It is the responsibility of the developer to notify Council to arrange a landscape inspection prior to any dedication of public open space. Council is to be notified a minimum of 10 working days prior to the onsite handover inspection with the developer, landscape architect, landscape contractor and relevant Council officers.

All proposed structures, cycleways and paths within public open space are subject to relevant standards and policies and shall require approval and subsequent inspection by the Certifying Authority. This includes gazebos, shelters, bridges and park fixtures.

2 DESIGN GUIDELINES

2.1 SPORTING FIELDS, PARKS, RESERVES AND OTHER SUBSTANTIAL PUBLIC OPEN SPACE AREAS

(a) The developer shall be responsible for the installation costs involved with the placement of adequate separate water and power meter as per the intended use of the subject site. The water and power meters will act alone from other metered services adjoining the site;

(b) During their maintenance and establishment period, the developer shall be responsible for all irrigation costs of the subject site;

(c) The developer shall be responsible for all electrical costs during their maintenance and establishment period relevant to the public open space site;

(d) Sufficient irrigation and drinking water outlets shall be provided by the developer at regional and district parks, reserves and sports grounds to the satisfaction of Council;

(e) Irrigation outlets and drinking water outlets may be required from the developer for some local and other minor parks and reserves to the satisfaction of Council;

(f) Large trees and large spreading shrubs shall not be planted within 3 metres of any pathway or cycleway in public open space areas. Consideration shall be given to access by emergency and maintenance vehicles in many instances;

(g) Trees, tall native grasses and large spreading shrubs shall not be planted within 10 metres from road intersections. Nature strips and road verge areas shall have a soft (lawn) or hard (paving/concrete) surface within these areas;

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

(I) Strappy leaf native grasses shall not be planted within 1 metre of any pathway or cycleway in public open space areas;

(j) Any space between the edge of a path and the roadside kerb, that is less than 1m in width, shall have lawn laid instead of native grasses as the landscaping;

(k) Areas in public open spaces that will require mowing, repair, litter and weed control should be no steeper than 1:4 to enable safe, efficient and effective maintenance, furthermore it must have a minimum 3 metres separation from live traffic in accordance with Workcover requirements;

(l) Lighting may be required in accordance with the CPTED requirements, and energy saving lamps shall be used and timer switches are to be utilised for turning lights off after certain time when the park is not expected to be used at night to the satisfaction of Council;

(m) All proposed structures, cycleways and paths within public open space are subject to relevant standards and codes and shall require approval and subsequent inspection by the Certifying Authority. Such items also include gazebos, shelters, bridges, electric BBQ's, etc;

(n) All structures, cycleways and paths shall be designed to address public safety using the NSW Police ‘Safer by Design’ or CPTED guidelines; and

(o) All proposed furniture and public art installations for any street, reserve, park or other public open space area, shall be detailed in all Landscaping Plans to the satisfaction of Council.

2.2 MOUNDING WITHIN PUBLIC OPEN SPACE AREAS

A maximum gradient of 1(V):6(H) for all types of mounding in public open space is preferred by Council for a safer maintenance environment and a more manageable and effective growing environment.

The absolute minimum requirement for mounding within any public open space is:

(a) at a maximum gradient of 1(V):4(H).

(1) Note: This section also applies to mounding used for acoustic barrier purposes.

2.3 LANDSCAPING PLANS

Landscaping Plans, prepared by a qualified Landscape Architect qualified Ecologist or qualified Landscape Designer, must be submitted with the Development Application, in accordance with Shellharbour Council's current Engineering Design Specifications. Much of this type of information should be in council's docs which detail what's required to be submitted with a DA. City Development look after this. The DCP generally does not contain DA info requirements. It directs to Council's website for this.

The following details must be included in the Landscaping Plans:

(a) All hard and soft landscaping elements in any proposed public open space;

(b) All proposed recreational park landscaping and any proposed recreational or playground equipment, street and park furniture, retaining walls, street lights, ground levels, universal access, access path gradients, proposed signage at (park name at regulatory signs at park entrances), paths, bins, seating, public art or other hard landscaping items, to the satisfaction of Council;

(c) All trees and other vegetation proposed to be removed and trees and vegetation that are proposed to be retained;

(d) A planting schedule (reference should be made to Council's Planting List).

(e) The following elements:

(i) That the tree selected can stand alone as a feature tree;

(ii) Power/Gas/Water/Sewer/Cable lines;

(iii) Streetlights, powerlines and other above ground services;

(iv) Pruning and shaping resilience of trees;

(v) Easements, cycle ways and paths;

(vi) Provide essential shade and upper canopy; (along pedestrian routes)

(vii) Driveways and bus stops;

(viii) Pedestrian crossings;

(ix) Lot frontage width and house setbacks;

(x) Lateral spreading habits of trees;

(xi) Road verge and nature strip widths;

(xii) Waste service collections;

(xiii) Vehicle vision and other safety view lines; and

(xiv) Cultural and heritage amenity of the area or street.

The Landscaping Plans must clearly display if the design is only conceptual or is detailed enough for the Construction Certificate issue. A revision number, issue number and issue date shall also be clearly displayed on the Plans.

The Landscaping Plans shall be prepared by a qualified Landscape Architect, qualified Ecologist or qualified Landscape Designer. Landscape Plans are required to be submitted with the Development Application.

2.4 LANDSCAPE DOCUMENTATION

- Landscape plans are required to be submitted to Council for approval prior to the issue of the subdivision construction certificate and prior to construction of any landscape works or the removal of any vegetation associated with the development site.
- Landscape plans submitted to Council for all greenfield subdivisions are required to be prepared by a qualified landscape architect, the landscape plans shall be prepared in accordance to all Council policies and current landscape master plans relevant to the proposed development.
- Scaled elevation drawings are required for all greenfield subdivision developments.
- Council requires landscape plans for street trees to be a separate landscape package to landscape plans for open space areas e.g. District, Local and City Wide Parks. Street tree plans and open space plans are to be submitted together for the assessment approval for the subdivision construction certificate.
- All existing tree and or vegetation to be retained and or removed are to be shown on a landscape/vegetation plan with all detail drawings and specifications of tree/vegetation protection measures. Plans are to be submitted to Council with all landscape plans for the issue of the subdivision construction certificate
- The Landscaping Plans must demonstrate that the existing cultural and heritage amenity (where relevant), as well as any existing surrounding trees and ecological communities, have been a consideration in the preparation of the proposed planting schedule for the development site.
- Council requires the submission of all landscape plans one A3 copy and an electronic copy for assessment of approval of the proposed landscape design of all open space areas of the proposed greenfield subdivision. The landscape plan shall clearly indicate the following requirements:

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

	Playground equipment locations Soft Fall location Fencing, bollards etc locations Bus stops, driveway locations				

2.5 CLEARING OF EXISTING TREES AND OTHER VEGETATION

- Approval advice and information must be sought from Council prior to any removal, pruning, impact upon or disturbance of any existing trees, landscape feature or other vegetation within the Shellharbour Local Government Area.
- Landscaping Plans for any proposed development must clearly detail that the protection of existing trees and other landscape features, other than any existing trees and natural landscape features authorised for removal, pruning, impact upon or disturbance, will be carried out as specified in AS 4970.
- All initial procedures for the protection of existing trees and landscape features, as detailed in AS 4970, must be installed prior to the commencement of any earthworks, demolition, excavation or construction works on the development site.
- The works and procedures involved with the protection of existing trees and other landscape features are to be carried out by suitably qualified and experienced persons or organisations. This work should only be carried out by a fully insured and qualified Arborist.
- Suitable qualifications for an Arborist are to be a minimum standard of Australian Qualification Framework (AQF) Level 3 in Arboriculture for the actual carrying out of tree works, and Australian Qualification Framework (AQF) Level 3 in Arboriculture for the preparation of Preliminary Site Assessment, Development Impact Assessments, Tree Protection Plans, Tree Health Assessments and Tree Risk Assessments.

2.6 ROAD AREAS

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

2.7 DESIGN GUIDELINES AND REQUIREMENTS

2.7.1 Sporting Fields, Parks, Reserves and Other Substantial Public Open Space Areas

- The developer shall be responsible for the installation costs involved with the placement of adequate separate water and power meters as per the intended use of the subject site.
- The water and power meters will act alone from other metered services adjoining the site; during their maintenance and establishment period, the developer shall be responsible for all irrigation costs of the subject site,
- The developer shall be responsible for all electrical costs during their maintenance and establishment period relevant to the public open space site
- All structures, cycleways and paths shall be designed to address public safety using the NSW Police ‘Safer by Design’ or CPTED guidelines and any other relevant standards and policies
- All proposed furniture and public art installations for any street, reserve, park or other public open space area, shall be detailed in all Landscaping Plans to the satisfaction of Council.

2.7.2 Turf Areas within Public Open Space

- Turf species should be of a type which has a low water requirement and a high drought tolerant and shade tolerant where applicable
- Maximum grade of 1 in 6 is Council’s accepted maximum grade for maintenance of local, district, citywide parks and sports grounds
- Turf adjacent to a boundary fence must be constructed with a minimum 150mm width concrete mowing strip
- Turf is to be laid in a stretcher bond pattern with the joints staggered and close butted newly laid turf should be rolled or tapered to ensure roots contact with soil

- A daily water regime for 4 weeks in the summer months and twice weekly regime for 4weeks in the winter months is recommended.

2.7.3 Mounding within Public Open Space areas

- A maximum gradient of 1(V):4H for all types of mounding in public open space is preferred by Council for a safer maintenance environment and a more manageable and effective growing environment.
- The minimum requirement for mounding within any public open space and acoustic barrier purposes is at a maximum gradient of 1(V):4(H).
- Mounding can be sealed with the use of hydro-seed or planted with a native plant species using a mix of groundcovers, shrubs and trees.

2.7.4 Tree Gardens within Public Open Space

- Tree gardens shall be located at a minimum of 10 metre intervals and should be of a minimum width of 4mts
- Tree species selected for tree gardens must be a diverse mix of native and indigenous species and shall be a minimum size of 200mm pot size. Shellharbour Native Species Plant List can be sourced www.shellharbour.nsw.gov.au in Shellharbour Council's DCP Appendix 7
- Tree gardens shall be incorporated with native groundcovers with a maximum mature height of 1metre or less. Minimum pot size of 140mm should be used.
- Tree gardens are to be mulched at a minimum depth of 75mm with the use of an organic mulch. Leaf mulch mulched from the removal of any vegetation from the development site should be used.
- Tree beds are to be defined by a spade edge or timber edge.

2.7.5 Gradients

Grade Percentage	Rate of Slope H:V	Angle of Slope	Restrictions
100%	1 in 1	45 Degrees	Maximum grade for hand maintenance
50%	1 in 2	26.6 Degrees	Turf is undesirable- hydro-seed, hydro-mulch and stabilisation required
33.5%	1 in 3	18 Degrees	Maximum grade for tractor drawn mowers
25%	1 in 4	14 Degrees	Maximum grade for turfing, slashing and vehicle access
16.7%	1 in 6	9.5 Degrees	Optimum grade for mowing machinery
8.3%	1 in 12	4.8 Degrees	Maximum wheelchair ramp
2.5%	1 in 40	1.4 Degrees	Maximum for car parking area
2.0%	1 in 50	1.1 Degrees	Optimum grade for mulched surfaces. Maximum for playing fields
1.0%	1 in 100	0.6 Degrees	Optimum grade for competition playing fields

2.7.6 Landscape areas within Local, District Parks

- Landscape beds can be planted with the use of a mix of native and exotic plant species. Noxious and environmental weeds will not be accepted Noxious and Environmental Weed List can be sourced at www.shellharbour.nsw.gov.au in Shellharbour City Council DCP Appendix 7.
- All landscape beds are to be retained with a concrete edge at a minimum width of 125mm.
- All landscape beds are to be mulched with an organic mulch, cottage leaf mulch is Council's preference. Inorganic mulch will not be acceptable
- The installation of plants adjacent to any shareway or pedestrian pathway must be set back a minimum 500mm from the paths edge, trees with a mature height greater than 8mts are to be set back 3mts from any infrastructure
- The tree species Ficus spp, Toona australis, Araucaria spp and Melaleuca quinquevervia are to be planted at a minimum of 5mts from any infrastructure.
- Strappy leaf native grasses with a minimum mature height of 500mm shall not be planted within 1 metre of any pathway or cycleway in public open space areas
- Any space between the edge of a path and the roadside kerb, that is less than 1m in width, shall have lawn laid instead of native grasses as the landscaping
- Areas in public open spaces that will require mowing, repair, litter and weed control should be a maximum gradient of 1(V):6 (H) is this excessive suggest 1:4 (BH)to enable safe, efficient and effective maintenance, furthermore it must have a minimum 3 metres separation from live traffic in accordance with Workcover requirements

2.7.7 Open Space – Local, District & City-Wide Parks Planting Materials

- A friable soil blend or friable native mix certified to Australian standards AS 4419 is to be used for all landscape works
- Plant stock must be container grown, hardy and tolerant of the various soil and environmental conditions found in the Shellharbour LGA
- An application of a slow release or organic fertiliser with a NPK 19-6-12 is required for all landscape works, a lower Phosphorus ratio is required for native plant species. Fertiliser shall be apply as per manufacturers application instructions.
- Organic mulches, leaf litter and various types of bark-chip must be used on all landscape works, minimum 75mm depth, inorganic mulches are not acceptable.
- Spade Edging soil cut at a 70 degree with a garden spade removing sods from landscaped bed and spread throughout turfed area. Spade edging is recommended for native tree gardens and natural areas.
- Treated pine timber minimum size 100mm x 50mm secured to 50mm x 50mm timber pegs. Edging must be fitted flush with adjoining surfaces, pegs spaced at 1200mm intervals secured with galvanised screws on the planting side Nails are not acceptable
- Timber edging is recommended for use on street trees, native tree gardens and natural areas
- Plain concrete edging 125mmH x 125mmW constructed on 50mm compacted fine crushed rock, steel trowel finish with 10mm jointex at 3000mm centres. Concrete edging to lay flush with adjacent turf area.
- Minimum pot size of plant material are as follow:

Native Trees	25lt
Exotic Trees	45lt
Exotic Deciduous Trees	45lt or Bare Rooted
Native and Exotic Shrubs	200mm
Native and Exotic Groundcovers	140mm

2.7.8 Park Furniture & Fixtures – Local Park, District Park & City-Wide Parks

- All types of park furniture shall be mounted on a concrete surface, curved edges are a Council preference for ease of manoeuvrability for maintenance machinery
- Park furniture proposed within turf areas must be located a minimum of 3 mts from any landscape or standalone trees. Park furniture should be designed with surrounding landscaping
- Timber framed shelters with a skillion or gable Colorbond roofing. Shelters can either be painted, oiled or weathered to suit the character of the area.
- Seating, table seating & table setting park timber furniture shall be either oiled, stained, painted, aluminium, stainless steel, power-coated or oxidised with an open style leg preventing entrapment for rubbish
- Furniture or Fixtures in close proximity to a saltwater environment is to be all stainless steel with a minimum grade of 316 and/or timber with stainless steel
- Park signage to be erected within a landscape area, on feature walls and or erected on fencing. Park name to be a feature design and located at the entrance of the park.

2.7.9 Fencing

- Fencing proposed for active open space areas is to be an 1800mm high open style fence, galvanised steel and power-coated. Fencing is to be installed with a 150mm wide concrete mowing edge.
- Fencing proposed for passive open space areas is to be a maximum 1800mm lapped and capped timber fencing, installed with a concrete edge to contain any adjacent landscape beds. Fencing is preferred to be oiled or left to weather
- Landscaping proposed adjacent to fencing for active open space areas should be a minimum width of 3mts. Landscaping shall be planted with a mix of native species, Shellharbour Native Species Listing can be sourced at www.shellharbour.nsw.gov.au in Shellharbour City Council DCP Appendix 7. Planting shall be planted a minimum of 1mt back from the boundary fencing for maintenance.

2.7.10 Lighting

- Lighting may be required in accordance with the CPTED requirements, and energy saving lamps shall be used and timer switches are to be utilised for turning lights off after certain time when the park is not expected to be used at night to the satisfaction of Council

2.7.11 Bollards

- Bollards should be a minimum height of 900mm above ground and 300mm below ground with a minimum 140mm diameter.
- Bollards are to be set back a minimum 500mm from any shareway or pedestrian pathway, bollards installed within a shareway are to be fitted with reflectors
- Bollards are to be installed with the addition of landscaping. Bollards constructed in turf areas is not permissible unless otherwise approved by Council.
- At the point of vehicle access of a share way removable lockable bollards are to be installed preventing unauthorised vehicles entering onto the reserve

2.7.12 Waste Receptacles

- All waste and recycle receptacle enclosures are to mounted on a concrete pad
- receptacle enclosures are to be a 240 litre capacity, clearly marked general waste and recycle, must be fitted with a hood a perforated casing fitted with a hexagon key lock

- Timber, galvanised steel, power-coated and stainless steel materials are acceptable
- All waste and recycle receptacles must be placed a maximum distance of 55 metres from the back of the kerb with a clear pathway for servicing. Steps will not be acceptable.

2.7.13 Bike Racks

- Bike racks must be mounted on a concrete pad and should be located at a reserves or parks point of interest or adjacent to shareway
- Bike racks should be stainless steel not power-coated

2.7.14 BBQ Units

- Easily accessible for all inclusive user groups
- BBQ units to be electric only, and comprise stainless steel

2.7.15 Drinking Fountains & Tap Outlets

- Irrigation and drinking water outlets shall be provided by the developer at regional and district parks, reserves and sports grounds to the satisfaction of Council
- Water outlets are to be provided at 60metre spacings, installed within landscaped areas, fitted with a tap key and should be a minimum height of 500mm from ground level. Quick coupling valves clearly marked above ground level can be installed within the tree gardens.

2.7.16 Playground Equipment – Local & District Park

- The design of a play space should be an innovative play space incorporating movement, sound and water play and is subject to the all-inclusive play space policy 'Everyone Can Play'
- Structured and natural playground equipment/areas are to comply with the AS 4486.1 Playgrounds and playground equipment
- Local parks are required to be fitted with a minimum of 3 items of play equipment, district parks are required to be fitted with a minimum of 5 items of play equipment.
- A certification report for the installation of the play equipment and soft-fall must be submitted to Council prior to the issue of the practical completion certificate.

2.7.17Soft-Fall Materials

- Mulch soft fall material for natural play areas must be a minimum of 300mm uncompacted depth, lined with filter fabric ,fitted with agline connected to stormwater system. Mulch soft fall to be contained with a 150mm width concrete edging.
- Rubber Wetpour soft fall material for structured play equipment must be installed as per AS…. Rubber crumb depth is calculated on the height of fall. Rubber crumb to be installed on a 150mm depth mechanically compacted road base, blue metal dust (5mm crushed limestone and 7mm fine road base). Wetpour soft fall is to be contained with a minimum 300mm width concrete edging.

2.7.18 Minimum Requirements for Park Furniture & Park Fixtures

Local Park	District Park	Citywide Park
3 Items Structured Play Equipment	5 Items Structured Play Equipment	Information Signage
Natural Play	Natural Play	Fitness Equipment

Picnic Table Setting	Picnic Table Setting 1 per BBQ	Table Setting
Seating with back	Seating with back 1 per 50m2	Seating
Shelter	Shelter	Shelter
Shade Provision - Structure/Natural	Waste & Recycle Receptacle Enclosures	Amenities
Service Meters	BBQ 1 x Disable BBQ 1	Drinking Fountain
Fencing	Bike Rack	Bike Rack
	3 x Fitness Equipment	Wi-Fi
	Lighting	Fencing
	Shade Provision - Structure/Natural	Car Parking
	Amenities	
	Drinking Fountain	
	Service Meters	
	Wi-Fi	
	Fencing	
	Car Parking	

8200 RECYCLED MATERIAL

1 GENERAL

1.1 INTRODUCTION

There is a need to conserve natural aggregates and to use recycled concrete, bricks, tiles and asphalt to reduce the amounts of these materials going to landfill. This can be achieved by incorporating the use of these materials into new civil works and subdivision design in certain circumstances. Please contact Council for prior written approval backed up by appropriate evidence.

2 GREENSPEC

The Institute of Public Works Engineering Australia (IPWEA) in conjunction with the EPA in 2010 released Specification for the Supply of Recycled Material, commonly referred to as Greenspec. The document provides a specification for the supply of recycled materials, primarily crushed concrete, brick and reclaimed asphalt.

Recycled materials can be used for the following uses;

- Road Base (Class R1/Class R2);
- Select fill (Class S) for use on subgrades to enhance strength or for raising site levels beneath paved surfaces and buildings;
- Bedding Material (Class B);
- Drainage Medium (Class D10/Class D20/Class D75);

Recycled materials must conform to the IPWEA Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage (2010).

The Supplier of recycled materials used in subdivisions must provide test certificates from a National Association of Testing Authority (NATA) accredited laboratory confirming that the material complies with the appropriate standards as outlined in the IPWEA Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage (2010).

If it is proposed to use recycled materials, please contact Council for the requirements to be met and Councils consideration of approval. The material should not be sourced until approval is granted. The use of recycled material requires written approval of Council.

3 EPA RESOURCE RECOVERY EXEMPTIONS AND ORDERS

The NSW EPA provides a list of current resource recovery orders (orders) and resource recovery exemptions (exemptions) in force in NSW for commonly recovered and reused wastes including;

- Reclaimed Asphalt Pavement;
- Recovered Aggregate;
- Recovered Glass Sand

Contractors can use an order and exemption without EPA approval however, all conditions of an order and exemption must be met for the reuse of recycled materials to be lawful.

4 RECLAIMED ASPHALT PAVEMENT

Reclaimed Asphalt Pavement Material used should comply with Roads and Maritime Services (RMS) QA Specification 3153.

5 COAL WASH NOTES

The coal wash Rejects Order specifies the chemical composition of the coal wash reject to be used.

6 NATIVE VEGETATION CLEARNING MEASURES AND MITIGATION

6.1 PRE-CONSTRUCTION SPECIFICATIONS

Pre-clearance fauna survey conducted by a suitably qualified ecologist must be conducted one day prior to clearing works.

Retained trees and native vegetation

- Tree protection zones (TPZ) must be established according to Shellharbour City Councils Development Control Plan (DCP) Section 20.8.4 and 20.8.5;
- Areas of retained native vegetation must be fenced and managed as no go zones as specified for TPZ's in according with Section 20.8.5 of the DCP.

Tree Removal

- Trees identified to be removed must be identified and confirmed by an arborist prior to felling works;
- All felling works must be completed by a qualified arborist and an ecologist must be onsite during felling works.

6.2 DURING CONSTRUCTION WORKS SPECIFICATIONS

Ecological Impact Management

- Materials and machinery must be stored away from drainage lines to minimise pollution run-off risk
- Sterile cover-crops are to be used to stabilise soil post earthworks
- Sediment and runoff control measures must be installed to prevent runoff entering adjacent bushland
- Noxious weeds within retained vegetation areas must be controlled and managed according to their specifications outlined in the Illawarra District Noxious Weeds Authority (IDNWA) website.
- Vegetation clearing must only occur within designated clearing zones specified in development plans [Plan Name; Number; Author; Date]
- Washing of machinery prior to the entry of the development site to minimise noxious weed spread.
- Ongoing weed control to minimise the impacts of edge effects on vegetation surrounding development site.

Reuse of woody debris and bush rock onsite to provide fauna habitat should be conducted according to RMS (2011) Biodiversity Guidelines Guide 5: Re-use of woody debris and bush rock.

7 ANNEXURE

7.1 ANNEXURES - REFERENCED DOCUMENTS

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

IPWEA/EPA	2010	Specification for the Supply of Recycled Material (Greenspec)
IPWEA	2010	Supply of Recycled Material for Pavements, Earthworks and Drainage
RMS		QA Specification 3153
RMS	2011	Biodiversity Guidelines Guide 5: Re-use of woody debris and bush rock