DOCUMENT CONTROL

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1 Introduction

1.1 PURPOSE

The UWA Design and Construction Standards (the *Standards*) outline UWA's expectations for its built forms in order to achieve consistency in the quality of the design and construction of those built forms. They are aligned with the UWA's *Campus Plan 2010* planning principles and UWA's requisites for aesthetic appeal, maintainability and environmental sustainability, while ensuring that there is sufficient scope for innovation and technological advancements to be explored within each project.

The Standards are intended for use by any parties who may be involved in the planning, design and construction of UWA facilities. This includes external consultants and contractors, UWA planners, designers and project managers as well as faculty and office staff who may be involved in the planning, design, maintenance or refurbishment of facilities. These Standards also provide facility managers, maintenance contractors and other service providers with an understanding of UWA services in order to assist in the maintenance and operation of facilities.

1.2 SERVICES

The UWA Design and Construction Standards for **Civil Works** (this document) are a part of UWA Design and Construction Standards set of documents (the Standards). The Standards are divided into the following service documents for ease of use, but must be considered in its entirety, regardless of specific discipline or responsibilities:

A Building and Architecture
B Mechanical Services
C Electrical Services
D Communication Services
E Hydraulic Services
F Security Services
G Fire Services and Fire Safety Engineering
H Structural Works
I Civil Works (this document)
J Irrigation Services
K Sustainability
L Vertical Transport

1.3 RELATED DOCUMENTS

1.3.1 University Documents

The Standards are to be read in conjunction with the following relevant University documents:

- UWA General Preliminaries Document
- UWA Specification for As-Constructed Documentation
- Relevant UWA planning and policy documents such as the *UWA Campus Plan*, *UWA Masterplan*, *Landscape Vision* and *Integrated Infrastructure Strategy*, *University Policy on Alterations to University Buildings*, etc.
- Relevant UWA operational and maintenance documents such as preferred vendors lists, room data sheets, operational and maintenance manuals, etc.
- Other documents as referenced within the *UWA Design and Construction Standards*.

1.3.2 Relevant Legislation

The planning, design and construction of each UWA facility must fully comply with current relevant legislation, including but not limited to:

- Relevant Australian or Australian / New Zealand Standards (AS/NZS),
- National Construction Code (NCC),
- Occupational Safety and Health (OSH) legislation,
- Disability Discrimination Act (DDA),
- Accessibility Aspiration Design Factors, and
- Local council and authority requirements.

1.3.3 Manufacturer Specifications and Data Sheets

All installation must be carried out in accordance with manufacturer specifications and data sheets to ensure product performance over its intended life and so as not to invalidate any warranties.

1.3.4 Project Specific Documentation

Requirements specific to a particular project, campus or other variable, will be covered by project specific documentation, such as client briefs, specifications and drawings. These Standards will supplement any such project specific documentation.

The Standards do not take precedence over any contract document, although they will typically be cross-referenced in such documentation.

Extracts from the Standards may be incorporated in specifications, however it must remain the consultant's and contractor's responsibility to fully investigate the needs of the University and produce designs and documents that are entirely 'fit for purpose' and which meet the 'intent' of the project brief.

1.4 DISCREPANCIES

The Standards outline the University's generic requirements above and beyond the above mentioned legislation. Where the Standards outline a higher standard than within the relevant legislation, the Standards will take precedence.

If any discrepancies are found between any relevant legislation, the Standards and project specific documentation, these discrepancies should be highlighted in writing to the Associate Director Capital Works, Campus Management.

1.5 DEPARTURES

The intent of the Standards is to achieve consistency in the quality of the design and construction of the University's built forms. However, consultants and contractors are expected to propose 'best practice / state of the art' construction techniques, and introduce technological changes that support pragmatic, innovative design.

In recognition of this, any departures from relevant legislation, or the Standards, if allowed, must be confirmed in writing by the Associate Director Capital Works, Campus Management.

Any departures made without such written confirmation shall be rectified at no cost to UWA.

1.6 PROFESSIONAL SERVICES

For all works, it is expected that suitably qualified and experienced professionals are engaged to interpret and apply these Standards to UWA projects. Works cannot be carried out by unqualified and unlicensed consultants or contractors.

Campus Management administer the online contractor safety induction. Upon completion the contractor will be issued with a UWA Contractors Safety Induction Card which they are required to carry at all times when working for the University.

1.7 STRUCTURE OF DOCUMENT

This document is structured into 4 parts:

Part 1 Introduction (this Section)

Part 2 General Requirements – outlines the general requirements or design philosophies adopted at UWA

Part 3 Checklist for project team – checklist of items for consideration at various stages of a project

Part 4 Specifications (if applicable) – materials specifications and/or preferred lists for materials, processes or equipment used by UWA.

1.8 DEFINITIONS

For the purpose of this document, the following definitions apply:

Can: Implies a capability of possibility and refers to the ability of the user of the document, or to a possibility that is available or might occur.

May: Indicates the existence of an option.

Shall: Indicates that a statement is mandatory.

Should: Indicates a recommendation.

2 General Requirements

2.1 CIVIL WORKS SCOPE

The requirement for the design of civil engineering services within UWA sites include but is not limited to the following:

- Earthworks
- External non-building earth retaining structures
- Stormwater drainage treatment and disposal
- Roadways
- Parking areas and other hardstand areas (loading areas, etc.)
- Pedestrian and cyclist paths
- Roadway, parking and hardstand area pavements including segmental paving treatments

Connections to external infrastructure should be designed in accordance with the relevant Authority's standards.

2.2 STANDARDS AND CODES

Design and construction of the civil works shall comply with all relevant statutory and UWA requirements, including the UWA *Design and Construction Standards* of other services.

A list of Standards and Codes are provided within the *References* section of this document. This does not represent an exhaustive list, and additional Standards and Codes shall be adopted as necessary to suit individual project requirements.

Care shall be taken to ensure current editions of all relevant Standards and Codes are adopted for the Civil Works.

All documents referenced by the relevant Standards and Codes shall be considered integral for compliance purposes.

2.3 DESIGN REQUIREMENTS

The civil works design must:

- minimise whole of life costs
- maintain a philosophy of simplicity and maintenance minimisation
- be capable of performing over the planned Service Life at the prescribed level of safety and serviceability under all actions to which they may reasonably be subjected
- interface seamlessly with all other civil works, landscape works and structures on adjacent sites, including the adjoining roadways, services and pedestrian areas.

- be based upon geotechnical design parameters established by geotechnical investigation
- take into account the effects of any ground improvements and earthworks on structures, services and infrastructure on the project site and adjacent sites.

2.3.1 Safety in Design

Safety in Design as required by legislation shall be undertaken for all projects.

2.3.2 Survey Information

Survey information shall be provided in Australian Height Datum (AHD). The co-ordinate system to be used should generally be Perth Coastal Grid (PCG94) or Map Grid of Australia (MGA50).

2.3.3 Existing Services

Existing Services are to be clearly shown on drawings.

2.4 EARTHWORKS

2.4.1 Earthworks Design

Where practical, areas shall be re-graded to minimise the necessity for underground drainage systems with surface inlet pits, and allow surface water to flow naturally to roads or drainage reserves without excessive concentration.

The design of site re-grading areas shall be considered with the objective of balancing cut to fill and achieving both an economical development and minimising haulage of imported fill or spoil to and from the development site. Bulk haulage should always be considered an adverse effect on adjacent development and infrastructure.

Unless protected by vegetation or some other appropriate means, slopes for earthworks shall be designed at sufficiently shallow grades, or sufficiently short runs, that significant erosion of material is unlikely.

The effect of the adjacent sites on the civil engineering works shall be considered, including:

- levels at boundaries;
- vehicular and pedestrian access routes, including gradients and traffic management;
- stormwater drainage, including major event overflow routes, which may need to cross other sites;
- services tunnels;
- existing road and pedestrian junctions; and
- local resident and businesses.

Provide any earthworks and site preparation works on the site, additional to the bulk earthworks, necessary to accommodate the works.

The earthworks and site preparation strategy shall be developed to the satisfaction of UWA and address the following:

- An on-site mass balance (cut / fill)
- Avoiding the need to import material onto the site. This applies particularly to the need for die-back free material.
- Avoiding a net export of soil from the site if possible
- Stability of batters (geotechnical slope stability and durability under weather)
- Gradients of batters for maintenance purposes (e.g., mowing or garden maintenance)
- Minimising the need for on-site earth retaining structures between levels
- Coordination of levels between UWA and adjacent sites and roadways to minimise the need for on-site earth retaining structures
- Gradients for mobility and access considerations
- Avoidance of trapped low points
- Provision of overland flow routes
- Coordination with other disciplines.

2.4.2 Specific Design Requirements

Alleviate flooding of infrastructure by creating major storm event flow paths after underground stormwater piping has been installed. Care shall be taken to provide depressions for overland flow from low points and over major drainage lines, to direct stormwater for storms up to a 100 year average recurrence interval.

Provide improved run-off from flat ground.

Re-grade excessively steep slopes that would preclude economical construction of building foundations or prevent effective use of the site. Batter slopes should generally not be steeper than 1 in 6 for the purpose of lawn maintenance.

Consider the implications of site re-grading in relation to the existing natural environment. Generally site re-grading shall be minimised in heavily vegetated areas.

Any imported fill material will be clean and free from organic or other deleterious materials, and be suitable for future use of the site. The designer will specify the fill material properties to ensure this.

The design must meet the requirements of the *Contaminated Sites Act 2003* and if there is any suspicion or knowledge that the site may be contaminated, the reporting and other actions required by the *Act* must be implemented.

Any excavated material that is not required on site will be disposed of in compliance with statutory requirements and local government regulations and in such a way as to support the project objectives.

The following design requirements and standards apply to minor earthworks:

- Batter slopes must not exceed the following limits:
- Lawn areas – 1 vertical : 4 horizontal maximum
- Other landscaped areas – 1:2 to 1:4 vertical : horizontal
- Stone pitched or other surface treatments – 1:1 to 1:2 vertical: horizontal.
- Refer project specific earthworks specifications for compaction requirements and tolerances.

2.5 ROADWORKS

2.5.1 Design Objectives

2.5.1.1 Roads

The road design shall reflect features that provide for a safe and practical road system that can be maintained by UWA at a reasonable cost.

The road design shall provide:

- coordination of vertical and horizontal alignments
- fitting the road to the natural contours of the land
- preservation of natural features (including vegetation)
- using higher than minimum standards to provide a functional and aesthetically pleasing road network
- the practicalities of building requirements
- the provision of public transport facilities where required
- The long-term maintenance of roads

Issues to be addressed include:

- Traffic engineering including the determination of traffic volumes for each internal roadway, circulation patterns, design vehicles and traffic controls (Give Way, Stop, roundabout, etc.)
- Level relationships of internal roadways to the external precinct roadways, including gradients of ramps, lines of sight at intersections / cross-overs
- Horizontal location relationships of internal roadways to external precinct roadways, including proximity of intersections / cross-overs to adjacent intersections / cross-overs, sight lines and vehicle – pedestrian interfaces
- Horizontal alignments, including lane configurations, on-road cycling lanes, curve radii and the accommodation of the design vehicle swept paths (including ramps)
- Vertical alignments, including gradients (including ramps), sight lines, crest and sag curves (bottoming out of

design vehicles), clearances to structural elements, the relationship to adjacent pedestrian path gradients and stormwater drainage (trapped low points, gutter flows, etc.)
- Traffic regulatory signage and line marking
- Liaison with other design consultants for lighting, University signage and landscaping requirements.

All road and kerb design and construction must comply with relevant standards and codes.

Provide opportunities for a variety of construction techniques, materials and treatment of roadways e.g., the use of porous pavements or cobbled stone effect to reduce car speeds and improve aesthetics.

Disabled parking to be appropriately designed and located close to building entrances and major pedestrian routes to provide convenient access for people with disabilities.

Kerbs must not present barriers to pedestrian or cyclist movement paths.

Roads shall be designed to give the best possible grade to suit the natural ground conditions and minimise the amount of cut and fill.

The layout, gradient, engineering design and pavement design of the loading areas, access ways, paths (pedestrian, cyclist and shared use paths), permanent vehicle parking areas must be designed to:
- select appropriate pavement and surfacing materials, types, layer thicknesses and configurations to ensure that the pavements performs adequately and requires minimal maintenance under the anticipated traffic loading over the service life
- select materials for the sub-grade, sub-base, base and wearing course, to meet the required service life of the pavement taking into consideration all traffic loading and environmental factors when selecting materials
- accommodate design loadings, including design vehicle types and numbers to determine equivalent standard axles (ESA) and special vehicle loadings (e.g., cranes)
- withstand all applied loadings and be suitable for all vehicle movements associated with all traffic likely to be experienced by the loading areas and vehicle parking areas over their service life, including private vehicles, emergency services vehicles, maintenance service vehicles, operational vehicles and specialist vehicles relating to event uses, including Pantech trucks and semi-trailers;
- withstand all applied loadings and be suitable for all vehicle movements associated with construction traffic
- the access around the perimeter of the works for fire tenders must comply with DFES requirements for access for fire emergency services vehicles.

All pedestrian surfaces must be designed for universal access.

Pavements must be designed with falls to facilitate shedding of water and prevent ponding.

2.5.1.2 Pavement

Regardless of the type of road pavement proposed, the design of the pavement shall involve consideration of the

following five input variables:

- Design traffic
- Subgrade evaluation
- Environment and drainage
- Pavement and surfacing materials
- Construction and maintenance considerations

The pavement design shall be undertaken in accordance with *AustRoads 2008, Guide to Pavement Technology Part 2: Pavement Structural Design*.

The environmental factors which significantly affect pavement performance are moisture and temperature. Both of these factors must be considered at the design stage of the pavement.

Issues to be considered include:

- Design loadings - including design vehicle types and numbers to determine equivalent standard axles (ESA) and special vehicle loadings (e.g., cranes)
- Pavement types – including identifying areas of flexible asphalt pavements (general at-grade pavements) and rigid pavements (in close proximity to ground water levels or where hydrocarbons or tyre shearing loads could cause surface pavement failures) and segmental brick paving (delineation / decorative)
- Subgrade preparation requirements.

2.5.1.3 Paths/cycle paths

All pedestrian paths and cycle paths must be designed in accordance with *Austroads Guide to Traffic Management, Guide to Road Design* and *AS 1428.1 Design for Access and Mobility*. In the event of conflict between the standards, *AS 1428.1* must take precedence.

Paths and paved areas shall be designed to eliminate trips, slips and falls. Adopt accessible gradients in accordance with current standards and safe separation of bicycles.

Paths and paved areas shall be designed to ensure accessibility at kerbs when paths intersect with roadways. Provide hazard and/or directional tactile indicators for visually impaired at required locations.

Provide clear and easy movement throughout the site.

Provide safe durable surfaces integrated within designs.

Major circulation paths shall be capable of vehicular use.

The design of pathway and paved areas strength must consider whether they form part of an emergency access route for emergency vehicles.

Materials to be durable, low maintenance, and where suitable, match existing adjacent pavement design adopted at UWA.

The use of permeable pavements is encouraged, however, consideration must be given to its limited structural strength compared to conventional pavement.

Issues to be addressed include:

- Alignments
- Gradients, including access and mobility requirements (ramps and landings)
- Pavement materials
- Stormwater drainage
- Roadway interfaces (ramps, traffic controls)
- Signage and line marking.

2.5.1.4 Pedestrian Crossings

Raised pedestrian crossings are preferred.

Pedestrian crossings shall be designed in accordance with Australian Standards and DDA requirements. Pedestrian crossings near driveways must be minimised and any adjacent bushes or shrubs must not obscure the view of motorists or pedestrians approaching the crossing.

Pedestrian crossings shall be designed to ensure accessibility at kerbs when paths intersect with roadways.

2.5.1.5 Car parks

Water Sensitive Urban Design must be implemented for all car parks.

Use landscaping to screen, shade and enhance the appearance of car parks. Tree planting must target 20% shade cover within 5 years.

Provide opportunities for a variety of construction techniques, materials and treatment of parking areas e.g., the use of porous pavements.

Provide appropriately designed car parks to meet the need of special users including people with disabilities.

Ensure safe and convenient pedestrian access from vehicles and facilities.

Ensure safe and convenient traffic circulation.

Minimise conflict between service vehicles and other car park users.

Provide sufficient turning areas on site to ensure vehicles can exit in a forward direction.

Issues to be addressed include:

- Number of internal parking bays required, including type (emergency vehicle; courier or short term; long term; staff; disabled, visitor, etc.) and ticketing and security requirements

- Vehicle circulation movements, aisle configurations (one-way / two-way)
- Parking bay and aisle dimensions
- Vehicle swept paths, including ramps and the proximity to structural elements such as walls and columns and reversing and other movements particularly for service vehicles at loading docks or other facilities
- Levels and gradients, including ramps, parking area grades with respect to door opening, pedestrian interfaces, stormwater drainage and the relationship of pavement levels to building items such as loading docks
- Traffic regulatory signage and line marking.

Co-ordinate with other services consultants for provision of services such as, lighting, access control, CCTV, ticketing, signage and landscaping requirements.

2.5.1.6 Traffic Management

Speed humps must only to be used on paved roads where other means of slowing vehicles is not available.

All speed humps must be constructed, sign posted and marked in accordance with the relevant Australian Standard, preferably of recycled content material.

2.5.1.7 Signage

All vehicular, cyclist and pedestrian traffic shall be directed by suitable directional, informative, regulatory or warning signs.

Signs are required for the following purposes:

- To control traffic movement and driver behaviour (e.g., speed);
- To warn against hazards to personal safety or potential damage to vehicles
- To direct and inform drivers, cyclists and pedestrians entering and circulating within UWA's public spaces.

Regulatory signs relates to the descriptions and functions of the types of signs in *AS 1742.1* (*The Manual of Traffic Control Devices)*.

Signage suitable for parking areas and access is provided in *AS/NZS 2890.1* and *AS/NZS 2890.6.*

2.5.1.8 Linemarking

Linemarking shall be employed to enhance the safety of vehicles, cyclists and pedestrians by providing clear delineation of designated areas of use and warnings of restrictions.

It shall:

- Designate parking bays for general and restricted use (such as disabled and loading bays)

- Identify areas of road pavement or paths set aside for specific purposes such as cycle lanes or pedestrian crossings
- Identify potential hazards, such as traffic calming devices, to users
- Provide visual and, where appropriate, tactile information to users of behavioural requirements, such as using lines for stopping control or arrows for turn control
- Aid direction finding by indication of route direction during times of low visibility
- Be used in conjunction with signs where appropriate

Pavement messages, such as KEEP CLEAR, may be used where appropriate unless they are likely to create a hazard by significantly reducing the skid resistance of user's vehicles.

2.5.2 Design Performance Requirements

The following design requirements and standards apply to UWA internal site roadways:

- Internal roadways and intersections must be designed in accordance with *Austroads Guide to the Geometric Design of Urban Roads*, however the designers should consider the applicability of the standards to the low speed environment on these roads.
- The design speed for all internal roads must be 40km/h, however roads may be locally posted / signed to lower operating speeds as appropriate to the location and environment.
- Traffic regulatory signage and line marking must be designed in accordance with *AS 1742*.
- Normal crossfall to be 3%.
- Longitudinal grades must be as follows:
    - Minimum grade 0.3%
    - Maximum grade 5% (other than short ramps)
- The design vehicles for internal intersections must be the larger of a 12.5m rigid single unit truck and a 19.0m semitrailer.
- Dead-end roadways must be avoided where possible. If required dead-end roadways must have a cul-de-sac head capable of turning a 12.5m single unit truck in a single movement
- Kerbing for internal roads must be semi-mountable profile.

2.5.2.1 Road Geometric Layout

The Geometric layout of roads within the campus must consider the expected traffic volume, operating speed and vehicle access.

Unless specified otherwise, the Geometric Layout should be designed for the following:

- Operating Speed – 20km/h
- Design Vehicle – single unit truck/bus with a turning radius of 12.5m

- Minimum kerb radius at intersections – 6m
- Minimum Carriageway width – 5.5m

Adequate provision shall be made in the design of median islands for the safety of pedestrians and cyclists. Islands shall have a minimum width of two metres with an absolute minimum width of 1.2 metres at the crossing location.

2.5.2.2 Road Grades

General

Within the campus, road grades shall be designed to be less than 10% and greater than 0.5%.

A vertical curve shall be provided where there is a change of grade greater than 1%.

Road Crossfalls

Crossfall of roads within the campus should generally be 3%. Roads may be crowned at the centre line or one way crossfall.

Inverted crowns may be considered in circumstances where it is beneficial for stormwater drainage disposal.

Verge grades

Where provided, verges should be graded at 2% from the top of the kerb for a minimum of 2m. Verges may be graded to suit the site topography if there are no adverse effects on stormwater drainage disposal.

2.5.2.3 Kerbing

Kerbing shall be provided to all roads and intersections unless specified otherwise.

The kerb types and typical uses permitted within UWA are:

- Flush Kerb
    - Adjacent to open space areas and non-active areas to achieve water sensitive urban design outcomes.
    - The edges of through carriageway
    - Car parks
    - Median islands where water sensitive urban design is used.
- Mountable Kerb
    - Roads where access for maintenance vehicles is required.

- Semi-Mountable Kerb
    - Median Islands.
    - Channelisation islands.
    - Sweeps at Intersections
- Barrier Kerb
    - Roads abutting public open space. Where water sensitive urban design is not used on open space areas the standard kerb adjacent to the open space should be barrier to prevent intrusion by vehicles.
    - Roads in which future paths will be constructed adjacent to the kerb line.

2.5.2.4 Pavement

Pavement designs shall be undertaken in accordance with the following documents:

- *Pavement Design – A Guide to the Structural Design of Road Pavements (Austroads, 2004)*
- *A Guide to the Design of New Pavements for Light Traffic (APRG Special Report No. 21, 1998)*
- *Main Roads WA Engineering Road Note 9 – Procedure for the Design of Flexible Pavements.*

Concrete segmental pavements can be designed where design traffic is > 10^6 ESAs using:

- *Concrete Masonry Association of Australia Concrete Segmental Pavements - Design Guide for Residential Accessways and Roads (CMAA-T45)*

Design life of pavements

The minimum design life of the pavement must be as below unless specified otherwise.

- Permanent deformation of the granular pavement - 40 years.
- Open graded asphalt – 10 years
- Dense graded asphalt 50mm total thickness or less – 20 years fatigue life
- Dense graded asphalt > 50 mm total thickness – 40 years fatigue life

Pavement thickness

Notwithstanding the design thickness obtained using the above guidelines, an accepted minimum pavement for roads in sandy soil conditions comprises:

- Sub-Base Course
    - Material – Limestone
    - Thickness – 150mm to 225mm
- Base Course
    - Material – Thicklift Asphalt (AC14)
    - Thickness – 40mm to 50mm

- Wearing Course
    - Material – Asphalt (AC10)
    - Thickness – 25mm

Alternative pavement profiles using different materials may be accepted for use if designed appropriately.

In non-sandy soil conditions, a pavement design shall be based upon the design traffic and ground conditions as reported in the Geotechnical report.

The sub base layer needs to be devoid of all organic material (living or dead) and shall extend a minimum of 150mm behind the rear face of any kerbing. The base and surfacing shall extend to the face of any kerbing.

Where the top surface of the sub base layer is below the level of the underside of the kerbing, the base layer shall also extend a minimum of 150mm behind the rear face of the kerbing.

Wearing course

The wearing course on all roads shall generally be 25mm asphalt directly applied to the asphalt base course.

Heavy duty trafficable bricks or blocks with a minimum thickness of 76mm, laid strictly in accordance with the manufacturer's recommendations and designed according to intended loads (pedestrian, light vehicle or industrial vehicle) may be considered to replace the wearing and base courses.

Selection of suitable pavement wearing surfaces shall be in accordance with *AustRoads Guide to the Selection of Road Surfacings*.

Segmental paving units subject to vehicular traffic must be heavy duty pavers laid in a herringbone pattern on sand bedding over a 150mm crushed limestone basecourse.

All paving must have a header course. Header courses must be laid on a prepared mortar bed unless laid against a concrete kerb that provides adequate lateral restraint.

2.5.3 Footpath/Cycle Paths

Paths should be designed using the appropriate Australian Standard and Department of Transport's *Guidelines on Planning and Designing for Pedestrians*.

The following design requirements and standards apply to pedestrian and cyclist paths:

- Internal pedestrian paths must be designed and detailed in accordance with *Austroads Part 13 Pedestrians* and *AS 1428*. In the event of conflict *AS 1428* must take precedence.
- Internal cycle paths must be designed and detailed in accordance with *Austroads Part 14 Cylists* and *AS 1428*. In the event of conflict, *AS 1428* must take precedence.

Minimum Path widths shall be:

- Pedestrian Only – 1.8m wide

- Cycle Path Only – 2.5m
- Shared Paths – 3.0m

Paths should be constructed of the following materials unless specified otherwise:

- Pedestrian paths – brick paving
- Cycle paths are to be hot mix asphalt.
- Paths shall be designed to withstand being traversed by maintenance and emergency vehicles.

Inspection pits and manhole cover lids may be located within footpaths only in cases where it is absolutely unavoidable.

Cycle/wheelchair ramps shall be provided to kerbs at all intersecting pathways with roadways, carparks and adjacent to buildings.

Car noses or tow bars protruding onto pedestrian paths must not reduce the width of those paths below minimum allowable widths. Extend path widths so that car noses or tow bars do not compromise minimum allowable widths. Consider the use of garden beds, lawn or changes in path texture to separate the accessible path from the car park. Wheel stops can be used as a last resort.

Ensure paths and ramps are clear of objects that a cane can go underneath or that protrudes into a delineated pathway. If this cannot be achieved, then provide tactile pavers around base of the objects.

Paths are to be clear of obstructions such as light poles.

Kerb ramps must not reduce the unobstructed path width.

Kerb ramps are to be constructed to the local government standard details, and meet all requirements for tactile indicators, in accordance with *AS/NZS 1428.4*.

Kerb ramps widths (not including feathering or curving to blend with kerbs) are to be the full width of the paths they associate with.

A defined pedestrian crossing must meet the statutory requirements. A crossing must include tactile markers on either end, where the crossing meets a path.

2.5.4 Parking

As a minimum parking facilities should be designed in accordance with the following documents:

- *Austroads Guide to Traffic Management Part 11: Parking*
- *AS/NZS 2890 – "Parking Facilities"*

The number of parking bays will be determined by UWA parking policy, local authority requirements and project specific requirements (e.g., visitor parking bays).

UWA has specific requirements for car park signage and ticket machines. Refer UWA Campus Management for

further information.

Disabled access parking bays are to make up a minimum of 2% of any main car-park area, unless specified otherwise.

Disabled access parking bays must be located as close as is practicable to accessible routes and likely destinations.

A maximum of 120.0 m travel should be allowed between disabled access bays and likely destinations.

Overhead obstructions including trees and branches are to be a minimum of 2.5m above ground level in parking areas.

Car-parking areas must be serviced with accessible kerb ramps with no more than 10.0 m travel distance from car to ramp. Accessible kerb ramps shall be clearly visible and be located near access parking areas.

Wheel stops or single 'raised' kerbs shall be avoided. If unavoidable, wheel stops shall be positioned so they are not hazardous. They shall be clear from paths and kerb ramps. If possible, islands shall be used in preference to wheel stops. Only low profile wheel stops shall be used.

The following design requirements apply to site parking and hardstandings:

- UWA site parking must be designed in accordance with *AS/NZS 2890.1*.
- Parking user classes as defined in Table 1.1 of *AS/NZS 2890.1* must be appropriate to the parking area users.
- Hardstanding areas for commercial vehicles must be designed in accordance with *AS/NZS 2890.2*.
- Parking spaces for people with disabilities must be designed in accordance with *AS/NZS 2890.6*.
- Hardstanding areas adjacent to loading docks and other delivery facilities must have appropriate sections of level paving to suit the dock layout and height.

2.5.5 Traffic management

Traffic management design shall comply with *Austroads Guide to Traffic Engineering Practice Parts 1–14* and *Guidelines for Local Area Traffic Management (Main Roads WA).*

Physical speed restricting devices should be used to reduce the speed of vehicles where necessary.

2.5.6 Signage

Signs shall be designed in accordance with *AS 1742* unless specified otherwise.

Signs for parking and circulatory areas smaller than those used on roads may be used if the requirements of Clause 4.3.6 of *AS 2890.1* are met.

Signs shall be clearly visible, easy to read and simple to follow.

The need for regulatory signs should be minimised as much as practical.

2.5.7 Linemarking

Line marking must conform to the relevant Australian Standards.

Pavement markings shall be white except for special markings which may be in yellow (such as a bus embayment) or blue (such as a disabled parking bay).

All parking bays shall be line marked except where delineation by a material providing similar appearance to a line is included in the pavement.

Directional arrows shall be used to indicate the direction of travel where users are required to continue in a specific direction.

2.6 STORMWATER

2.6.1 Drainage Design

Stormwater drainage shall be designed in accordance with the following standards and guidelines and any other standard/guideline deemed relevant to the works at the time.

Australian Standards

- *AS 3500.3* *Plumbing and Drainage*
- *AS 1260* *Unplasticised PVC Pipes & Fittings for Sewerage Applications*
- *AS 3571* *Glass Reinforced Pipes, Joints & Fittings*
- *AS 3725* *Concrete Pipe Laying Design*
- *AS 4058* *Precast Concrete Drainage Pipes*

Austroads Guide to Road Design

- *Part 5 Drainage* *General and Hydrology Conditions*
- *Part 5a Drainage* *Road Surface, Networks, basins and Subsurface*
- *Part 5b Drainage* *Open Channels, Culverts and Floodways*

Department of Water

- *Department of Water (DoW) Stormwater Management Manual for Western Australia (2007)*
- *Department of Water (DoW) Decision Process for Stormwater Management in WA (2009)*

Institute of Engineers Australia

- *Australian Rainfall and Runoff: A Guide to Flood Estimation. Volumes 1 and 2 (1998)*
- *Australian runoff quality - a guide to water sensitive urban design (2006)*

Local Council

For all interface with local council stormwater drainage the designer is to liaise with the relevant Councils and adhere to any requirements and/or guidelines put forward by the Council.

In the event of any inconsistencies between the aforementioned documents, precedence should be given to the document in accordance with the order they are listed above.

2.6.1.1 Design Principles

The stormwater drainage system shall be designed to allow for all pavement/hardstand areas, roof catchments and landscaped areas and is in accordance with the following design principles:

- Minimise interruptions to existing drainage systems and flow patterns
- Avoid ponding on pavement, hardstand and landscaped surfaces
- Prevent scour, erosion and sediment transportation
- Avoid adverse impacts on the environment
- Mitigate the need for maintenance to both the drainage network and surface
- Allow for the effects of any existing drainage features on or adjacent to the site.

Stormwater management must be in accordance with the principles of Water Sensitive Urban Design as described in the *Department of Water Stormwater Management Manual* for Western Australia. The system must comply with the following principles:

- Surface flow to be utilised in preference to piped flow where practicable
- Flow along permeable surface in preference to constructed drains
- Maximise the recharge of the groundwater through infiltration.

Drainage systems shall be designed and constructed in such a way as to ensure accessibility for maintenance purposes.

Modifications to existing drainage systems must not adversely affect the performance of drainage within or outside of the site.

Where practicable the system should adopt the concept of the major/minor system whereby the drainage system is designed to carry and control flows from minor events whilst well defined overland flow paths are designed for major events.

2.6.1.2 Average Recurrence Intervals

The following Average Recurrence Intervals (ARI's) apply to the serviceability and flood protection of the design. The following ARI's should be applied with consideration for the effects of global warming and storm surge.

Item	Drainage System/Special Requirement	ARI (Years)
1	Piped Systems	10
2	Kerb Overtopping	10
3	Gutter Flow Spread Limits*	10
4	Swales and Channels	10
5	Major Systems Check	100
6	Drainage System overflows which may cause erosion and scour	10
7	Sub-Soil Drainage	10
8	Outlets to LGA/Water Corporation/Water Body	**
9	Stormwater Treatment Facilities (For Stormwater Held on Site)	1 (1 hour)
10	Stormwater Treatment Facilities (For Stormwater Discharging to External Network)	**

*Rainfall Intensity for calculating gutter flow spread limits can be limited to 100mm/hr.

** Rainfall Intensity for stormwater discharging to externals networks to be to relevant authority requirements.

Drainage System ARI Requirements

Flows from existing catchments must not exceed predevelopment flow rates and volumes, unless the downstream catchment is able to control flows to the requirements of this document.

The major systems check must ensure that there is no structural damage and no inundation of building floor levels. Freeboard to building floor levels shall be a minimum of 300mm.

Where no clear overland flow route exists within a catchment, the stormwater system is to be designed for the major event as indicated in the table above.

2.6.1.3 Stormwater Treatment

Where the stormwater drainage system is located in an area susceptible to chemical and or contaminant spillage, an appropriate separator system is to be employed which will intercept the contaminant at the location of spillage prior to exposure to the downstream network. Refer to *UWA Design and Construction Standards – Hydraulic Services* for further information.

Where stormwater is held onsite, a stormwater treatment facility appropriate to the surroundings and network shall be specified. The stormwater treatment facility is to function up to and including the ARI identified in *Section 2.6.1.2* of this document.

Primary treatment facilities, such as litter traps, are to be specified at inlets immediately upstream of underground storage tanks. Facilities are to be easily accessible and maintainable. Primary treatment facilities shall not impede the flow of stormwater in large events.

Where stormwater is discharged to an external network, stormwater treatment facilities are to be specified to the relevant authority requirements.

2.6.1.4 Scour Protection

The stormwater system must be designed and constructed to minimize future maintenance and provide new or additional scour protection to all areas susceptible to scouring such as drains, batters and landscaped areas.

2.6.1.5 Temporary Drainage

Temporary drainage employed during construction must satisfy all requirements within this document up to and including a 1 year 1 hour ARI. If stormwater from the area of works is discharging to an external network via pipe or overland flow, the system must satisfy the requirements of all relevant authorities.

2.6.1.6 Open Channel Flow

Overland flow paths such as swales and open channels must adhere to the following requirements:

- Minimum longitudinal grade of 0.3%
- Maximum batter slope of 1 in 6
- The use of vegetation to control scour must be maximised
- For all flow paths, flow velocities must be minimised and flow compensation and infiltration maximised
- The design of overland flow paths shall consider the impacts on and the requirements of other services.

2.6.1.7 Culverts and Pipe Drainage Networks

Drainage pipe networks must be self-cleaning and must be designed to account for maximum water levels in runoff/storage areas and at outlets and connection to existing networks.

A blockage factor of 50% should be applied to the inlet capacity of all sag inlets.

Disused pipes and pits must be removed or entirely filled in-situ with concrete slurry.

Allowance shall be made for a minimum 100mm sump in all stormwater pits.

Manholes shall be provided at change in pipe direction.

The designer is to provide consideration for accessibility and maintenance of the network.

The maximum length of pipe without an intermediate pit must be 100m to facilitate maintenance.

The maximum water depth in pits must be at least 0.2m below the adjacent surface level.

Where possible stormwater pits shall be specified as soakwell liners with permeable bases to maximise the

infiltration of stormwater across the site.

Where alternatives are available, stormwater infrastructure shall not be specified/constructed under permanent buildings/structures.

Materials

Materials utilised in the stormwater system are to adhere to the following requirements. Alternative materials will be considered and should be submitted for approval by UWA.

- Pipes greater or equal to 300mm nominal internal diameter shall be reinforced concrete pipe commercially available to a class appropriate to the cover and loading
- Pipes smaller than 300mm nominal diameter shall be PVC pipe to a class appropriate to the cover and loading
- Stormwater pits are to be reinforced concrete liners with concrete base slabs
- Grated inlet class shall be specified in accordance with the loading requirements expected at the location
- Consideration is to be given to the classification and acidity of the soil conditions and an appropriate class or alternatively material selected to achieve the design life specified in *Section 2.6.11* of this document.
- Consideration shall be given to requirements of other services when selecting inlet/manhole lid type. Refer *UWA Design and Construction Standards – Hydraulic Services* for further information.

2.6.1.8 Subsoil Drainage

Subsoil drainage systems must be provided where pavement is below the expected maximum groundwater level and the expected capillary rise, and at any other location where the integrity of structure is at risk.

Subsoil drainage must commence at the surface with a removable cap which enables flushing and be protected and identifiable from the surface.

Intermediate flushing points along the subsoil drain runs must consist of manholes which are located at 60m maximum intervals.

Un-slotted subsoil drain discharge pipes must include manholes to enable flushing at maximum 100m intervals.

Subsoil drainage shall be surrounded by stone aggregate to increase localised permeability and be wrapped in an appropriate geofabric or filter materials to ensure sand does not enter the system.

2.6.1.9 Management of Surface Runoff

Surface runoff shall be directed away from building entrances and any other areas which may be negatively impacted by the accumulation of stormwater.

Infiltration rates used in hydrologic modelling must be calculated form the results of field investigations at actual or geologically comparable locations.

Where possible surface runoff shall be directed towards landscaped areas or open channels/swales to maximise infiltration.

Consideration shall be given to avoid the concentration of stormwater flows through high traffic pedestrian areas. Particular attention shall be given to the depth and velocity of surface flow.

Stormwater Discharge

Stormwater runoff from pavement, hardstand and landscaped areas must be managed in one of the following ways, listed in order of decreasing preference

- Infiltration to permeable surface - if soil permeability is adequate to ensure the infiltration of stormwater and does not result in the ponding of stormwater
- Infiltration areas - runoff directed via pipes or swales to an infiltration area such as an underground tank
- Outfalls - discharge into LGA or Water Corporation external stormwater networks and water bodies such as the Swan River. Outfalls to external networks or water bodies are to comply with the requirements of and subject to the approval of the relevant authority.

2.6.1.10 Below Ground Storage

Below ground storage may be in the form of soakwells or underground tanks and must adhere to the following requirements.

- General
    - Have sufficient load rating to allow for the loads the storage facility would be expected to be exposed to over its design life, construction and design. Particular attention shall be paid to the product's potential for material creep and weakening over its design life
    - Consideration shall be given to maintenance accessibility
    - Where specific maintenance practices apply, a maintenance manual is to be provided to the client.
- Detention Storage
    - To be designed as an infiltration system with consideration to the in-situ permeability of the soil and ground water table.
- Retention Storage
    - To be designed with an orifice outlet to the requirements of the relevant authority.
    - Primary stormwater treatment shall be considered prior to an orifice outlet to mitigate the potential for blockage.

2.6.1.11 Service Life

The service life for key stormwater infrastructure must meet or exceed the following minimum performance requirements.

Element	Service Life (years)
Stormwater Pipe	50
Pit, Pit Covers and Trench Grates	50
Underground Tanks	50

Service Life of Key Stormwater Drainage Infrastructure

2.6.1.12 Maintainability

The design is to consider maintenance implications arising from the following items:

- The type and extents of drainage provided
- Maintenance accessibility, for both personnel and plant/equipment
- The potential for differential settlement and lateral movement
- Selection of materials to withstand environmental exposure
- Potential for damage caused by vegetation and root ingress.

3 Checklist for Project Team

Activity	Responsibility	Stakeholder(s)	Timeframe
Review of existing Geotechnical Report for adequacy, or scope definition for procurement of Geotechnical Services.	Project Manager / Civil Works Consultant	CM (Engineering Services) / CM (Capital Works)	Gate 2 Feasibility
Review of existing Environmental Reports for adequacy, or scope definition for procurement of Environmental Services	Project Manager / Civil Works Consultant	CM (Engineering Services) / CM (Capital Works)	Gate 2 Feasibility
Review of existing Stormwater Management Plan, or scope definition for producing a Stormwater Management Plan	Civil Works Consultant / Hydraulic Consultant / Landscape Architect	CM (Engineering Services) / CM (Capital Works)	Gate 2 Feasibility
Review of existing Traffic Engineering report for adequacy, or scope definition for procurement of Traffic Engineering services	Civil Works Consultant	CM (Engineering Services) / CM (Capital Works)	Gate 2 Feasibility
Review of existing services information and scope definition for procurement of Location services.	Services Consultants	CM (Engineering Services) / CM (Capital Works)	Gate 2 Feasibility
Project Manager / Civil Works Consultant	Project Manager / Civil Works Consultant	CM (Engineering Services) / CM (Capital Works)	Gate 2 Feasibility

Abbreviations

AHD	Australian Height Datum
ARI	Average Recurrence Intervals
CM	Campus Management
DDA	Disability Discrimination Act
DFES	Department of Fire and Emergency Services
DOW	Department of Water
ESA	Equivalent Standard Axles
LGA	Local Government Authority
MGA	Map Grid of Australia
PCG	Perth Coastal Grid
UWA	The University of Western Australia

References

AS 1260 Unplasticised PVC Pipes & Fittings for Sewerage Applications

AS 1428 Design for Access and Mobility

AS 1742 Manual of Uniform Traffic Control Devices

AS/NZS 2890 Parking Facilities

AS 3500 Plumbing and Drainage

AS 3725 Concrete Pipe Laying Design

AS 3571 Glass Reinforced Pipes, Joints & Fittings

AS 4058 Precast Concrete Drainage Pipes

Australian Rainfall and Runoff: A Guide to Flood Estimation. Volumes 1 and 2, Institute of Engineers Australia

Australian Runoff Quality - a Guide to Water Sensitive Urban Design, Institute of Engineers Australia

Concrete Segmental Pavements Design Guide for Residential Accessways and Roads (CMAA-T45), Concrete Masonry Association of Australia

Contaminated Sites Act 2003

Decision Process for Stormwater Management in WA, Department of Water

Engineering Road Note 9 – Procedure for the Design of Flexible Pavements, Main Roads WA.

Guide to the Design of New Pavements for Light Traffic (APRG Special Report No. 21, 1998).

Guide to the Geometric Design of Urban Roads, Austroads

Guide to Pavement Technology Part 2: Pavement Structural Design, Austroads

Guide to Road Design, Austroads

Guide to the Selection of Road Surfacings, Austroad.

Guide to the Structural Design of Road Pavement, Austroads.

Guide to Traffic Engineering Practice Parts 1–14, Austroads

Guide to Traffic Management, Austroads

Guidelines on Planning and Designing for Pedestrians, Department of Transport

Guidelines for Local Area Traffic Management, Main Roads WA

Stormwater Management Manual for Western Australia, Department of Water

Change Log

It is envisaged that revisions to this document will be undertaken at intervals of not more than two (2) years. This version differs from the previous version in the following areas:

Section	Title	Description
		No changes