STORMWATER DESIGN GUIDELINES

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1. SCOPE

1.1 Purpose

This standard provides guidelines to consulting engineers, planners, and developers of stormwater drainage infrastructure to be designed and constructed for the City of Karratha or for developments located within Karratha (where applicable).

Developers subdividing or developing land shall undertake stormwater drainage design to mitigate the risk of flooding to personnel and property.

The City is the authority responsible for the future care, control and management of the road and stormwater drainage infrastructure. All designs submitted will be checked against these guidelines, and the City reserves the right to request revisions or further details if they are not satisfied with the information supplied.

All stormwater drainage designs and calculations shall be carried out by a qualified person experienced in hydrologic and hydraulic design.

1.2 General

Residential and commercial developments create impermeable surfaces, such as concrete, asphalt, and rooftops, which reduce the amount of stormwater that can infiltrate into the ground. This leads to high volumes of stormwater runoff that need to be directed away from developed areas.

Stormwater drainage infrastructure is required in developed areas to avoid flooding, erosion, and damage to property and infrastructure.

1.3 Applicable Standards

The installation, materials and workmanship shall comply with all relevant current Australian Standards, Codes and Regulations and all reference codes and Standards listed in the prefaces to those standards and codes.

Where Australian Standards and Codes do not exist the appropriate International Standard or Codes shall apply. Request an instruction from the City for amendments to Standards, Codes or Regulations that come into effect during the works and affect the works of the contract.

Document	Title
AGRD5	Austroads – Guide to Road Design Part 5: Drainage - General and Hydrology Considerations

AGRD5A	Austroads – Guide to Road Design Part 5A: Drainage: Road Surface, Networks, Basins and Subsurface
AGRD5B	Austroads – Guide to Road Design Part 5B: Drainage-Open Channels, Culverts and Floodway Crossings
ARR 2019	Australian Rainfall and Runoff – A Guide to Flood Estimation
AS 1597 Suite	Precast reinforced concrete box culverts
AS 2439.1	Perforated plastics drainage and effluent pipe and fittings - Perforated drainage pipe and associated fittings
AS/NZS 3500.3	Plumbing and drainage - Part 3: Stormwater drainage
AS 3600	Concrete Structures
AS/NZS 3725	Design for installation of buried concrete pipes
AS 3735	Concrete structures for retaining liquids
AS 3850 Suite	Prefabricated concrete elements
AS/NZS 4058	Precast concrete pipes (pressure and non-pressure)
AS/NZS 4671	Steel for the reinforcement of concrete
AS 5100.5	Bridge Design – Part 5: Concrete
Department of Water and Environmental Regulation (DWER)	Stormwater Management Manual for Western Australia
MRWA 200131-062	Main Roads Western Australia Drawing – Trenching and Bedding Details for Pipe Culverts
IPWEA LGGSD	Institute of Public Works Western Australia – Local Government Guidelines for Subdivisional Development Edition 2.3
IPWEA DS-031	Excavation, bedding and backfilling precast box culverts

1.4 Acronyms

Acronym	Full Form
AGRD	Austroads Guide to Road Design
AEP	Annual Exceedance Probability – The likelihood for the storm event to be met and exceeded
ARR	Australian Rainfall & Runoff
BOM	Bureau of Meteorology
IFD	Intensity Frequency Duration (for a rainfall event)
IPWEA	Institute of Public Works Engineering Australasia
LGGSD	Local Government Guidelines for Subdivisional Development
MRWA	Main Roads Western Australia

WSUD	Water Sensitive Urban Design

2. DESIGN REQUIREMENTS

The following describes the requirements for the design of the stormwater network, including drainage and storage.

2.1 Design Approach

Designers shall:

- Adopt the storm event design criteria in accordance with Table 1.
- Determine the total catchment area of the development, including any upstream and surrounding catchment areas.
- Design and evaluate the topography, including proposed landscaping features.
- Determine the runoff coefficient in accordance with Table 2 and consider the existing soil for infiltration.
- Design a suitable drainage system consisting of open channels, swales, pit and pipes system and detention areas (if required), including producing hydraulic & hydrological modelling as required for effective stormwater management.

Developers whose land shares a common drainage catchment have a responsibility to ensure that the whole catchment, including major roads, is drained appropriately. Larger developments which may have a staged development process, will be required to demonstrate an overall drainage plan for the entire catchment prior to obtaining approval for any individual stages.

2.2 Design Criteria

2.2.1 Design Rainfall Data

Design rainfall shall be determined in accordance with *Australian Rainfall & Runoff (ARR) – A Guide to Flood Estimation (2006)*. Storm events are classified based on Intensity-Frequency-Duration (IFD).

IFDs are recommended by AS3500.3 based on the impact of overflow on buildings, contents, injury, and nuisance to personnel. IFD data is to be derived from information obtained from the Bureau of Meteorology (BOM) website. The assessment must be based on the latitude and longitude of the location under design.

Stormwater drainage infrastructure shall be designed for a design storm event in accordance with Table 1

The storm events shall be used for the design of stormwater drainage elements, including drains, roads, storage, open spaces, and other zones.

Table 1: Design Rainfalls for Karratha (20.74, 116.86), IFDs from AS3500.3 Table 5.4.3 & CL 5.4.4

Criticality of public infrastructure	IFD Storm event	Design Rainfall Rate (mm/hr)	Design Rainfall Volume (mm)
Small impact, low-density areas	AEP 63% 5 minute	58	5
Normal impacts	AEP 50% 5 minute	68	6
Sites subjected to ponding in flat areas or flooding of parking lots to depths greater than 150mm.	AEP 10% 5 minute	120	10

Impeded access to commercial & Industrial Buildings.			
Where ponding could occur against two or more adjoining buildings, or where, access is impeded to Hospitals, town halls, and school entrances.	AEP 5% 5 minute	141	12
Detention Basin Design	AEP 1% 96 hour	4.26	409

2.2.2 Hydrology and Hydraulics

The Rational Method shall be used for regular shaped catchments and as long as requirements for WSUD are met. Where catchments are irregular in shape or run-off characteristics vary considerably within the catchment, partial area calculations may be required to determine peak flows to be used in the design. Rational Method calculations to determine flows shall be carried out in accordance with WSUD. All calculations must be undertaken by a qualified person in hydrologic and hydraulic design. Coefficients of discharge shall be calculated in accordance with WSUD.

Run-off coefficients shall be determined in accordance with Table 2.

Table 2: Run-off coefficients for Karratha (AS3500.3:2021 CL 5.4.6)

Catchment Area	Run-off coefficient (C)
Roofed Area	1.0
Paved Area (Unroofed)	0.9
Pervious area – AEP 63%	0.35
Pervious area – AEP 50%	0.36
Pervious area – AEP 10%	0.41
Pervious area – AEP 5%	0.43
Pervious area – AEP 1%	0.48

Run-off coefficients have been conservatively calculated for clay soils.

2.3 Basis of Design – Existing Infrastructure

New drainage infrastructure shall be designed in line with the City's existing drainage basis of design as follows:

- Stormwater is directed to existing paved roads or open drains (e.g., Karratha Industrial Estate or KIE).
- New developments within the KIE, including building and or civil infrastructure upgrade within existing lots, will require a new DA to be submitted to the City's Planning department. Detailed design and drawings will need to accompany the DA for review and approval by the City's Engineering Services team.
- High kerbs contain stormwater within the road network.
- Stormwater is conveyed to topographic low points using open channels and swales.
- Stormwater is discharged to the environment for infiltration and evaporation.

A network of drainage channels and drainage reserves exists and interconnects to discharge stormwater onto low-lying areas.

The City prefers the use of open channels to convey stormwater over pit and pipe designs. If subsoil or subsurface drainage is required, refer to Section 2.9 for the design of pit and pipe systems.

2.4 Open Channels & Swales

Open channels shall be designed to have smooth transitions with adequate access provisions for maintenance and cleaning. Where permitted by the City, the use of an open channel to convey flows from a development site to the receiving water body, such as channel, shall comply with the requirements of this Guideline, WUSD and ARR. Drainage channels shall be sized to appropriately convey volumes of stormwater.

The design of open channels shall be generally in accordance with WSUD. Open channels will be designed to contain the major system flow for 1% AEP (100-year ARI) less any flow that is contained in the minor system (if applicable), with an appropriate freeboard for open channel and allowance for blockage of the minor system in accordance with WSUD. Freeboard shall be calculated in accordance with WSUD.

The longitudinal gradient shall be between 1 in 50 to 1 in 25 to promote flow. Maximum side slope gradient on grass-lined open channels shall be 1 in 4 for maintenance purposes unless otherwise approved by the City.

The maximum velocity of flow shall be as follows:

Table 3: Maximum allowable velocities in open channels to prevent soil erosion (AGRD 5 Clause 3.5.7)

Storm Event AEP (%)	Maximum Allowable Velocity (m/s)	Uses in Engineering Design
63% 5 minutes	0.5	Water Sensitive Urban Design
50% 5 minutes	0.5	Stormwater pit and pipe design
20% 5 minutes	0.6	
10% 5 minutes	0.7	Floodplain Management and waterway design
5% 5 minutes	0.8	
2% 5 minutes	0.9	
1% 5 minutes	1.0	

To avoid soil erosion at bends and junctions, mortared stone pitching shall be provided at changes in direction 22.5° or greater.

The flow velocity of stormwater in channels with steep gradients can be adjusted using bed control.

Open channels located next to roads shall have the following requirement: When the channel is conveying an AEP 5% 5-minute storm, the water surface shall be a minimum of 300mm below the road shoulder surface.

2.5 Overland Flow

The major system shall be designed generally in accordance with WUSD. Where overland flow is to be transferred from the road network into the drainage reserve, open space or parkland, dedicated drainage flow paths must be provided in accordance with WUSD with a minimum width of 5m. An unlined flow path or channel shall be designed to allow access to facilitate maintenance activities. The widths of the access and maintenance berms are required to be a minimum of 4.5 m. The transfer of overland flow from road reserve to open space shall not be permitted within private property.

2.6 Road Drainage

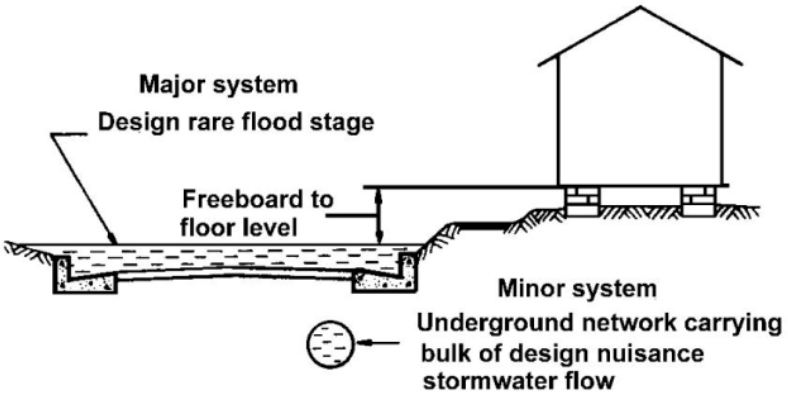

Figure 1: Required Freeboard to habitable floor level (extract from AGRD5A Figure 2.1)

The road system shall be designed for kerbs to contain all flows within the AEP 5% 5-minute event. Allowable spread width for minor events should be in accordance with the Local Government Guidelines for Subdivision Development (IPWEA 2017), which details allowable spread width based on road classification.

Roads and road reserves shall be designed so that a freeboard of 500mm is maintained to the habitable floor level of buildings. The road system is to be designed for a maximum product of flooded depth and average velocity of 0.3m^2/s in accordance with ARR 2019 Clause 7.2.3 and 7.2.4, satisfying safety requirements for:

- Safety of pedestrians, especially children
- Vehicle stability, especially small, low clearance vehicles.

Aquaplaning

Roads shall be assessed for the potential of aquaplaning risks in accordance with Austroads Part 5A, for an AEP63% 5-minute storm.

The film thickness of water on roads during a rainfall event shall be calculated using the Gallaway formula in AGRD5A Clause 4.9.1.

The acceptable film thickness is as per Table 4.

Table 4: Acceptable Film Thickness Limits (Refer AGRD5A Clause 4.10.1)

Applications	Maximum allowable film thickness (mm)
80km/hr Intersections & roundabouts, including approaches and exits Steep downhill sections Merge and diverge sections for entry ramps, overtaking lanes and climbing lanes Superelevated curves	2.5 desirable 4.0 maximum
All other roads	5.0 maximum

Kerb Breaks

Kerb breaks shall be provided at appropriate points throughout the road network to discharge stormwater to

drainage reserves and vegetated open channels in a controlled manner. Scour protection is required for kerb opening and shall be designed and constructed to minimise erosion.

Roundabouts

Generally, roundabout road pavements shall be designed with a cross slope on the circulating roundabouts, which allows for water to drain away from the central island. Kerb openings shall be provided on the perimeters of the roundabout.

Where a roundabout is required to be banked towards the centre:

- For central islands with vegetation, kerb openings shall be used to assist plant growth
- For paved central islands, pit and pipe drainage systems will be required to capture and convey stormwater.

2.7 Culverts

Culverts shall be designed where road crossings are required over open channels. The minimum culvert sizes recommended by the City are 450 mm diameter for pipe culverts and 600 mm x 450 mm for box culverts. Minimum cover to pipes shall be in accordance with MRWA or manufacturer's recommendations; however, a minimum cover of 600 mm is preferred wherever possible.

The minimum vertical and horizontal clearance between stormwater culverts and other services is to be 300 mm. In areas where any part of the pipe is below AHD RL 5.0, exposed to saltwater or aggressive soil, culverts shall have cover to reinforcement in accordance with AS3600, AS3735 and AS5100.5.

Culverts shall be pre-cast reinforced concrete box culverts complying with AS 1597, including provisions for lifting the culverts in accordance with AS 3850.

Culverts used in a crown orientation (inverted U) shall be placed on a concrete poured in-situ slab base. The slab thickness can be determined as per MRWA drawing 201131-0065-2, based on its cover from road finish level. A minimum of 150 mm thick bedding material shall be used on the underside of the slab. The slab shall be constructed on a bedding material consisting of 150mm thick MRWA *501.11 Crushed Rock Base basecourse* compacted to 95%MMDD. This may be adjusted based on the bearing capacity of the soil and Geotechnical Engineer's recommendation.

In general, the culverts and all associated structures should be designed as follows:

- Vehicle and embankment fill loads determined in accordance with AS/NZS 3725.
- Load capacity determined in accordance with the manufacturer
- Culverts designed for a AEP 5% 5 minute flow capacity
- Target maximum velocity of 0.5m/s to prevent soil erosion of the bedding material
- Culverts shall be sized to ensure the maximum water level is 300 mm below the interior top level of the culvert in accordance with AGRD5 Clause 4.6.6.
- Minimum cover on top of culvert shall be 300mm CBR15 compacted backfill to 95%MMDD in accordance with *IPWEA drawing DS-031*. Road pavements and/or footpaths shall be constructed on the compacted backfill.
- Scour protection at culvert inlet and outlet locations shall be designed and constructed to minimise erosion. The design outlet flow velocity for an outlet scour protection shall be the design storm event for the subject culvert. Refer to *MRWA Standard Drawing 200131-0061-4, 200131-0062-4 and 200131-0063* for details for pipe culverts. Refer to *IPWEA Standard Drawing DS-031* for trenching and bedding details for box culverts.

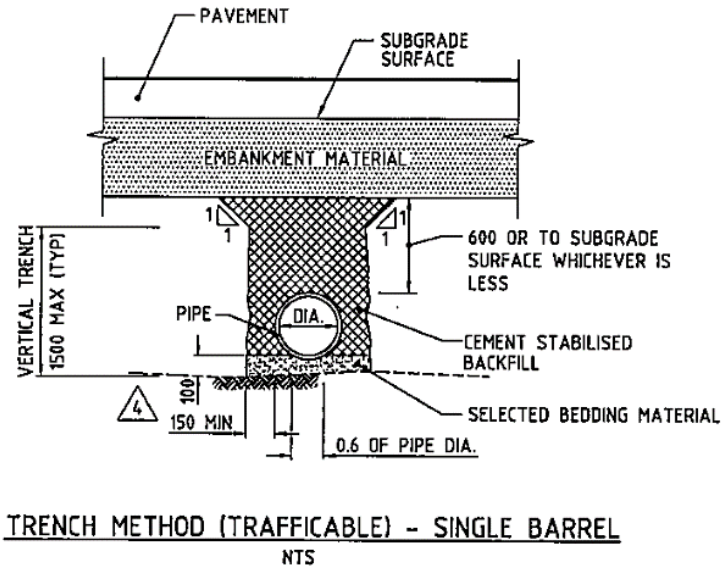

Figure 2: Pipe Culvert Detail (Source MRWA 200131-0062-4)

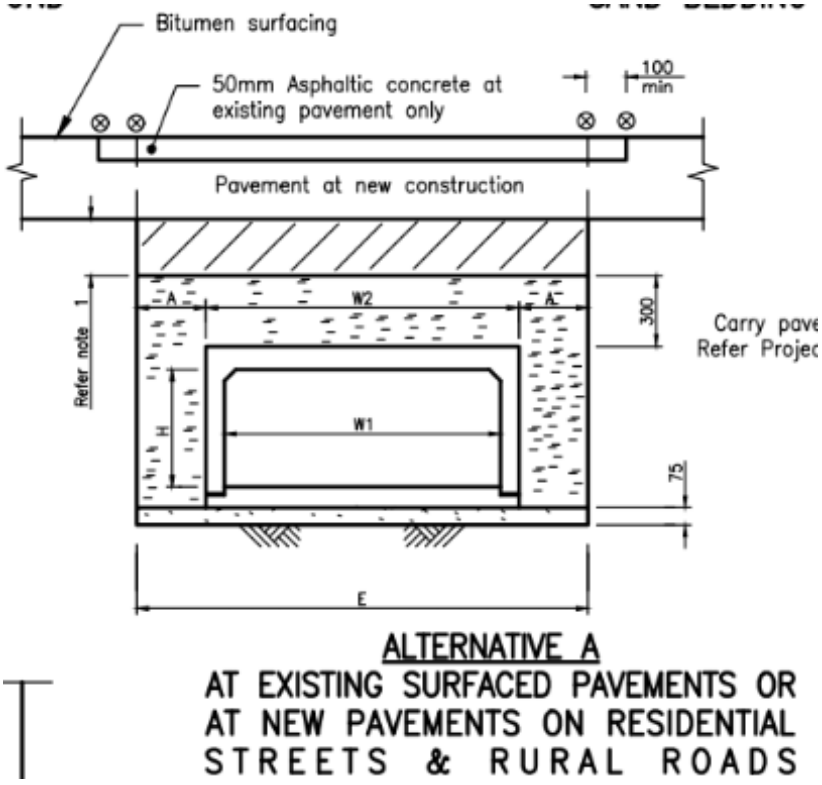

Figure 3: Box Culvert Detail (Source IPWEA DS-031)

Rock protection shall be provided for a minimum of 1m at the base of culvert outlets, with a minimum thickness of 500mm in accordance with AGRD5 Table 3.11.

Rock protection shall be Facing class in accordance with AGRD5 Table 3.12.

Refer to IPWEA Standard Drawing SD-350, SD-351, and SD-355 for further details on pipe culverts. Refer to MRWA Standard Drawing 9381-6066 for further details on box culverts.

Due to the potential for blockage, the minimum culvert diameter is 450mm, and the culverts are required to have the minimum grade needed to produce self-cleansing velocity.

For details regarding the pipe gradients associated with the required self-cleansing velocities, refer to Austroads' "*Guide to Road Design Part 5A: Drainage – road Surface, Networks, basins and Subsurface".*

2.8 Detention Facilities and Drainage Reserves

Detention facilities shall be designed as buffer storage capacity drainage to downstream facilities. Detention basins shall be sized for an AEP 1% 96-hour storm event and account for rainfall on all upstream catchment areas and rainfall landing in the basin itself.

Detention facilities shall comply with the following requirements in accordance with IPWEA LGGSD 2.3:

- Maximum slope 1 in 6
- Base minimum slope 1 in 200
- Maximum water depth 1.2m
- Include a low point storage for an AEP 63% 5-minute event.
- Suitably vegetated in the public open space
- Discharge to the environment via a gross pollutant trap
- Fencing to restrict public access
- Dedicated overflow design for harmless escape of water in the event an outlet is blocked, and storage is completely filled.

Detention basins must be designed to fully discharge so that there will be no ponding of water after the event to prevent stagnant water, odour, and mosquitos.

2.9 Pit & Pipe Systems

Subsoil or subsurface drainage requiring buried pipes and pits will be required for the following areas:

- Built-up areas where open channels pose fall hazards, interrupt pavement infrastructure, or pose aesthetic issues
- Areas with a high-water table

In general, the pipes and all associated structures should be designed to manufacturer standards and as follows:

- Pit and pipe drainage system designed for a 5% (min) AEP storm event as part of an overall stormwater systems design for a 1% AEP event.
- Minimum gradient in accordance with Table 5.
- Minimum pipe diameter 450mm
- Minimum cover of 600mm where possible, at the approval of the City. A minimum level of cover will need to be determined in accordance with AS/NZS 3725 based on vehicle loads above and in the vicinity of the pipe
- Maximum headwater level 300mm below pavement level
- Pipe diameters smaller than 450mm shall require approval by the City
- Drainage pipes shall be laid in accordance with AS3500.3 Clause 6.3.1.1:
    - With no lipped joints or internal projections
    - In a manner preventing ingress of soil
    - With protection to prevent damage during installation and service, i.e. vehicle barriers, if required

- Using sweep junctions

Drainage pipes shall also be graded to achieve a minimum self-cleaning flow velocity of 1.2m/s in accordance with AGRD5A Clause 6.5.4.

Drainage pipes shall be designed to have a maximum velocity of 1.5m/s in accordance with recommendations in AS3500.3 Clause 5.4.11.2 (d).

Maximum and Minimum gradients for precast concrete drainage pipes to achieve a flow velocity between 1.2m/s and 1.5m/s are as follows:

Table 5: Minimum gradients for drainage pipes in accordance with AS3500.3 Table 6.3.4.

Nominal Size	Minimum Gradient	Maximum Gradient
DN450	1 in 250	1 in 150
DN525	1 in 300	1 in 200
DN600	1 in 350	1 in 200
DN675	1 in 400	1 in 250
DN750	1 in 450	1 in 250
DN900	1 in 600	1 in 350
DN1050	1 in 700	1 in 400

Precast concrete pipes used for drainage shall comply with AS/NZS 4058:2007 and be designed with a bell and spigot with a rubber ring joint.

Pipes shall be buried with an adequate depth of cover to ensure adequate resistance against vehicle loads. Loads shall be determined using AS/NZS 3725:2007 Clause 6. The load capacity of the pipes shall be determined in accordance with the manufacturer's performance test results in accordance with AS/NZS 4058:2007 Clause 4.

The minimum trench cover and width for reinforced concrete pipes shall be calculated in accordance with AS/NZS 3725:2007.

Pits

Gully pits are to be placed at all low points, on the upstream side of intersections, and the upstream side of pedestrian ramps and crossings.

In addition to the above, intermediate gully pits are to be placed to ensure that gutter flow meets the safety conditions.

Junction pits are to be placed at all pipe junctions and at pipe direction or grade changes. Pits to be positioned so that they do not impact future access to residential lots.

The maximum distance between junction pits is 90m.

Junction pits shall not be used as infiltration devices due to the clayey soil conditions within Karratha region.

2.10 Materials

The following pipe and culvert materials are approved subject to minimum cover and installation requirements stated by the manufacturer:

- Precast concrete pipe in accordance with AS/NZS 4058

- Pre-cast concrete culverts complying with AS 1597
- Cast in-situ concrete drainage infrastructure to City of Karratha Concrete Specification CKS-100
- Perforated High-Density Polyethylene (HDPE) flexible plastic pipes complying with AS 2439.1 for subsoil drainage
- Other pipes or culverts will be considered, subject to the City's assessment and approval.

2.11 Subsoil Drainage

The purpose of subsoil drainage is to prevent excessive moisture in pavement and subgrade to ensure strength & serviceability during its design life.

Pavement drains are used to remove water from the subgrade and pavement materials. Formation drains are used to intercept water before it reaches the road structure.

Subsoil drainage shall be installed in the following areas:

- Areas prone to being waterlogged
- Areas with building foundations
- Areas with a high-water table
- Slopes and embankments to prevent the risk of failure
- Roads on reactive clay-type subgrades
- Areas where there is existing evidence of scour or erosion of the land
- Where road is restricted by kerbing with no possibility of kerb openings installation

2.12 Maintenance

The drainage system shall take into consideration requirements of future maintenance activities, including the provision for safe plant access for cleaning, silt removal and maintenance of vegetation.

Roads and access tracks shall be designed in accordance with the City's Road Specification CKS-400, taking into consideration the Gross Vehicle Mass of Light or Commercial Vehicles involved in stormwater drainage infrastructure maintenance.

3. DEVELOPMENT REQUIREMENTS

3.1 Stormwater Management Plan

A Stormwater Management Plan (SWMP) shall be produced by a qualified design consultant and submitted to the City prior to commencing stormwater drainage design. The proposal shall investigate:

- Types and locations for WSUD strategies to be implemented
- Consider upstream and downstream catchments
- Identify necessary infrastructure (e.g., floodways) and proposed treatment
- Identify any upgrades required to existing drainage or road infrastructure

The results of this investigation shall be included in a master plan for drainage, which shall be provided to the City for approval prior to commencing any development.

The stormwater management plan requirements are detailed in Table 6.

Table 6: Stormwater Management Plan Requirements

Design Aspect	Purpose	Requirement
Lot contour levels and finished levels	To confirm stormwater flow paths within a Lot	Feature, topographical and underground utilities survey in accordance with City of Karratha specification CKS-910
Floor levels	To reduce the risk of property flooding during major events	500mm freeboard from the 1% AEP flood level
Catchment overflow analysis – pre and post development	To ensure catchments do not overflow due to the new development	
Drainage flow rate analysis – pre and post development	To ensure the drainage network is designed with sufficient flow capacity	Between 1.2m/s and 1.5m/s
Drainage flow paths	To confirm stormwater flow paths external to Lots	
Flow velocity analysis	To reduce the risk of erosion and identify any rock protection required	
Lot discharge design	To identify which lots will discharge to an adjacent drain or require stormwater directed onto roads	
Residential roof design	To confirm residential roofs are designed to discharge to the lot directly without gutters or downpipes, as these are not effective for high-intensity rainfall and are not typically cyclone-rated	No gutters or downpipes permitted
Drainage discharge point design	To prevent erosion at the outlet of culverts and stormwater pipes	Appropriate scour protection (rocks or rip rap) designed on the outlet of drains in accordance with AGRD5

3.1.1 Specific Requirements

In general, a stormwater management plan is designed to reduce infrastructure flooding risks, reduce public health/safety and environmental impact risks from stormwater infrastructure, manage minor events close to the source for water quality, manage the catchment runoff or flooding for up to the 1% AEP 96-hour storm event and protect infrastructure and assets from catchment runoff or flooding. In addition to information outlined in Table 6 above, some specific details to be provided in a SWMP are:

- Site characteristics (i.e., existing land use, climate, surface water etc.).
- Proposed land use and drainage strategy.
- Hydraulics/hydrology modelling.
- SWMP implementation, including concept design and documentation.

As there is a range of development types and sizing, each development application will be reviewed on a case-by-case basis. The City reserves the right to request further information and details as required to assist with the review and endorsement process.

3.1.2 Drawings

The City will generally require the following information to support a stormwater management plan:

- Feature and topographical surveys information showing existing development and ground levels.
- A plan to scale, showing the proposed development.
- Proposed grading of the site with contours.
- Proposed Finished Ground Levels (FGL) and Finished Floor Levels (FFL).
- Locations for stormwater infrastructure, including but not limited to kerbing, pipes, silt traps, erosion control measures.
- Size (depth & diameter) and locations of all soak wells, infiltration basins and landscape areas.
- Locations and details of excess water discharge methods to the Town's drainage system.
- Details of proposed roof direction.
- Sealed and unsealed areas (and what they consist of).
- Identify any services or infrastructure on the site that require protection.
- Cross sections of infiltration basins and swales; and
- Information identified under State Planning Policy 2.9 Planning for Water Guidelines Table E.1.

3.2 Impact on Existing Drainage Infrastructure

Any proposed modifications to existing drainage infrastructure will be reviewed by the City as it may impact on the hydraulic capacities of drainage control points such as road crossings. It is important that new developments are designed to ensure post-development flows do not exceed pre-development flows so additional pressures are not placed on these drainage points within the network.

If, during the design phase, it is determined that existing drains do not meet the requirements of the new development, then the developer must arrange appropriate approvals for altering the existing infrastructure prior to undertaking any work. Alterations to existing drains are not permitted without authorisation.

Any proposed development that affects existing drainage reserves will require a detailed investigation. The Local Government Guidelines for Subdivision Development (IPWEA 2017) illustrate a floodplain development strategy and identify a flood fringe that can be utilised if necessary. The minimum requirement for this type of impingement will include a hydrologic and hydraulic assessment to demonstrate:

- Minimum habitable floor level of 500mm above the water level from an AEP1% 96-hour storm.
- Total development does not increase the surface of the drainage reserve water level by more than 150mm during an AEP1% 96-hour storm.

Environmental considerations are also major design requirements for all drainage infrastructure and subdivision designs must be undertaken in consultation with relevant agencies; in particular, soil erosion and sediment control will be necessary during construction and maintenance periods.

To avoid mosquito breeding and associated issues, all drainage systems and associated structures should be designed in consultation with the Department of Health.

3.3 Dwelling Requirements

The roofs of all dwellings shall not contain gutters or downpipes; roofs shall be designed to discharge directly to the lot. In rare cases, where a new shed or patio is to be built next to an established dwelling where direct

discharge is not possible; detailed design/drawings will need to be provided as part of the DA for review and approval by the City's Engineering Services team.

Lots should be landscaped to retain an AEP20% 5-minute storm to avoid excessive discharge to the drainage network.

3.4 Outfall to Private Property

In instances where stormwater is to be discharged into private land downstream of a development, the developer must ensure that an easement is provided over the route of the drain in addition to constructing and/or improving the drainage outlet. The easement shall be in favour of the City.

3.5 Water Sensitive Urban Design (WSUD)

The City supports the principles of WSUD and recommends they be adopted to suit the climatic and ground condition of the region.

3.6 Discharge Water Quality

All developers are to maintain surface and groundwater quality at predevelopment levels and improve the quality of water leaving the developed area, if possible. All runoff contained in the drainage infrastructure network needs to receive treatment prior to discharge into the environment consistent with the Stormwater management manual (DoW, 2004-2007).

3.7 Landscaping and Irrigation Reuse

Recreation reserves should be irrigated by stormwater where possible which can further reduce peak flows to open drains. This can be achieved with appropriate landscaping, especially upstream towards stormwater generation sources as possible.

Landscaping proposals should assess:

- If there is sufficient rainfall volume and frequency to irrigate and support vegetation growth, including any water loss to evapotranspiration.
- If there is any impact to the drainage network's flow capacity or cause flooding.
- The use of v-notched weirs or drop structures within open drains to reduce flow velocities, erosion and downstream sedimentation.

3.8 Innovation

The City supports innovation in stormwater design, however good supportive evidence must be supplied with any proposal.

3.9 Local Government Guidelines

The City acknowledges that the Local Government Guidelines for Subdivisional Development by the Institute of Public Works Engineers Australia (Guidelines for Subdivision) are considered as the minimum standard for subdivision development and are to be read in conjunction with this document and other policies and legislations relevant to Agencies associated with subdivisional approvals.

Better Urban Water Management (WAPC 2008) was developed to facilitate better urban water management of our urban water resources by ensuring an appropriate level of consideration is given to the total water cycle at each stage of the planning system and should also be considered in association with Local Government Guidelines for Subdivisional Development during the development process within the City.

The *Australian Rainfall and Runoff: A Guide to Flood Estimation (ARR 2019)* provides guidance on design flood estimation to be used in conjunction with the design parameters included in this document.

3.10 Bioretention

Maintaining a level of vegetation cover in constructed features such as drainage reserves is important for increasing soil stabilisation and reducing erosion. Vegetation can act to inhibit stormwater flows and potentially lead to flooding in serious cases; however, a balance of vegetation cover is required to ensure optimal drainage system performance.

Drainage channels should be vegetated with native grasses, whilst trees should occupy drainage reserves. It is preferred that shrubs not be used in drainage reserves due to the additional maintenance requirements. Species should be selected to reduce water requirements with watering to assist in the establishment and reduced to zero by handover. Table 7 below has examples of species that are considered suitable; however, this is not an exhaustive list, and other species approved by the City can be considered.

Table 7: Recommended species for establishment in new drainage reserves

CATEGORIES	SPECIES	HABITAT
Trees	Eucalyptus victrix (Western Coolibah); 1 – 12 m	Floodplains and flats
	Terminalia canescens (Joolal); 1 – 10 m	Variety of habitats
Grasses	Cymbopogan ambiguous (scent grass)	Variety of habitats
	Themeda triandra	Variety of habitats

3.11 Construction

A *Before You Dig* enquiry shall be completed prior to commencing any excavation or earthworks. This must be confirmed on site by undertaking physical service location of underground services prior to commencing construction. The service location must be undertaken by a licenced surveyor, and plans must be submitted to the City for review, approval, and record-keeping purposes.

During construction, the Developer or Developer's Consulting Engineer must notify the City to carry out a joint inspection of the hold points activities identified in the table below. **All hold points must be attended by the City, engineering consultant and contractor representatives, respectively.**

No	Activity	Hold Points (Y/N)	Required Attendees
1	Excavation to base level	N	
2	Inspection of base level	**Y**	City of Karratha, consulting engineer and/or contractor
3	Review and approval of compaction testing of the base level	**Y**	City of Karratha, consulting engineer and/or contractor
4	Review and approval of As Constructed Levels	**Y**	City of Karratha, consulting engineer and/or contractor
5	Bedding installation and compaction	N	Consulting engineer to provide photographic evidence to the City
6	Overlay installation and compaction	N	
7	Overlay compaction test results	**Y**	City of Karratha, consulting engineer

	review and approval		and/or contractor
8	Backfill	N	
9	Backfill material every 300mm lift (maximum) compaction test result review and approval	**Y**	City of Karratha, consulting engineer and/or contractor
10	Review and approval of As Constructed Levels	**Y**	City of Karratha, consulting engineer and/or contractor

Standard Number:	**CKS-500**
Previous Standard Number:	**Stormwater Design Guidelines for Residential Developments 2011**
Last Reviewed:	**January 2025**
Next Reviewed:	**January 2026**
Responsible Officer:	**Principal Engineer Coordinator**