Roads

Master Specification

RD-DK-D1 Road Drainage Design

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Contents

RD-DK-D1 Road Drainage Design

1 General

1.1 This Design Standard specifies the requirements for undertaking the design and documentation of stormwater systems associated with DPTI road infrastructure.

1.2 The key standards and guidelines that are required for stormwater design are listed, as well as the key design requirements and documentation deliverables.

1.3 For road stormwater design guidance, DPTI require the use of the Austroads Guide to Road Design - Drainage Parts 5, 5A and 5B as the primary reference. Where DPTI requirements vary from these guides, or where additional information is appropriate, this has been detailed in a DPTI Supplement in the final section of this design standard.

1.4 The requirements for undertaking hydrological analysis of stormwater catchments and systems associated with DPTI road, rail and marine infrastructure are set out in Master Specification RD-DK-D2 Hydrology.

1.5 Where road drainage design will include the proposed alteration to natural watercourses and / or the design and hydraulic modelling of any modifications to any of the existing constructed stormwater networks under the responsibility of a Drainage Authority or Council (including any constructed basins/wetlands), the Contractor must:

a) undertake the design in consultation with all relevant Drainage Authorities and Councils;

b) obtain written approval of any alterations to the Council stormwater system and any natural watercourses from all relevant Drainage Authorities; and

c) provide copies of all approvals to the Principal (who will forward these to the DPTI Stormwater Group).

1.6 This design standard does not cover the design of stormwater systems for railways. Refer http://www.dpti.sa.gov.au/contractor_documents/public_transport_technical_standards.

2 Design Standards, Guidelines, Reference Documents and Standard Drawings

2.1 Unless specified otherwise, all stormwater and hydrological assessments shall comply with the most recent revisions (including published amendments) of the following Guidelines and Codes of Practice.

a) Austroads Guide to Road Design – Drainage - Parts 5, 5A and 5B. These are the primary reference / guideline documents.

b) Australian Rainfall and Runoff (ARR), various editions as quoted.

c) Austroads Waterway Design Guide (1994).

d) Austroads Guide to Pavement Technology Part 10: Subsurface Drainage.

e) Environmental Protection Authority "Stormwater Pollution Prevention – Code of Practice for Local, State and Federal Government".

f) DPTI Protecting Waterways Manual.

g) DPTI Stormwater Treatment Infrastructure Manual.

h) EPA Environment Protection Water Quality Policy.

i) Australian Runoff Quality, A Guide to Water Sensitive Urban Design, Engineers Australia.

j) DPTI - Easements Across Departmental Land Instructions to Engineers – Amendment No. 13

k) DPTI – Care, Control and Management of Roads (Highways) by the Commissioner of Highways (Section 26 of the Highways Act) – Operational Instruction 20.1.

l) DPTI – Instruction to Engineers SAI 24 – DD302 (DPTI Policies on Assistance to Councils for Stormwater Drainage).

m) DPTI publications are available from: https://www.dpti.sa.gov.au/standards.

2.2 Stormwater and hydrological assessments must comply with the following Australian Standards:

a) AS/NZS 3725:2007 Design for installation of buried concrete pipes.

b) AS/NZS 3500.3: 2015 Plumbing and Drainage

c) AS 1597.1 - 2010 Precast reinforced concrete box culverts – Small culverts (up to 1200 x 1200 RCBC).

d) AS 1597.2 – 2013 Precast reinforced concrete box culverts – Large culverts (exceeding 1200 x 1200 RCBC). To be used in conjunction with DPTI Design Standard: Structural (refer to DPTI Structures Group Standards and Guidelines).

e) AS 4139 – 2013 Fibre reinforced concrete pipes and fittings.

f) AS 2566.1 – 1998 Buried flexible pipelines – Structural design.

g) AS 3996 – 2006 Access covers and grates.

h) AS 3735 – 2001 Concrete structures retaining liquids.

2.3 The design can use the following Reference Documents where relevant for design guidance:

a) Storm drainage design in small urban catchments, John Argue, 1986.

b) Queensland Urban Drainage Manual.

c) Hydraulic Design of Highway Culverts (HDS 5), U.S. Department of Transportation Federal Highway Administration.

d) Hydraulic Design of Energy Dissipaters for Culverts and Channels (HEC-14), U.S. Department of Transportation Federal Highway Administration.

e) Design of Roadside Channels with Flexible Linings (HEC-15), U.S. Department of Transportation Federal Highway Administration.

f) Urban Drainage Design Manual (HEC-22), U.S. Department of Transportation Federal Highway Administration.

g) CPAA Design Manual – Hydraulics of Precast Concrete Conduits, Concrete Pipe Association of Australasia.

h) Best Practice Erosion and Sediment Control, International Erosion Control Association (Australasia) (IECA 2008).

i) Austroads Guidelines for Treatment of Stormwater Runoff from the Road Infrastructure.

j) Water Sensitive Urban Design Technical Manual, Greater Adelaide Region (Department of Planning and Local Government, 2010). Available (as at October 2014) at: http://www.sa.gov.au/topics/housing-property-and-land/building-and-development/land-supply-and-planning-system/water-sensitive-urban-design.

k) WSUD: Basic Procedures for 'Source Control' of Stormwater, John Argue.

l) Services in Streets - a code for the placement of infrastructure services in new and existing streets (1997 edition), South Australian Public Utilities Advisory Coordinating Committee (PUACC).

m) Land subsidence and sea level rise in the Port Adelaide estuary: Implications for monitoring the greenhouse effect (paper by Belperio AP in Australian Journal of Earth Sciences Volume 4, Issue 4,1993).

n) Predicting Storm Runoff in Adelaide – How much do we know (Paper by Kemp DJ & Lipp WR in seminar proceedings, Living with Water, Hydrological Society of SA, October 1999).

2.4 The design can use the following DPTI Standard Drawings:

Culvert Headwall and Endwall Drawings

a) S-4002, Sheet 17 Driveable Culvert Endwall Type 1.

b) S-4002, Sheet 18 Driveable Culvert Endwall Type 2.

c) S-4002, Sheet 19 Box Culvert Skew Angle 0 - 20 degrees.

d) S-4002, Sheet 20 Box Culvert Skew Angle 21 – 45 degrees.

e) S-4002, Sheet 21 Reinforced Concrete Pipe 450 mm – 900 mm Angle 0-20 degrees.

f) S-4002, Sheet 22 Reinforced Concrete Pipe 1050 mm – 1800 mm Angle 0-20 degrees.

g) S-4002, Sheet 23 Reinforced Concrete Pipe 450 mm – 900 mm Angle 21 - 45 degrees.

h) S-4002, Sheet 24 Reinforced Concrete Pipe 1050 mm – 1800 mm Angle 21 - 45 degrees.

Stormwater Inlets and Junction Boxes

i) S-4065, Sheet 1 Concrete Channels and Grates.

j) S-4080, Sheet 1 Single Pipe Junction Box Types A, B and C.

k) S-4080, Sheet 2 Side Entry Gullies.

l) S-4080, Sheet 3 Combined Junction Boxes and Side Entry Gully.

m) S-4080, Sheet 6 Grated Field Pit.

n) S-4080, Sheet 7 Grated Inlet Pit for Concrete Side Drain (V-Shaped grate).

o) S-4080, Sheet 13 Special Combined Junction Boxes with Side Entry Gullies or Grated Inlet Pit.

Kerbing

p) S-4070, Sheet 6 Median and Traffic Island Kerbing.

q) S-4070, Sheet 7 Kerb and Gutter.

Floodways

r) S-4002, Sheet 25 Batter Protection – Floodway Road Crossing.

3 Definitions

Term	Definition
AEP	Average Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
AS	Australian Standards
DPTI	Department of Planning, Transport & Infrastructure
DRAINS	Hydrological Modelling Software (Watercom)
EPA	Environment Protection Authority
FRC	Fibre Reinforced Concrete
GP	Gross Pollutants
HGL	Hydraulic Grade Line
IPCC	Intergovernmental Panel on Climate Change
JB	Junction Box
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
RCBC	Reinforced Concrete Box Culvert
RCP	Reinforced Concrete Pipe (circular)
SEDMP	Soil Erosion and Drainage Management Plan
SEP	Side Entry Pit
STI	Stormwater Treatment Infrastructure (water quality)
WSRD	Water Sensitive Road Design
WSUD	Water Sensitive Urban Design

4 Design Requirements

Design Life

4.1 Unless specified otherwise, the various components of the design must be designed for the following minimum design life (i.e. Before replacement of that component is required) as per Table RD-DK-D1 4-1.

Table RD-DK-D1 4-1 Minimum Design Life

Component	Design Life (years)
Scour protection	50
Inaccessible stormwater components	100
Stormwater components that are easily accessible for refurbishment of replacement, except for water quality components	50
Water quality components*	20

* includes sedimentation / retention / detention basins and ponds.

Design Standard (ARI)

4.2 Unless specified otherwise, the following minimum design Average Recurrence Intervals (ARIs) must be applied in the design of DPTI maintained stormwater infrastructure. Where the stormwater infrastructure is intended to be maintained by the Local Council, the particular Council(s) involved may have design standards that differ from those listed below. These different standards would then apply.

<u>Bike Lanes</u>

Table RD-DK-D1 4-2 Design Standard for Bike Lanes

Component	Design Standard (ARI) (years)
0.5 m of lane clear of gutter flow	1 (where practicable, may not be achievable on very flat grades)

<u>Unsealed Roads in remote areas</u>

Table RD-DK-D1 4-3 Minimum Design Life

Component	Design Standard (ARI) (years)
Longitudinal swales	5 May need to calculate two flows, one from the road pavement and one from surrounding land depending on location
Catch drains (designed to exclude external flows from the road corridor)	10
Transverse road culverts where the vertical alignment requires a culvert	20
Bridge crossings on major or named watercourses where the vertical alignment requires a bridge	50

Component	Design Standard (ARI) (years)
New channels or watercourses associated with a major culvert / bridge	50
Floodways	50
Scour protection in channels, etc.	The greater of: • 50 years; • ARI of the channel design; or • Channel capacity.

Sealed Unkerbed Roads (normally located in rural areas)

Table RD-DK-D1 4-4 Design Standard for Sealed Unkerbed Roads

Component	Design Standard (ARI) (Years)
Longitudinal swales	5 May need to calculate two flows, one from the road pavement and one from surrounding land depending on location
Capture of concentrated flow across traffic lane(s)	5
Catch drains (designed to exclude external flows form the road corridor)	10
Sheet drainage down fill batters greater than 1.5m high and steeper than 1:4 from more than 1 traffic lane	10
Transverse road culverts	20
Bridge crossings on major or named water courses	50
New channels or watercourses associated with a major culvert / bridge crossing	50
Floodways	50
Scour protection in channels, etc.	The greater of: • 50 years; • ARI of the channel design; or • Channel capacity.

Sealed Kerbed Roads (normally located in urban areas)

Table RD-DK-D1 4-5 Design Standard for Kerbed Roads

Component	Design Standard (ARI) (Years)
Longitudinal and minor network stormwater systems (urban road drainage) (gutter flow widths not exceeding criteria also apply to guide kerb inlet spacing	5
Capture of concentrated flow across traffic lane(s)	5

Component	Design Standard (ARI) (Years)
Longitudinal drainage for elevated roadways or long bridge structures	10
Catch drains (designed to exclude external flows from the road corridor)	10
Landlocked road sag points / underpasses / depressed roadways	20
Transverse road culverts	50 Or the Council required standard
Bridge crossings on major or named watercourses	50 Or the Council required standard
Major storm for the purpose of checking the effect of the project on major (overflow) flow paths, i.e. not exacerbating flooding of downstream properties due to runoff from the project itself or by the project redirecting major flow paths that originate from further upstream.	100
Measures to ensure that external surface flows do not enter depressed (below natural surface) sections of roadways	100
New channels or watercourses associated with a major culvert / bridge crossing	Match culvert / bridge ARI
Scour Protection in channels, etc.	The greater of: • 50 years; or • ARI of the channel design.

National highways

Table RD-DK-D1 4-6 Design Standard for National Highways

Component	Design Standard (ARI) (Years)
Longitudinal and minor network stormwater (urban road drainage) (gutter flow widths not exceeding criteria also apply to guide kerb inlet spacing)	5
Capture of concentrated flows across traffic lanes	5
Longitudinal drainage for elevated roadways or long bridge structures	10
Catch drains (designed to exclude external flows from the road corridor	20
Landlocked road sag points / underpasses / depressed roadways	20
One lane each direction free of inundation in underpasses / depressed roadways	100
Transverse road culvert and bridge crossings	100 Or the Council required standard
Major storm for the purpose of checking the effect of the project on major (overflow) flow paths, i.e. not exacerbating flooding of downstream properties due to runoff from the project itself or by the project redirecting major flow paths that originate from further upstream	100

Component	Design Standard (ARI) (Years)
Measures to ensure that external surface flows do not enter depressed (below natural surface) section of roadways	100
New channels or watercourses associated with a major culvert / bridge crossing	Match culvert / bridge ARI
Scour protection in channels, etc.	The greater of: • 50 years; or • Channel design capacity.

<u>Freeways / expressways / motorways</u>

Table RD-DK-D1 4-7 Design Standard for Freeways / Expressways / Motorways

Component	Design Standard (ARI) (Years)
Longitudinal and minor network stormwater (urban road drainage) (gutter flow widths not exceeding criteria also apply to guide kerb inlet spacing)	10
Capture of concentrated flows across traffic lanes	10
Longitudinal drainage for elevated roadways or long bridge structures	20
Catch drains (designed to exclude external flows from the road corridor	20
Landlocked road sag points / underpasses / depressed roadways	20
One lane each direction free of inundation in underpasses / depressed roadways	100
Transverse road culvert and bridge crossings	100 Or the Council required standard
Major storm for the purpose of checking the effect of the project on major (overflow) flow paths, i.e. not exacerbating flooding of downstream properties due to runoff from the project itself or by the project redirecting major flow paths that originate from further upstream	100
Minor storm event have all lanes in each direction free of inundation	10
Major storm event have a minimum of one lane in each direction clear of inundation	100
Measures to ensure that external surface flows do not enter depressed (below natural) section of roadways	100
New channels or watercourses associated with a major culvert / bridge crossing	Match culver / bridge ARI
Scour protection in channels, etc.	100

Note: Where there are two different design standards for a component, the higher standard applies.

5 Road Drainage Design

General

5.1 For stormwater drainage design in road corridors, DPTI require the use of Austroads Guide to Road Design. The following Austroads Guide to Road Design are applicable for the design of stormwater infrastructure:

a) Part 5 – Drainage: General and Hydrology Considerations.

b) Part 5A – Drainage: Road Surface, Networks, Basins and Subsurface.

c) Part 5B – Drainage: Open Channels, Culverts and Floodways.

5.2 The following sections list SA Government and DPTI requirements that clarify, modify or add to the direction provided in the Austroads guides with the relevant section in the guide referenced. If further clarification is required this can be obtained from the DPTI Stormwater Group.

5.3 The requirements for undertaking hydrological analysis of stormwater catchments and systems associated with DPTI road, rail and marine infrastructure are set out in Master Specification RD-DK-D2 Hydrology.

5.4 Where work under the contract includes the alteration to natural watercourses and / or the design and hydraulic modelling of any modifications to any of the existing constructed stormwater networks under the responsibility of a Drainage Authority or Council (including any constructed basins / wetlands), the Contractor must:

a) undertake the design in consultation with all relevant Drainage Authorities and Councils;

b) obtain written approval of any alterations to the Council stormwater system and any natural watercourses from all relevant Drainage Authorities; and

c) provide copies of all approvals to the Principal (who will forward these to the DPTI Stormwater Group).

6 Safety in Design (Austroads Part 5 Section 2)

Workplace Health and Safety Act and Standards (Austroads Part 5 Section 2.2)

6.1 DPTI require a safety in design assessment to be completed for the stormwater design. This will need to consider safety in all aspects of the proposed stormwater infrastructure, including design, construction, operation and decommissioning. This assessment can be incorporated into the stormwater design, road design or standalone Safety in Design reports. The appropriate report to be used for a particular project is to be confirmed with the relevant DPTI Project Manager.

7 Environment (Austroads Part 5 Section 3)

7.1 Climate Change, resulting in more extreme and frequent rainfall events will have a significant effect on stormwater infrastructure design associated with DPTI road corridors. Guidance on climate change is outlined in Austroads Part 5 Section 3.2 however specific guidelines on seal level rise, catchment changes and increase in rainfall patterns for South Australia are outlined below.

Climate Change - Sea Level Rise (Austroads Part 5 Section 3.2.2)

7.2 Climate change projection recommendations from the SA Coast Protection Board (2012) are to allow for 0.3 m of sea level rise by 2050 and for 0.7 m by 2100. International Panel on Climate Change (IPCC) Report 5 (2014) predictions is for 1 metre sea level rise to the year 2100 and for this rate of level increase to continue. The analysis of stormwater catchments that discharge at or close to sea levels should make allowance for these predictions.

7.3 Allowance should also be made for land subsidence in some areas of Adelaide, particularly Port Adelaide - see Belperio AP in reference document list.

Climate Change - Catchment Changes (Austroads Part 5 Section 3.2.3)

7.4 Allowance should also be made for changes in stormwater catchments due to climate change. South Australian ecology is sensitive to climate change and with South Australia's climate predicted to become warmer (+4 degrees average temperature) and drier (-30% average annual rainfall) by the year 2100, we can expect reduction in vegetation growth, resulting in increased stormwater runoff during extreme events.

Climate Change - Increase in Rainfall Patterns (Austroads Part 5 Section 3.2.4)

7.5 Climate change projections released by the Bureau of Meteorology and CSIRO in 2015 do not include information about changes to rainfall intensity–duration relationships however it is widely accepted that rainfall intensity patterns are sensitive to climate change. Results from climate modelling in various locations in Australia indicate that 1% AEP, 24 hour duration rainfall intensities can increase by up to 20% in some areas and fall in other areas. Given the regional uncertainty in predicting climate change impacts on rainfall intensities, a 5% increase in rainfall intensity per oC of local warming is recommended.

7.6 The IPCC mid-range (most likely) global estimate for average temperature increase to the year 2100 is +4 degrees. The Goyder Institute climate downscaling modelling for each Natural Resource Management region in SA identified a 3.2 to 4 degree increase in average temperature by the year 2090. Kangaroo Island predicted increase in average temperature by the year 2090 is 3.2 degrees.

7.7 ARR (2016) Book 1, Chapter 6 recognises that failure to account for the impacts of climate change can lead to poor decisions when exposure to climate change is high and outlines a Climate Futures Web Tool for predicting future changes to rainfall intensities. Where the consequence of asset failure is high, a detailed local study should be undertaken. The Climate futures Web Tool features a six step process involving assessment of climate change risks such as geographic location (NRM cluster), design flood standard, effective service life, projected temperature increase, purpose of asset, and assessment of the consequences of climate change projections using the tool. The tool will predict a percentage change in rainfall intensity

Climate Change - Storm Surge (Austroads Part 5 Section 3.7.3)

7.8 Assessment of stormwater catchments and design of infrastructure impacted by sea levels must consider the influence of storm surge on predicted tide levels. Storm surges of 1.4 metres above tide level have been recorded along the metropolitan Adelaide coastline and more than 2 metres above normal tide level at Port Pirie. While there is no specific hydrodynamic modelling for South Australian coastlines, it is expected that more severe weather events due to climate change including higher wind speeds will likely increase storm surge levels over the next 50 years.

Fauna Passage / Crossings (Austroads Part 5 Section 3.3)

7.9 Refer to DPTI Environment Standards and Guidelines for more guidance, in particular the Protecting Waterways Manual. The requirement for these crossings shall be determined in conjunction with the DPTI Environment Group and the DPTI Stormwater Group prior to their design.

Spill Management (Austroads Part 5 Section 3.4.3)

7.10 Where there are sensitive downstream ecosystems (as identified by the Water Quality Risk Assessment process), road design elements that do not meet Austroads Guidelines that are likely to increase the likelihood of collisions (such as shortened acceleration lanes or merging lanes at intersections) and high traffic volumes, accidental spill retention is required.

7.11 Where deemed required, DPTI require the provision of a minimum of 50 m^3 of accidental spill volume to be provided. The location and functionality of this volume is to be detailed in an STI location proforma for inclusion in the DPTI Stormwater Treatment Infrastructure (STI) manual (refer to Section 15 – Stormwater Documentation Deliverables). The stormwater design report (in an Appendix) must also include an Emergency Response Plan detailing the measures to be undertaken in the event of an accidental spill to ensure spills are contained and no sensitive downstream environments are impacted. This is to be provided to the DPTI Stormwater Group who will ensure that it is conveyed to DPTI's Traffic Management Centre.

Water Sensitive Urban Design - Performance Objectives (Austroads Part 5 Section 3.5.4)

7.12 The SA Government Water Sensitive Urban Design (WSUD) Policy sets performance targets for water quality improvement that apply to road projects. These are:

a) 80% reduction in average annual load of Total Suspended Solids (TSS);

b) 45% reduction in average annual load of Total Nitrogen (TN);

c) 60% reduction in average annual load of Total Phosphorus (TP);

d) 90% reduction in average annual load of Gross Pollutants (GP);

e) runoff from the project does not exceed the pre-urban development 1yr ARI peak flow rate where the project drains to an unlined watercourse; and

f) no increase in 5yr ARI peak flow or 100yr ARI flood risk.

7.13 In addition, the Protecting Waterways manual sets the following targets:

a) retention of litter greater than 50mm for flows up to the 3 months ARI peak flow; and

b) no visible oils / hydrocarbons for flows up to the 3 months ARI peak flow.

7.14 In addition, it should be noted that where road projects are upstream of stormwater reuse infrastructure such as wetland systems, any change in water quality can impact the effectiveness of pre-reuse water quality treatment and the subsequent amount of water either reused directly or recharged to an aquifer.

7.15 The SA WSUD Policy targets, and the general requirement for permanent water quality (WSUD / WSRD) treatment devices, apply to all DPTI road projects, except where it can be demonstrated that no reasonable or practicable options exist to meet the targets or install treatment devices. In such cases, reasons for not achieving WSUD targets and evidence to support the decision must be provided in the Design Report.

7.16 Notwithstanding SA WSUD Policy targets, the Contractor should undertake a Water Quality Risk Assessment in accordance with DPTI's Protecting Waterways Manual to identify any water quality requirements specific for the road project site. Any site specific requirements that have been identified by DPTI will be contained in the Contract Documents and / or Project Scope documents for the specific project.

7.17 If water quality measures are not specified for a particular project (such as for a developer funded project), the Contractor shall undertake, as part of the design, a Water Quality Risk Assessment in accordance with the DPTI Protecting Waterways manual in consultation with the DPTI Technical Services section, EPA, regional NRM Board and local council.

7.18 The design of water quality treatment needs to demonstrate that all practical and reasonable steps have been taken to mitigate water quality impacts and that reasonable attempt has been made to meet water quality targets.

Water Sensitive Urban Design - MUSIC Model (Austroads Part 5 Section 3.5.5)

7.19 DPTI require the completion of a Model for Urban Stormwater Improvement Conceptualisation (MUSIC) model when designing WSRD elements. This is to be provided to the DPTI Stormwater Group for review and acceptance during the design phase. DPTI may consider alternative design methodologies, however prior approval is required from the DPTI Stormwater Group before these are used.

Water Sensitive Urban Design - Key Design References (Austroads Part 5 Section 3.5.4)

7.20 A key South Australian based WSUD reference is the SA Government Water Sensitive Urban Design Technical Manual, Greater Adelaide Region (Department of Planning and Local Government, 2010). This is currently available at the following website: http://www.sa.gov.au/topics/housing-property-and-land/building-and-development/land-supply-and-planning-system/water-sensitive-urban-design.

Water Sensitive Urban Design - Bio-retention Systems (Austroads Part 5 Section 3.5.8)

7.21 Design should be undertaken in accordance with the Adoption Guidelines for Stormwater Biofiltration Systems 2015 by the CRC for Water Sensitive Cities. For bio-retention systems the overflow must be designed assuming 75% blockage of the filter area. Consideration of bio retention systems is encouraged where there is space allowed to provide separation between traffic lanes and pedestrians.

Water Sensitive Urban Design - Wetlands (Austroads Part 5 Section 3.5.9)

7.22 In South Australia, appropriate plants are critical to the success of wetland systems as they are likely to be ephemeral. They will need to survive inundation and dry periods. Plant selection will need to be approved by the Landscape Group. With appropriate plant selection for these conditions, contrary to the Austroads guide, wetlands are considered suitable for the treatment of flows from catchments consisting of predominantly road or road surfaces.

Water Sensitive Urban Design – Maintenance & Disposal (Austroads Part 5 Section 3.5.4)

7.23 The DPTI Stormwater Treatment Infrastructure (STI) manual details all existing DPTI Water Sensitive Road Design (WSRD) devices. When designing new WSRD infrastructure, documentation needs to be provided to detail this infrastructure in the STI manual (refer to Section 4 – Project Stormwater Documentation Deliverables).

7.24 Maintenance of any WSRD infrastructure is key to its treatment effectiveness. It must be considered, designed and detailed appropriately. Key maintenance activities must be detailed in the STI manual documentation.

Erosion and Sediment - General (Austroads Part 5 Section 3.6)

7.25 Concentrated surface runoff must not be designed to discharge down any fill batter with slope exceeding 1:6, unless contained within an enclosed conduit (pipe or box culvert) system. Where the batter is flatter than 1:6, an appropriately stabilised batter chute (open channel) may be used to transfer such flows down the batter.

7.26 Where a catch drain is used at the top of a cut face (i.e. kerbing or swales), the effect of a major event (100 year ARI) shall be considered and the stormwater infrastructure sized so that significant damage to the road formation is avoided in this event. This is to avoid situations where substantial catchments areas are being diverted via catch drains and the kerbing or swales have inadequate capacity.

Erosion and Sediment – Erosion & Scour Protection Measures (Austroads Part 5 Section 3.6.4)

7.27 Sheet runoff from more than one sealed traffic lane shall not be allowed to discharge down any fill batter greater than 1m in height and steeper than 1:4 in slope unless collected and contained within a formal drainage system, or the surface has been appropriately designed or protected to cater for the expected flow rate and velocity.

7.28 Where dispersive soils (Soils having Emerson Class 1 or 2 in accordance with AS 1289.3.8.1-2006) are exposed in any cuts, a minimum of 150 mm of non-dispersive topsoil shall be placed before revegetation to protect the cut face from erosion from local runoff. Longitudinal stormwater infrastructure shall also be used at the top of such cut faces to prevent external water from flowing down the cut face.

7.29 Scour protection, as deemed necessary, shall be provided at any other area susceptible to scouring, such as bridge piers and abutments, verge drains, culvert inlets and outlets, longitudinal drain outlets and cross-sectional changes along constructed or natural watercourses where there may be a risk of erosion. Scour protection shall prevent scour for the design flow. Techniques shall be appropriately selected and designed to suit the application and performance requirements.

7.30 Where dispersive soils (Soils having Emerson Class 1 or 2 in accordance with AS 1289.3.8.1-2006) are exposed in areas where scour protection measures are required to be constructed, in addition to any other requirements, a minimum of 200 mm of non-dispersive topsoil or other cohesive material (depending on location and circumstances) shall be placed before vegetation is planted or other scour protection measures are constructed.

7.31 Permanent (expected design life of at least 50 years) scour protection measures must be provided in areas of concentrated flow (such as swales and channels) where the maximum allowable flow velocity of the insitu soil type has been exceeded as defined in Table 3.5 (or Table 2.5 in Part 5B: Drainage – Open Channels, Culverts and Floodways). This requires that 50yr ARI flows and velocities must be used to design the scour protection measures.

7.32 Native grassed lined swales are the preferred scour protection solution followed by non-native grassed lined swales followed by rip rap lined channels before more engineered channel s can be considered. Each of the preferred scour protection solutions must be demonstrated to be unsuitable before moving onto the next.

7.33 Grassed linings need to be designed having regard to the grass species to be used, the average annual rainfall, summer dry periods between rainfall events and the expected high flow duration in the swale / channel. Table 2.6 of the Austroads Guide Part 5B can be used as a guide for determining if grass is a suitable treatment option once flow velocities have been determined. All native grassed swales must be designed on the basis of a maximum cover of 50% and non-native grassed swales on the basis of a maximum cover of 70%. The project landscape architect must also be consulted during the design phase to ensure that all scour protection objectives are achieved. The maximum side slope for grassed channels is 1 in 6.

7.34 Where rip rap is to be used, this must be designed and specified in accordance with the Austroads guide. Rip rap channels must include an underlying geotextile fabric appropriate to the rock size with an appropriate freeboard to ensure flows are restricted to the rip rap lined area. The maximum side slope for rip rap lined channel is 1 in 3.

7.35 Drop structures may be included to reduce flow velocity. The design must demonstrate that the risk of downstream scour has been adequately mitigated.

7.36 Reno mattresses and other synthetic channel protection linings must be used in accordance with manufacturer's recommendations. Refer to Tables A23 – A27 in Appendix A of IECA 2008 (listed in Section 2.3 - Reference Documents above) for guideline allowable flow velocities for various channel linings. Such linings must be demonstrated to be vandal and fire resistant.

Erosion and Sediment – Rock Protection (Austroads Part 5 Section 3.6.5)

7.37 SA experience has been that where rock is machine placed on 1 in 1.5 slopes recommended in Austroads, the placed rocks have not been stable. Therefore the maximum allowable bank / cross slope for machine placed rock protection is 1 in 3. Designs that specify steeper slopes will need to identify the source of rock, dimensions and demonstrate that it can be effectively laid, e.g. where rock used will have parallel faces. Such designs will need approval of the DPTI Geotechnical and Stormwater Groups.

Erosion and Sediment – Ground Cover (Austroads Part 5 Section 3.6.9)

7.38 Ground cover must be self-sustaining, i.e. not contain solely sterile species.

8 Drainage Considerations (Austroads Part 5 Section 4)

Selection of ARI (Austroads Part 5 Section 4.6)

8.1 Refer to Section 4 of this document "Design requirements" as the prime point of reference for selection of the design ARI for a given project and its required stormwater design standard.

Freeboard - Culvert Design (Austroads Part 5 Section 4.7.6)

8.2 Culvert obverts must not be designed higher than the subgrade level (i.e. intruding into the pavement layers) without prior approval from both the DPTI Pavements Unit and the DPTI Project Manager.

Other Considerations – Drainage Construction Materials (Austroads Part 5 Section 4.8.1)

8.3 Unless approved otherwise by the DPTI Stormwater Group, stormwater infrastructure and materials must comply with the following requirements.

8.4 Culverts must comply with the following:

a) box culverts must be reinforced concrete (RCBC);

b) when box culverts (RCBC) are required, a minimum 450 x 300 RCBC must be used in rural / unkerbed areas and 375 x 225mm in urban / kerbed areas;

c) pipe culverts must be either concrete (RCP), fibre cement (FRC) or Twin-Wall Ribbed Polypropylene (TWRPP) stormwater drainage pipes. Where TWRPP is used, a length of RCP (i.e. 2.44m) must be used to connect it to an inlet or outlet headwall. Where there are disparities in the internal diameters of RCP and TWRPP pipes, the internal diameter must increase from the inlet to outlet to reduce the risk of blockage;

d) the diameter of pipes used in drainage networks or as cross culverts must not be less than 375 mm in urban / kerbed areas and 450 mm in rural / unkerbed areas;

e) rubber ring jointed pipes (RRJ) must be used:

i) where pipes are required to permanently hold water;

ii) where a change of direction is being made by deflecting pipe joints;

iii) below the measured maximum groundwater level;

iv) where pipe movement is expected during operation such as within a fill formation; and

v) where the pipe is closer to a tree than three times its mature canopy radius.

f) pipe loadings for pipe class selection must be the more critical of expected construction equipment loading or traffic loading;

g) prior to the use of jacking pipes, the designer must gain prior approval from the DPTI Structures Unit; and

h) culvert classifications and installations must be as required by the Australian Standard relevant to the culvert material used.

8.5 The following materials must not be used for stormwater purposes:

a) metal culverts to AS 2041; and

b) plastic pipes (except TWRPP).

9 Aquaplaning (Austroads Part 5A Section 4)

9.1 An aquaplaning assessment must be completed as part of the stormwater design in accordance with the methodology in this section and evidence of this assessment must be provided in the stormwater design report (refer to Section 4 - Stormwater Documentation Deliverables). The full road design surface must be examined, but evidence of the assessment is only expected at critical locations where the water film depth is close to, or exceeds, the criteria in Section 4.10. Where the allowable water film depth is exceeded, the road or stormwater design shall be altered to reduce or eliminate this depth.

9.2 In addition, road crossfalls shall be an absolute minimum of 2.5%, with a desirable minimum of 3.0%. Crossfall in excess of 3.0% will need to be considered where high longitudinal grades reduce the effectiveness of the crossfall to remove surface sheet runoff from the pavement.

9.3 All concentrated flows across the road pavement must be avoided for the relevant design ARI event (minimum of the 5 year ARI event) to avoid the risk of aquaplaning. Locations that need to be checked include median or kerb terminations, and at crossfall transition points.

10 Kerbed Drainage - General (Austroads Part 5A Section 5)

10.1 In general, DPTI require the completion of a DRAINS model to undertake the required hydraulic calculations for stormwater infrastructure in DPTI roads.

Kerbed Drainage Elements - Kerbing (Austroads Part 5A Section 5.3.1)

10.2 In general, only DPTI Standard kerbing must be used as detailed on the DPTI Standard Drawings listed in Section 2.4 – DPTI Standard Drawings.

Kerbed Drainage Elements - Inlets (Austroads Part 5A Section 5.3.2)

10.3 In general, only DPTI Standard stormwater inlets must be used as detailed on the DPTI Standard Drawings listed in Section 2.4 – DPTI Standard Drawings. Where standard inlet pit structures are too wide for narrow medians, alternative inlet structures may be used (such as the Rocla Drainway Kerb Inlet System) in conjunction with a DPTI standard pit base and subject to approval by the DPTI Stormwater Group. Grated inlets are only to be used after prior approval from DPTI's Stormwater Group due to the risk of blockage.

10.4 The use of any other manufacturer's alternative stormwater inlets can only be used after prior approval from both DPTI's Stormwater Group and Structures Unit.

10.5 Where concentrated flows are collected by a kerb line (including medians or islands) stormwater inlet pits should be provided in the design to collect this flow. However, where it is impractical to provided underground stormwater infrastructure, kerb openings / gaps may be considered. These kerb openings are usually a minimum of 300 mm in width and spaced evenly along the kerb to ensure concentrated flow discharges do not exceed the recommended flow depths defined in Section 4.0 Aquaplaning in this Austroads guide. Kerb openings should not be used where design speeds exceed 80 km/hr.

Kerbed Drainage Elements – Inlet Locations (Austroads Part 5A Section 5.3.4)

10.6 At landlocked sag points, extra stormwater inlets must be provided up to 10 metres either side such that their gutter levels are 50 mm higher than the sag point level. This is to provide inlet redundancy in the event of inlet blockage. Ideally, a second outlet pipe will also be provided to a separate outfall to cater for pipe redundancy in the event of pipe blockage, However, it is recognised that this is not always practical.

10.7 To allow for stormwater pipe access locations for maintenance purposes, DPTI require a maximum pit spacing of 100 metres in general or 200 metres for outlet pipes greater than 1800 mm in diameter

Design Criteria–Pavement Spread & Gutter Flow Widths (Austroads Part 5A Section 5.4.2)

10.8 DPTI require that flow widths be minimised for the relevant ARI event (generally 5 year or 20 year at landlocked sag points) so that a 2.2 metre width is provided clear of water in the outside travel lane. For the 100 year ARI event on national highways or freeways / expressways / motorways, one lane in each direction is to be provided clear of water. (This is most likely to be a design constraint where either a New Jersey barrier is used or in sections of cut that prevent stormwater escaping elsewhere.)

10.9 Where a new road design (including scope for a new or upgraded drainage system) is to include bicycle lanes on the road adjacent the kerb, 0.5 m of the cycle lane must be maintained clear of water in a 1 year ARI event where practical. It is recognised that this requirement may not be achievable in areas with very flat grades. In addition, the stormwater design should aim to eliminate 1 year ARI kerbside flow widths prior to pedestrian crossings or other high usage points such as bus stops.

Design Criteria – Gradient (Austroads Part 5A Section 5.4.5)

10.10 DPTI require a minimum longitudinal kerb gradient of 0.3%. The road designer shall aim to maximise gradient to reduce the extent of required drainage infrastructure without significantly increasing the cost of earthworks.

Design Theory – Inlet Capture Rates (Austroads Part 5A Section 5.5.2)

10.11 The full sized University of SA test rig inlet capture test results (both on-grade and sag) must be used for the DPTI Standard Side Entry Pit and Grated Inlet Pit for Concrete Side Drain. For other types of inlets (approved for use by the DPTI Stormwater Group) it is acceptable to use the HEC-22 Wizard in DRAINS to estimate inlet capacity where test results are not available.

Design Theory – Blockage (Austroads Part 5A Section 5.5.2)

10.12 Blockage factors should also be applied to the design event not just when analysing the major event.

10.13 In a sag, the percentage of full theoretical capacity allowed should be 60% for kerb inlets and 30% for grates.

10.14 In industrial or commercial areas which generate a lot of litter, e.g. timber dunnage / fast food outlet packaging or where deciduous street trees are present, an additional 5% reduction should be applied to the capacity of kerb inlets and 15% to grates for each of the above factors. This should be applied to both on grade (Table 5.4 figures) and sag inlets (above figures).

11 Underground Piped Networks (Austroads Part 5A Section 6)

Design Considerations (Austroads Part 5A Section 6.2)

11.1 If there are no other service constraints, longitudinal stormwater drains are to be located as detailed in the South Australian Public Utilities Advisory Coordinating Committee (PUACC) publication “Services in Streets - a code for the placement of infrastructure services in new and existing streets (1997 edition). Where stormwater must be located within close proximity to existing services, the relevant service authority guidelines must be used to determine required horizontal and vertical clearances.

Bedding and Haunch Support (Austroads Part 5A Section 6.4.2)

11.2 Assume that HS2 bedding and haunch support will be provided in construction.

Design Criteria (Austroads Part 5A Section 6.5)

11.3 A minimum of 150 mm freeboard is required between design water levels and gutter inverts at all kerb inlet pits. Note that the gutter invert at a properly constructed kerb inlet pit should be 50 mm lower than the gutter invert adjacent to the pit. The 150 mm requirement applied to the gutter invert level adjacent to the pit.

11.4 A minimum 20 mm difference in level is required between all inlet pipes and the outlet pipe from a junction box. The base of all junction boxes must be mortared with a semi-circular shape up to 1/3 the height of the main inlet and the outlet pipe to minimise hydraulic losses through the junction box. The mortar must be properly keyed to the sides and base of the pit.

Design Criteria - Size (Austroads Part 5A Section 6.5.2)

11.5 DPTI require a minimum 450 x 300 mm RCBC in rural areas and 375 x 225 mm for RCBC in urban areas. For pipes the minimum required diameters are 375 mm in urban / kerbed and 450 mm in rural / unkerbed environments for pipes.

12 Basins (Austroads Part 5A Section 7)

Basin Construction (Austroads Part 5A Section 7.1.4)

12.1 All basins must contain an impervious lining. Prior approval is required from the DPTI Stormwater Group before a basin is designed without an impervious liner if, for example, higher infiltration rates are required for the basin functionality. For sedimentation basins or where removal of accumulated pollutants is expected than a minimum 150 mm rock lining or alternative approved by DPTI Stormwater Group shall be provided to delineate the basin design invert.

Detention Basins (Austroads Part 5A Section 7.2)

12.2 Where used, DPTI require that detention basins be configured such that outflows for all rainfall events up to a 100 year ARI event do not exceed existing peak outflows. Multi-stage outlets may be required to achieve this. DPTI require all detention basins to be sized using a runoff routing model such as DRAINS. The basin must be assessed for multiple storm durations for the design ARI to ensure the highest storm volume is detained.

12.3 Triangular hydrograph methods are only acceptable to obtain preliminary design sizes for feasibility estimates.

12.4 Where the basin includes a bank above natural surface, which may overtop in a rarer storm event, provision must be made for safe overflow by a formalised spillway to ensure that the banks do not scour and fail.

Detention Basins – Other Design Considerations (Austroads Part 5A Section 7.2.0)

12.5 For all basin designs, maintenance requirements are to be considered, designed and detailed including the following:

a) All weather access needs to be provided to the basin (from the nearest public road) for maintenance vehicles including room for a vacuum truck to park within 10 metres of all basin inlet and outlet structures.

b) Access to the basin invert for a maintenance vehicle appropriate to the size and layout of the basin (e.g. front end loader or excavator) if maintenance is expected to be required in the future (i.e. sedimentation basins, detention basins, ponds and wetlands). Ramps must be provided with a 1:10 or flatter gradient.

c) Where the basin is to become a DPTI asset, all maintenance requirements need to be detailed in the appropriate format for entry into the DPTI Stormwater Treatment Infrastructure (STI) Manual (refer to Section 4 – Project Stormwater Documentation Deliverables).

13 Subsurface Drainage (Austroads Part 5A Section 8)

13.1 Subsurface drainage is rarely required on DPTI roads. The requirement and scope for subsurface drainage must be decided after consultation between the project designers, DPTI's Geotechnical Group and Pavement Unit, including consideration of the particular geotechnical and groundwater conditions and the overall proposed stormwater system extent. Either the stormwater or pavement designers may complete the subsurface drainage design, but this must be completed in accordance with this section of the Austroads Guide and the more comprehensive Austroads Guide to Pavement Technology Part 10: Subsurface Drainage.

13.2 Subsurface drainage must be connected to drainage pits within the drainage network at intervals of no more than 250 m and must include flush out points with appropriate covers at intervals of no more than 100 m.

14 Open Drains and Channels (Austroads Part 5B Section 2)

14.1 All open channels must be trapezoidal or an alternative shape that does not have an invert of limited width (i.e. v-shaped). If dispersive soils (soils having Emerson Class 1 or 2 in accordance with AS1289.3.8.1 – 2006) are be exposed by an open channel excavation then a minimum of 200 mm of non-dispersive topsoil or other cohesive material must be provided underneath any proposed vegetation or other erosion control layers. These protective layers must be detailed on the design to ensure that the construction contractor over-excavates the channel to allow for backfilling with the non-dispersive material to ensure the channel design cross-section is achieved.

Batter Drains and Chutes (Austroads Part 5B Section 2.14)

14.2 Fill batter chutes (open channels) must not be used unless the fill batter slope is flatter than 1:6. For slopes of 1:6 and steeper all stormwater drains down batter slopes shall be piped to the toe of batter.

15 Culverts (Austroads Part 5B Section 3)

Culvert Type and Culvert Size (Austroads Part 5B Section 3.4 and 3.5)

15.1 Refer to previously listed allowable materials and minimum pipe / box / culvert sizes to be used under DPTI roads. These are summarised under the comments shown in section Kerbed Drainage - General (Austroads Part 5A Section 5) above.

Structural Design Requirements - General (Austroads Part 5B Section 3.6)

15.2 Where box culverts are to be used with a clear span greater than 1.2 metres, a structural design is required in accordance with the requirements in the DPTI Structural Design Standard available on the DPTI webpage (design to be approved by the DPTI Structures Unit): (https://www.dpti.sa.gov.au/standards).

15.3 For box culverts with clear span equal to or less than 1.2 metres, DPTI will accept structural designs completed by box culvert manufacturers as long as they are designed and manufactured in accordance with AS1597.1 and AS1597.2.

Structural Design Requirements – Cover Over Pipes (Austroads Part 5B Section 3.6)

15.4 Pipes require a minimum of 600 mm of cover to the road surface. Where there is insufficient cover for all or some of the pipes under the road surface, box culverts should be used.

Hydraulic Design Considerations – Outlet Velocity (Austroads Part 5B Section 3.7.2)

15.5 The Department of Transport and Main Roads (Qld) reviewed its scour and erosion protection guidance since Table 3.1 (2010) was published as a result of significant scour during flood events. Their updated guidance should be used.

Hydraulic Design Considerations – Culverts in Flat Terrain (Austroads Part 5B Section 3.7.3)

15.6 In certain situations levee banks should also be constructed to guide water to the intended culvert and to ensure that water does not travel along the road embankment to the next culvert, potentially exceeding its capacity.

Blockage of Culverts (Austroads Part 5B Section 3.11)

15.7 Flood debris is significant in South Australia in rare flood events. Blockage of multiple pipe and culvert runs by floating debris including branches and other vegetation is common. Often there is preferential flow in one cell, with sedimentation occurring in others. Culverts and pipes are put on a maintenance schedule to be cleared when they are identified in periodic inspections as being greater than 50% blocked.

15.8 To minimise the risk of blockage, single pipes, single span culverts, or single span wider structures should be used. Where multiple spans are proposed, blockage factors must be applied to the design according to Table RD-DK-D1 15-1.

Table RD-DK-D1 15-1 Blockage Factors

Number of spans / culverts	1	2	3	4	5	6 or more
Blockage factor (%)	0	10	15	20	25	30

15.9 Where the spans or pipe diameters are less than 2 m an additional 10% blockage factor should be applied.

15.10 Where the spans or pipe diameters are less than 1.5 m an additional 15% blockage factor should be applied.

15.11 Where the spans or pipe diameters are less than 1 m an additional 25% blockage factor should be applied.

Culvert End Treatments – Traversable Endwalls (Austroads Part 5B Section 3.11)

15.12 DPTI allow the use of driveable endwalls (headwalls) for culverts up to 600 mm in diameter or span (refer to Section 2.4 – DPTI Standard Drawings). These drivable endwalls are normally used face on to traffic, typically under driveways and side roads. The potential for blockage is significantly increased with these structures, so a blockage factor of 50% must be used in the design.

15.13 For all road cross culverts above 600 mm in diameter or span the headwalls should all be located outside the clear zone if practical. Otherwise, an assessment should be done of the relative hazard of the culvert vs alternative physical protection such as guardrail to determine whether any treatment is required.

15.14 Traversable endwalls are not required where there is another obstacle such as an embankment, or tree that will prevent an errant vehicle from reaching the endwall.

16 Floodways (Austroads Part 5B Section 4)

Design Considerations – Geometric (Austroads Part 5B Section 4.2.2)

16.1 Floodways should be designed to cross at right angles in straight sections of the watercourse wherever possible. The road longitudinal profile should follow the bed of the watercourse as closely as possible while meeting sight distance requirements. This will minimise the effect on the hydraulics of the watercourse and hence scour on the floodway.

Flood Protection – Other Floodways (Austroads Part 5B Section 4.5.3)

16.2 Many floodway structures have been constructed in the semi-arid areas of SA. The most cost effective have been 400 mm cement treated pavement with spray seal and concrete cut-off walls to reduce the risk of undermining of the pavement. The downstream cut-off wall is more critical, typically 900-1200 mm deep and the upstream 600-900 mm. The nominal width of concrete cut-off walls is 300 mm, however creek bed material is frequently loose and as a result walls are often far from vertical. This generally requires a significant increase in the volume of concrete for the cut-off walls, typically double what would be indicated by the design. The floodway's are built with one way cross fall in the direction of flow, generally 1%, but this will vary with the bed slope of the creek. In most situations the cut-off walls should extend only across the main channel where the water depth and velocity will be higher. Cement treated pavement should extend to the apparent width of the floodplain.

16.3 Where larger and steeper watercourse are involved, typically in the Flinders Ranges, more elaborate floodway's along the lines described in Section 4.5.3 will need to be considered.

17 Stormwater Documentation Deliverables

17.1 The following Road Drainage Design records must be provided to the DPTI Stormwater Group.

Drawings

17.2 The drawings described in the DPTI: Road Design Standards and Guidelines and Part D010. In particular a drainage longitudinal section (including HGL), catchment plan and details drawing (if relevant) are to be provided in conjunction with the main drainage layout drawing which is to be shown on the general construction drawing or a dedicated drainage layout drawing.

17.3 As-Constructed drawings (if associated with construction contract).

17.4 Drawings of any temporary stormwater and / or sedimentation control devices required to comply with the Soil Erosion and Drainage Management Plan (SEDMP).

Design Reports / Stormwater Models

17.5 A stormwater design report is to be provided detailing all aspects of the stormwater design, including the stormwater management philosophy for the project, all relevant calculations and design considerations, water sensitive urban design elements and performance against WSUD Policy targets, and assessment of hydraulic grade lines, design flood events, stream velocities and scour protection. This report is to be provided to the DPTI Stormwater Group upon completion of the stormwater design and in draft form at relevant stages of the design to allow for review and feedback. Performance against SA WSUD policy targets shall be recorded and presented using the table in Appendix 1: Design performance against SA Water Sensitive Urban Design targets.

17.6 In conjunction with the design report, all relevant stormwater models including digital elevation terrain models are to be provided upon completion of the design and at relevant review periods.

As-Constructed GIS Stormwater Data (Design and Construct)

17.7 The engineering consultant and / or construction Contractor must submit to the DPTI Stormwater Group the final as-constructed stormwater system details in shapefile format, suitable for use in ESRI ArcGIS. This information must consist of a separate "Pits" shapefile detailing the location of all new stormwater pits, junction boxes and headwalls including attribute information that lists as a minimum:

a) pit type (e.g. Double Side Entry Pit);

b) pit invert level (metres AHD);

c) design pit surface level (i.e. gutter invert for SEP, surface level for JB) (metres AHD); and

d) year of construction.

17.8 In conjunction with the "Pits" shapefile, a "Pipes" shapefile is also to be provided detailing the location of all new stormwater and modified stormwater pipes / culverts, including the following minimum attribute information:

a) pipe material and type (RCP, FRC, RCBC, etc.);

b) pipe diameter, length and Pipe Class;

c) width / height (for RCBC) (in millimetres);

d) Upstream and Downstream pipe invert levels (m AHD); and

e) year of construction.

17.9 These two shapefiles are to be provided in MGA coordinates suitable to be overlaid with aerial imagery and other state government data.

Stormwater Treatment Infrastructure (STI) Design and Construct

17.10 The engineering consultant and / or construction Contractor must submit information, in the form of proformas as detailed below, which record physical details and maintenance requirements for any stormwater treatment devices (including detention basins) that are associated with the works.

17.11 The engineering consultant and / or construction Contractor must update the Stormwater Treatment Infrastructure (STI) manual by completing a "New STI (Location) Proforma" (Refer to https://www.dpti.sa.gov.au/standards) and a "New STI (Type) Proforma" if not already included in the manual (https://www.dpti.sa.gov.au/standards).

Approvals from relevant Councils and Drainage Authorities

17.12 The relevant Council(s) and / or Drainage Authority must be consulted during the progress of the design, and written approval from the Council(s) and / or Drainage Authority must be obtained and submitted to the relevant DPTI Project Manager at the conclusion of the stormwater design if the design involves discharge into any Council and / or Drainage Authority controlled fixed capacity downstream stormwater infrastructure / watercourses.

18 Hold Points

18.1 There are no Hold Points referenced in this Part.

19 Appendix 1: Design Performance against SA Water Sensitive Urban Design Targets

Table RD-DK-D1 19-1 Design Performance against SA Water Sensitive Urban Design Targets

Criteria	Target	Project Reference Design
a) % reduction in average annual load of Total Suspended Solids (TSS)	80%	
b) % reduction in average annual load of Total Nitrogen (TN)	45%	
c) % reduction in average annual load of Total Phosphorus (TP)	60%	
d) % reduction in average annual load of Gross Pollutants (GP)	90%	
e) Increase in 1 year ARI peak flow rate (where the project discharges stormwater runoff to an unlined watercourse)	No exceedance of pre-urban development 1 year ARI peak flow rate	
a) Increase in 5 year ARI peak flow	No increase	
b) Increase in 100 year ARI flood risk	No increase	