Chapter 7 Stormwater drainage

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7.1 Introduction

(1) The planning, design and implementation of stormwater drainage must integrate the two distinct components of stormwater management, i.e. water quantity and water quality. The stormwater drainage system must:
    (a) prevent or minimise adverse social, environmental, and flooding impacts on the City’s waterways, overland flow paths and constructed drainage network;
    (b) ensure that the design of channel works as part of development maximises the use of natural channel design principles where possible;
    (c) achieve acceptable levels of stormwater runoff quantity and quality by applying total water cycle management and water sensitive urban design principles.

(2) In addition to this planning scheme policy, urban stormwater drainage systems are planned, designed and constructed in accordance with the current edition of the following:
    (a) Queensland Urban Drainage Manual (QUDM);
    (b) Australian Rainfall and Runoff;
    (c) Waterway Design: A guide to the hydraulic design of Bridges, Culverts and Floodways (AustRoads 1994);
    (d) AustRoads – ‘Guide to Road Design Part 5: Drainage design’;
    (e) Brisbane City Council Department of Works Supplement to the Queensland Urban Drainage Manual;
    (f) Integrated Maintenance Manual for Waterways, Wetlands and Open Drains.
    (g) Local Stormwater Management Plans for:
        (i) Castlemaine—Caxton Streets—Relief Drainage Investigation;
        (ii) Gillibrand Street Catchment—Relief Drainage Investigation;
        (iii) Gerler Road, Clayfield Catchment—Local Stormwater Drainage Study;
        (iv) Hendra–Doomben Drain Catchments (Kemble Street)—Relief Drainage Investigation;
        (v) Hendra–Doomben Drain Catchments (Racecourse)—Relief Drainage Investigation;
        (vi) Langsville Creek Catchment—Relief Drainage Investigation;
        (vii) Long Street East, Graceville—Local Stormwater Management Plan;
        (viii) Milton Drain—Local Stormwater Management Plan;
        (ix) New Farm—Teneriffe Catchment—Relief Drainage Investigation;
        (x) Pashen Creek, Hawthorne Catchment—Local Stormwater Management Plan;
        (xi) Sandy Creek (Indooroopilly)—Relief Drainage Investigation;
        (xii) Stratton Street Drainage Investigation;
        (xiii) Sydney Street, Merthyr Catchment—Relief Drainage Investigation;
        (xiv) Water and Campbell Street Catchments—Relief Drainage Investigation;
        (xv) Watersham Street Taringa Catchment—Relief Drainage Investigation;
        (xvi) Woolcock Park Relief Drainage Study; and
    (h) Stormwater Management Plans for:
        (i) Albany Creek Catchment Master Drainage Plan;
(i) Bald Hills Creek Stormwater Management Plan;
(ii) Blunder Creek Master Drainage Plan;
(iii) Bullockhead Creek Master Drainage Plan;
(iv) Cedar Creek Master Drainage Plan;
(vi) Gumdale to Tingalpa Stormwater Management Plan;
(vii) Hemmant—Wynnum West Area Master Drainage Investigation and Flood Study;
(viii) Master Drainage Plan for Carseldine and Taigum Catchments;
(ix) McKay Brook Stormwater Management Plan;
(x) Pullen Pullen Creek Master Drainage Plan;
(xi) Scrubby Creek Catchment Management Plan;
(xii) Sheepstation Gully Stormwater Management Plan;
(i) Technical Guidelines for Assessing Energy Efficiency;
(j) Urban Creek Erosion—Guidelines for Selecting Remedial Works 1996;
(k) Urban Stormwater Management Strategy;
(l) Water Sensitive Urban Design: Streetscape Planning & Design Package;

(3) This chapter identifies the following for stormwater drainage in accordance with the structure set out in Table 7.1A:

(a) design and construction standards;
(b) advice about satisfying assessment criteria in the City Plan;
(c) the information that the Council may request to be supplied for a development application.

Table 7.1A —Structure of chapter

<table>
<thead>
<tr>
<th>Section</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>Left blank intentionally.</td>
</tr>
<tr>
<td>2. Property drainage systems</td>
<td>Details the design standards for property drainage design within the local government area.</td>
</tr>
<tr>
<td>3. Hydrology and hydraulics</td>
<td>Details hydrological and hydraulic assumptions, methodology and parameters for undertaking design.</td>
</tr>
<tr>
<td>5. Stormwater detention and retention system</td>
<td>Provides guidance on when on-site stormwater detention and retention is required and relevant design standards.</td>
</tr>
<tr>
<td>6. Disposal of property runoff</td>
<td>Lawful point of discharge requirements.</td>
</tr>
<tr>
<td>7. Road drainage and open channels</td>
<td>Design and Average Recurrence Intervals assumptions including hydrology, hydraulics and velocity information.</td>
</tr>
<tr>
<td>9. Water cycle management</td>
<td>Effective water quality control and how to prepare a Stormwater quality management plan.</td>
</tr>
<tr>
<td>10. Title encumbrances</td>
<td>Easement requirements.</td>
</tr>
<tr>
<td>11. Additional documents</td>
<td>List of studies and plans.</td>
</tr>
</tbody>
</table>
7.2 Property drainage systems

7.2.1 General

The purpose of a drainage system may include the following:
(a) reduce the level and frequency of ponded rainwater on a property that may constitute a health problem;
(b) reduce surface or sub-surface stormwater that could cause nuisance, damage or hazard on the property;
(c) mitigate effects of improvement on a property that could result in increased nuisance, damage or hazard on other properties;
(d) reduce erosion and resulting environmental impacts.

7.2.2 Design standards

7.2.2.1 General

(1) Stormwater drainage systems are to be designed for minor and major design parameters.

(2) The major drainage system is that part of a drainage system in a catchment that is designed to safely convey rare design storms, and may comprise open space floodway channels, road reserves, pavement expanses, overland flow paths, natural or constructed waterways, detention/retention basins and other major water bodies.

(3) Piping of major flows (e.g. 2% AEP flows for overland flow) cannot be relied upon for managing major flows as it is unlikely that all flows could be captured by inlets and blockage of the minor system can occur. In all instances a major flow path would still need to be provided.

(4) The minor drainage system is that part of a drainage system in a catchment that conveys flows from the minor design storm such as the 50% AEP and 10% AEP events and usually comprises kerb and channel, roadside channels, gully inlet pits, underground pipes, manholes and outlets.

7.2.2.2 Design average recurrence intervals

(1) The rainfall intensities used for flow estimation in Brisbane for the 100% AEP to 1% AEP storms are shown in Table 7.2.2.2A.

Table 7.2.2.2A—Rainfall Intensity-Frequency-Duration (IFD) for Brisbane

<table>
<thead>
<tr>
<th>Duration (Minutes)</th>
<th>100% mm/h</th>
<th>50% mm/h</th>
<th>20% mm/h</th>
<th>10% mm/h</th>
<th>5% mm/h</th>
<th>2% mm/h</th>
<th>1% mm/h</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>117</td>
<td>151</td>
<td>191</td>
<td>215</td>
<td>248</td>
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<td>325</td>
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<td>6</td>
<td>110</td>
<td>141</td>
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<td>161</td>
<td>181</td>
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<td>94</td>
<td>121</td>
<td>154</td>
<td>173</td>
<td>200</td>
<td>236</td>
<td>263</td>
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<tr>
<td>10</td>
<td>90</td>
<td>116</td>
<td>147</td>
<td>167</td>
<td>192</td>
<td>227</td>
<td>253</td>
</tr>
<tr>
<td>11</td>
<td>86</td>
<td>111</td>
<td>142</td>
<td>161</td>
<td>185</td>
<td>219</td>
<td>244</td>
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<tr>
<td>12</td>
<td>83</td>
<td>107</td>
<td>137</td>
<td>155</td>
<td>179</td>
<td>212</td>
<td>237</td>
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<tr>
<td>13</td>
<td>80</td>
<td>104</td>
<td>133</td>
<td>150</td>
<td>174</td>
<td>205</td>
<td>229</td>
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<tr>
<td>14</td>
<td>78</td>
<td>100</td>
<td>129</td>
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<td>169</td>
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<td>15</td>
<td>75</td>
<td>97</td>
<td>125</td>
<td>142</td>
<td>164</td>
<td>194</td>
<td>217</td>
</tr>
<tr>
<td>16</td>
<td>73</td>
<td>95</td>
<td>122</td>
<td>138</td>
<td>160</td>
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<td>211</td>
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<td>17</td>
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<td>206</td>
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<tr>
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<td>69</td>
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<td>87</td>
<td>113</td>
<td>128</td>
<td>148</td>
<td>176</td>
<td>197</td>
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<tr>
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<td>66</td>
<td>85</td>
<td>110</td>
<td>125</td>
<td>145</td>
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<td>193</td>
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<tr>
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<td>122</td>
<td>142</td>
<td>168</td>
<td>189</td>
</tr>
<tr>
<td>22</td>
<td>63</td>
<td>81</td>
<td>105</td>
<td>120</td>
<td>139</td>
<td>165</td>
<td>185</td>
</tr>
</tbody>
</table>
Based on coefficients issued by the Bureau of Meteorology (Ref FN2615) for 27475 S 152025 E
Calculated in accordance with Australian Rainfall and Runoff (1997 Edition).
Refer to QUDM for application of IFD to flow estimation.

(2) Longer recurrence interval design storms need to be considered in instances where the level of danger to persons or risk of significant property damage warrants such an approach. Where critical infrastructure or vulnerable uses are proposed the 0.2% AEP storm may need to be estimated (refer to the Flood overlay code for applicability). The probable maximum flood (PMF) may need to be considered where flood evacuation is a critical consideration.

### 7.2.2.3 Drainage

(1) Council’s design standards for stormwater infrastructure vary for different types of land uses. The design standards for roof water, drainage in private roads/driveways and for drainage in roads fronting those types of development are set out in Table 7.2.2.3B.

(2) Pipe drainage of on-site roof water and surface water from paved and unpaved areas must comply with AS/NZS 3500.3:2003 Plumbing and drainage - Stormwater drainage, QUDM section 7.13 for Level III, IV and V drainage standards.

(3) The design of the major system must ensure flows can be conveyed safely. Where the major system is part of a road this may require increasing the capacity of the minor system above that shown in this table to ensure flow depths and hazard are acceptable (refer QUDM).

### Table 7.2.2.3B—Design standards for drainage systems

<table>
<thead>
<tr>
<th>Development category</th>
<th>Design parameter</th>
<th>Design standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural areas (typically 2-5 dwellings per hectare)</td>
<td>Minor drainage system</td>
<td>Minimum 50% AEP</td>
</tr>
<tr>
<td></td>
<td>Major drainage system</td>
<td>Minimum 2% AEP (less piped flow if applicable)</td>
</tr>
<tr>
<td>Residential developments (Low density residential)</td>
<td>Minor drainage system</td>
<td>Minimum 50% AEP</td>
</tr>
<tr>
<td></td>
<td>Major drainage system</td>
<td>Minimum 2% AEP (less piped flow if applicable)</td>
</tr>
<tr>
<td></td>
<td>Roof water drainage</td>
<td>Level II QUDM</td>
</tr>
<tr>
<td>Residential developments (Low-medium density to High density)</td>
<td>Minor drainage system</td>
<td>Minimum 10% AEP</td>
</tr>
<tr>
<td></td>
<td>Major drainage system</td>
<td>Minimum 2% AEP (less piped flow if applicable)</td>
</tr>
<tr>
<td></td>
<td>Roof water drainage</td>
<td>Level III and Level IV QUDM</td>
</tr>
<tr>
<td>Industrial uses</td>
<td>Minor drainage system</td>
<td>Minimum 50% AEP</td>
</tr>
<tr>
<td></td>
<td>Major drainage system</td>
<td>Minimum 2% AEP (less piped flow if applicable)</td>
</tr>
<tr>
<td></td>
<td>Roof water and lot drainage</td>
<td>Level IV QUDM</td>
</tr>
</tbody>
</table>
7.2.3 Collection of roof water runoff

(1) Refer to QUDM 7.13 and AS/NZS 3500.3:2003 Plumbing and drainage - Stormwater drainage.

(2) Gutters and downpipes are to be designed to ensure no overflows for up to the 5% AEP storm of 5 minute duration.

(3) Roof water collection for low density residential subdivisions is to be in accordance with UMS 351.

(4) Pipes must be located clear of any driveways and must not cross footpaths in front of adjoining properties.

(5) Minimum pipe sizes for roof water lines applicable to low density residential development are shown in Table 7.2.3A.

(6) The pipes at each property must be sized in accordance with QUDM Level II drainage system, assuming a minimum of 15L/s for each 250m² of roof. For larger roof areas the flow rate may need to be determined and an appropriate pipe size provided accordingly.

Table 7.2.3A—Minimum size of roof water lines for low density residential development

<table>
<thead>
<tr>
<th>No. of lots (nominal 250m² roof area at each lot)</th>
<th>Minimum pipe diameter</th>
<th>Easement width</th>
<th>Minimum pipe slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>150mm</td>
<td>Not required</td>
<td>1%</td>
</tr>
<tr>
<td>3-4</td>
<td>225mm</td>
<td>1.5m</td>
<td>0.5%</td>
</tr>
<tr>
<td>5-6</td>
<td>300mm</td>
<td>1.5m</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

7.2.3.1 Run-off from existing property improvements

If the efficiency of any existing drainage system on the property will be compromised by proposed additional site improvements, the existing system is to be suitably modified to offset any adverse impacts and meet the requirements of AS/NZS 3500.3:2003 Plumbing and drainage - Stormwater drainage.

7.3 Hydrology and hydraulics

7.3.1 General

The following factors must be considered in the design and selection of the final drainage treatment:

(a) design discharges based on the ultimate development in the catchment;
(b) future maintenance requirements to ensure the drainage facility continues to meet its design performance;
(c) safety of persons, particularly children;
(d) erosion and siltation both within and on adjoining properties not increased as a result of the development;
(e) the existing treatments of other sections of the drainage system;
(f) the general amenity of the area and particular use of parkland;
(g) environmental issues, including vegetation protection orders (VPOs), maintenance of natural channels and buffer vegetation, preservation and rehabilitation of flora and fauna habitats, riparian vegetation, archaeological values, heritage values, water quality and existing features such as wetlands;
(h) integration of total water cycle management.
7.3.2 Flow estimation methods

(1) For guidance to the design of urban drainage systems Council refers the designer to QUDM and Australian Rainfall and Runoff. Council will accept flow estimations using the rational method or from runoff or storage routing models (e.g. DRAINS, ILSAX, XP-RAFTS, WBNM, RORB).

(2) For complex drainage situations (particularly as part of a flood study for setting building development levels) or for sizing stormwater detention systems a runoff/storage routing model must be used to estimate flows and/or analyse the hydraulics of an urban drainage system.

7.3.3 Rational method assumptions

Where the rational method for flow estimation is considered suitable the following sections provide Council’s standards for assumptions.

7.3.3.1 Fraction impervious

(1) For estimating the coefficient of runoff used within the rational method refer to QUDM section 4.05.

(2) The $C_{10}$ coefficients of discharge shown in Table 7.3.3.1A are to be used for rational method calculations.

Table 7.3.3.1A—Coefficient of discharge $C_{10}$ for development

<table>
<thead>
<tr>
<th>Development category</th>
<th>$C_{10}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central business areas (including in the Principal centre zone and Major centre zone)</td>
<td>0.90</td>
</tr>
<tr>
<td>Industrial uses and other commercial uses (including in the District centre zone and Neighbourhood centre zone)</td>
<td>0.88</td>
</tr>
<tr>
<td>Significant paved areas (e.g. roads and car parks)</td>
<td>0.88</td>
</tr>
<tr>
<td>Medium Density and High Density Residential land uses</td>
<td>0.88</td>
</tr>
<tr>
<td>Low-Medium Residential land uses</td>
<td>0.87</td>
</tr>
<tr>
<td>Low density residential area (including roads)</td>
<td></td>
</tr>
<tr>
<td>Average lot $\geq 750m^2$</td>
<td>0.82</td>
</tr>
<tr>
<td>Average lot $\geq 600m^2 &lt; 750m^2$</td>
<td>0.85</td>
</tr>
<tr>
<td>Average lot $\geq 450m^2 &lt; 600m^2$</td>
<td>0.86</td>
</tr>
<tr>
<td>Average lot $\geq 300m^2 &lt; 450m^2$</td>
<td>0.87</td>
</tr>
<tr>
<td>Low density residential area (infill subdivision excluding roads)</td>
<td></td>
</tr>
<tr>
<td>Average lot $\geq 750m^2$</td>
<td>0.81</td>
</tr>
<tr>
<td>Average lot $\geq 600m^2 &lt; 750m^2$</td>
<td>0.82</td>
</tr>
<tr>
<td>Average lot $\geq 450m^2 &lt; 600m^2$</td>
<td>0.83</td>
</tr>
<tr>
<td>Average lot $\geq 300m^2 &lt; 450m^2$</td>
<td>0.85</td>
</tr>
<tr>
<td>Rural/ environmental protection areas (2-5 dwellings per ha)</td>
<td>0.74</td>
</tr>
<tr>
<td>Open space areas (e.g. parks with predominately vegetated surfaces)</td>
<td>0.70</td>
</tr>
</tbody>
</table>

7.3.3.2 Time of concentration

Refer to QUDM section 4.06 for calculation of time of concentration.
7.3.3.3 Creek flow times

1. For open creek catchments (< 100 ha), minor channel or creek flow times may be initially determined by assuming an average stream velocity of 1.5m/s.

2. For medium sized open creek catchments (100-500 ha), the stream velocity method (QUDM Table 4.06.5) or the modified Friend’s equation (QUDM Section 4.06.11) must be used.

3. For large open creek catchments (> 500ha), the rational method should be used. However, detailed hydrological modelling of Brisbane’s major creeks indicate that the rational method provides a reasonable estimate of peak discharge if an average flow velocity of 0.9m/s is assumed.

7.3.4 Hydraulic grade-line analysis

Refer to QUDM section 7.16 for hydraulic grade line calculations.

7.3.5 Pipe capacity assumptions

1. Pipe capacity for trunk stormwater systems is to be estimated using hydraulic grade line analysis of the drainage system for the relevant design storm or using a suitable computer model (refer to QUDM section 7.16).

2. For smaller pipelines (typically 1.05m reinforced concrete plant or less), the capacity can be estimated using pipe flowing full at grade assumptions. The adopted pipe velocity when using this method must not be greater than 3m/s, because various hydraulic losses in the drainage system at pits and bends will limit the allowable velocity. Otherwise a hydraulic grade line analysis of the drainage system must be undertaken.

3. Where the pipe capacity is being estimated to determine the proportion of overland flow through a site as part of a flood study, the hydraulic grade line analysis must use a starting water level that is relevant to the major storm event (e.g. 2% or 1% AEP storm event).

7.3.6 Tailwater level assumptions

1. Designers are referred to QUDM section 7.16.6 and QUDM section 8.0 for advice regarding the correct tailwater level requirements for drainage design of stormwater outlets.

2. An allowance of 300mm for climate change must be assumed for the minor system design where stormwater drainage discharges into tidal waterways or the Brisbane River.

3. If tailwater is critical for managing major flows and setting flood immunity a sensitivity check must be undertaken to examine impacts of higher sea level in accordance with best climate change predictions at the time.

4. In areas situated beside Moreton Bay and lower parts of the Brisbane River near the river mouth storm surge may occur at times of most intense rainfall as a result of cyclones or significant low pressure systems. In small catchments this may result in concurrent flooding whereby the peak flow off the catchment will coincide with peak storm tide levels. Drainage design should choose appropriate tail-water levels in the situation carefully if it influences flood immunity for development.

7.3.7 Hazard estimation

The hazard associated with stormwater flows is determined by the product of depth and velocity, and or maximum total depth of flow (refer to QUDM section 7.04). For pedestrian safety the following criteria will apply:

(i) The velocity x depth product in a roadway in the major storm is to be limited to 0.6m²/s in the kerb and channel.
(j) Where there is an obvious danger of pedestrians being swept away where the velocity x depth product is to be limited to 0.4m²/s.

(k) For areas involving small children (e.g., child care centres) the velocity x depth product should be limited to <0.2m²/s in all cases.

7.4 Drainage infrastructure

7.4.1 Surface runoff

7.4.1.1 Table drains

(1) Table drains are generally only permitted in the road reserve for rural locations and when a new half road is constructed in these instances, table drains are required to manage the road runoff in the absence of kerb and channel.

(2) Table drains must be separated from the carriageway by regularly spaced delineator posts.

(3) To prevent erosion and to minimise maintenance, table drains must be free draining.

(4) Where a drain is relatively flat (minimum velocity <0.6m/s) the provision of a concrete invert and access to facilitate the removal of sediment must be considered. A further consideration is the provision of silt traps at the head of the drain to minimise the environmental effect of silt removal along the full drain lengths.

7.4.1.2 Swales

(1) Swales are not permitted on a local road where residential lots have frontage and access and are ideally located in the road median of higher order roads, or along the frontage of parks in a local access road.

(2) Swales cannot replace conventional stormwater drainage as their intent is to treat the water quality of small frequent rainfall events (<3 month ARI) and their design must ensure that they can convey the 50% AEP flow while:
   (a) limiting flow depths to 300mm (and/or meeting road flow width/depth criteria);
   (b) ensuring the hazard in the swale is safe for pedestrians (<0.4m²/s).

7.4.1.3 Cut-off drains

(1) Where provided, cut-off drains must prevent overland flow from adjacent properties causing problems on the developed land.

(2) These drains must be connected to stormwater infrastructure and directed to a lawful point of discharge.

7.4.1.4 Overland flow paths

(1) All developments must provide an overland flow path for the major design storm less the piped flow. Blockage of inlets and culverts should also be taken into account as required.

(2) Overland flow paths are to be provided by the proposed road/driveway system for internal drainage or small external catchments. However, larger flow paths may require swales or channels.

(3) Design Manning's roughness values for a grassed open channel or swale is determined by a number of factors including vegetal retardance and hydraulic radius. QUDM Section 9.03 provides sufficient correlation to determine design Manning's roughness values.

(4) A design Manning's roughness value of 0.10 is to be used for estimating flood immunity or determining easement extents in overland flow paths.
7.4.2  Sub-soil drainage system
(1) Sub-soil drainage systems are to be designed and constructed in accordance with section 6 in AS/NZS 3500.3:2003 Plumbing and drainage - Stormwater drainage.
(2) Subsoil drains shall not be directly connected to the street kerb and channel (they must be first connected to a pit), but must be connected to a gravity fed system and disposed of in a manner that will not adversely impact on adjacent properties.

7.4.3  Stormwater pipelines
7.4.3.1  Pipe size and type
(1) The pipe sizes are to be designed for a minimum capacity in accordance with minor drainage requirement in Table 7.2.2.3B and Table 7.7.1A. In all cases the minimum size for a reinforced concrete pipe that will be contributed as a Council asset is 375mm diameter.
(2) The pipe types and classes must comply with the following requirements:
   (a) domestic applications (low density residential) must be in accordance with Standard 1254: 2010 – PVC-U Pipes and fittings for stormwater and surface water applications;
   (b) commercial, industrial, medium and high density residential applications must be in accordance with Australian Standard 1260: 2009 – PVC-U Pipes and fittings for drain, waste and vent application.
(3) The minimum pipe class is:
   (a) steel reinforced concrete pipe – Class 2.
   (b) fibre reinforced concrete pipe – Class 1.
   (c) unplasticized polyvinyl chloride (UPVC) for roof water drainage – sewer class SN6.
   (d) flexible stormwater pipe – class SN8.
(4) The minimum pipe size for any development other than a dwelling house is 150mm nominal diameter for internal underground site drainage. Where the pipe also conveys stormwater from an adjoining upstream property (now or in future) the minimum pipe size is 225mm nominal diameter.

7.4.3.2  Pipe grade
(1) The minimum pipe grade is to be designed in accordance with QUDM section 7.12.
(2) Where anchor blocks are required they shall be designed according to section 3.5.3 of AS/NZS 3500.3:2003 Plumbing and drainage - Stormwater drainage.

7.4.3.3  Depth of cover to pipes
(1) Refer to QUDM Table 7.10.1 for minimum cover on pipes.
(2) Minimum pipe cover for polyvinyl chloride (PVC) pipelines varies for different locations and loadings and is set out in the technical manual and in Australian Standard 2032: 2006 Installation of PVC pipes.
(3) Minimum cover for construction loads is to comply with UMS 301 and UMS 302.

7.4.3.4  Connections to stormwater drainage under buildings
A connection to stormwater drainage under a building is to be carried out in accordance with section 7.2.9 of AS/NZS 3500.3:2003 Plumbing and drainage - Stormwater drainage.
7.4.3.5 Above ground pipe work

Above ground pipe work is to be carried out in accordance with section 6 of AS/NZS 3500.3:2003 Plumbing and drainage - Stormwater drainage.

7.4.3.6 Pipe bedding

Pipe bedding requirements are to comply with UMS 311.

7.4.4 Access chambers and manholes

1. Refer to QUDM section 7.06 for design criteria.
2. Manholes and chambers must be provided in accordance with UMS 321 to UMS 329.
3. Step irons must be installed to manholes/chambers with depths between 1.35m and 3m.
4. Fixed ladder access must be provided to any manholes/chambers >3m deep.

7.4.5 Gullies and field inlets

1. Refer to QUDM section 7.05 for blockage assumptions for inlets, location of inlets in roads and safety issues.
2. Standard gullies must not be located on sharp horizontal kerbs (<10 m kerb radius).
3. All new gullies are to be constructed in accordance with UMS 330 (i.e. "lip-in-line").
4. ‘Kerb in line’ gullies may be acceptable where an existing gully is either being replaced or upgraded and the existing verge width is less than 2m wide.
5. Anti-ponding gullies (refer to UMS 334) are only permitted in special circumstances at intersections when the road geometry does not allow the kerb and channel to drain to the standard gully at the tangent points. The inlet capacities of these gullies must be excluded from the calculations.

7.4.6 Gully inlet capacities

Refer to UMS 381 to UMS 392 for the relevant hydraulic capture charts for gully inlets.

7.4.7 Building near and/or over underground stormwater infrastructure

1. For underground stormwater facilities with or without drainage easements and where pipes or conduits are greater than or equal to 225mm in diameter or width, building over/near stormwater requirements will be applicable if the site is subject to any one or more of the following conditions:
   a. any proposed works contravening the drainage easement terms;
   b. any earthworks (filling or excavation) proposed directly over or adjacent to the stormwater drainage or manholes that will result in changes to surface levels or loading conditions over these stormwater facilities;
   c. any building work proposed over the stormwater drainage or manholes;
   d. any proposed works that will affect the structural integrity of the drainage or its trench;
   e. proposed changes to the loading conditions on an existing manhole cover, for example, changing the use of a non-vehicular trafficable area to a vehicular trafficable area;
   f. proposed use of rock bolts or ground anchors within 2m of the stormwater drainage;
   g. proposed property access width of less than 2m from the front entrance or access road to any manhole or property connection located on site;
   h. proposed driveways or concrete pavements over manholes or property connections;
   i. clashing of services or utilities (other than sewers) with the stormwater drain line that may affect the structural integrity of the stormwater drainline or its trench, or sewers larger than 150mm diameter crossing any stormwater drainline.
(2) When building over stormwater an adequate buffer zone is required between the edge of foundation system and the edge of the stormwater infrastructure to minimise structural damage during excavation, boring or piling operations.

(3) The following minimum horizontal clearances are required where undertaking such works near stormwater infrastructure and may need to be increased if it is anticipated that the pipe bedding will be affected:
   (j) 1m clearance applies to an excavated footing system such as beams and pad footings excavated by backhoe or similar;
   (k) 1m clearance applies to bored piers;
   (l) 6m clearance applies to driven, vibrated or jacked piles.

(4) Works shall be carried out in accordance with section 7.2.9 of AS/NZS 3500.3:2003 Plumbing and drainage - Stormwater drainage. Typically, where a drain is laid near to a footing the trench shall be located beyond a 45° angle from the base of the footing, as shown by Figure 7.4.7A.

(5) When determining the minimum setback from existing stormwater infrastructure, allowance needs to be made for future upgrading of the pipeline to meet Council’s design standards where this pipeline is undersized.

Figure 7.4.7A — Building near and over stormwater and subsoil drains

7.4.8 Building near and over aboveground stormwater infrastructure

Where building over overland flow paths or channels refer to the undercroft clearance requirements of the Flood Planning Scheme Policy.

7.5 Stormwater detention and retention systems

7.5.1 General

(1) Stormwater detention systems are used to reduce the peak discharge from a development to mitigate flood impacts on downstream development or maintain the capacity of existing
infrastructure. They are complex systems that have limited suitability to many sites, particularly areas with limited grade into downstream areas.

(2) The detention can be in either free draining systems (detention basin or tank) or wet systems (retention basin that integrates with a water quality treatment system such as a wetland or pond).

(3) Locating basins off-line to external catchments is preferred as it reduces detention storage volumes, reduces the risk of failure due to excessive flows and in the case of basins flowing into each other it can lessen the risk of a sequential over-topping and associated risk of failure.

(4) Both types may have multiple uses (e.g. pollution control, environmental wetland, recreational) as well as hydraulic functions.

7.5.2 When to provide stormwater detention

(1) As a general rule, stormwater detention is less likely to be required at the bottom one-third of the catchment.

(2) The majority of infill development should not require stormwater detention, although stormwater detention maybe required under three specific conditions, being:
   (a) when a development is likely to increase runoff to such an extent that the downstream drainage (both piped and overland) cannot cater for the additional capacity or adverse impacts are created;
   (b) where there is no practical way to increase the downstream system capacity;
   (c) if the increase in flows from the development would cause adverse flooding impacts to adjacent or downstream properties.

(3) Stormwater detention requirements may be waived where:
   (a) the site discharges directly into the Brisbane River or Moreton Bay where flooding is controlled by river flooding or storm tide;
   (b) the site discharges directly into the lower catchments of creeks or major drains where it would generally be undesirable to have detention where it may allow peak flows from the site to coincide with the wider catchment flood peak;
   (c) the proposal is for residential development where stormwater is disposed to Council’s kerb and channel or piped stormwater system and major flows from the site would drain to Councils road reserve;
   (d) for infill development only, the development site has an existing actual impervious fraction greater than 60%;
   (e) the applicant can demonstrate to Council’s satisfaction that, if the total catchment containing the site were developed to its full potential while maintaining the existing infrastructure, stormwater detention on the subject site would not be of benefit in reducing adverse flooding impacts on downstream roads, properties and open watercourses, which may be the case at the lower end of major catchments;
   (f) the downstream drainage system has been upgraded, or is proposed to be upgraded by the development to cater for fully developed peak flows from the catchment to the Council’s standard of service;
   (g) the development site is located entirely within the 1% AEP floodplain (waterway/creek or river flooding sources).

7.5.3 General requirements

(1) Stormwater detention is offline to existing creeks/flowpaths and external catchments.

(2) Where an online system is proposed it must provide regional benefits to flow reduction and be designed for ultimate catchment development. These basins will require incorporation of natural low flow channels, riparian vegetation and use of weir outlets (no piped low flow outlet) to promote fauna movement and reduce likelihood of outlet blockages.

(3) Where stormwater from any public asset such as a road reserve is directed into a stormwater detention system, such detention systems must be located within public land such as a park or
drainage reserve, but not within road reserves. Only above ground detention storages will be permitted in Council owned lands. Tanks in public roads will not be accepted.

(4) Above ground detention basins should be integrated with water quality treatments by locating the detention storage requirement above the water quality extended detention depth.

(5) Council will not support the installation of on-site (lot based) stormwater detention facilities in a residential subdivision on each freehold lot as there is no provision to adequately ensure these facilities are protected or maintained into the future.

(6) The use of stormwater detention tanks in commercial or industrial developments will be permitted where located on lots or within privately owned roads/driveways. Similarly, tanks could be utilised within roads/driveways owned by community title for residential developments.

7.5.4 General design objectives

(1) Sufficient detention storage must be provided to ensure peak flow rates and/or flood levels at any point within the downstream drainage system do not increase as a result of the development from the 50% AEP storm to the 1% AEP storm events (for all relevant storm durations).

(2) Where stormwater detention is considered necessary, sizing of detention storage for sites less than 2ha may use the simplified sizing method.

(3) Where alternative detention storage requirements for smaller sites are proposed and/or where a site area exceeds 2ha, sizing of detention storage must be justified using a suitable runoff or storage routing model (e.g. DRAINS (ILSAX), RAFTS, RORB, WBNM).

7.5.5 Simplified detention storage sizing method

(1) For development sites less than 2ha in area to avoid complex hydrological modelling. In every case the sizing would require confirmation at the detailed design stage by a Registered Professional Engineer Queensland.

(2) Sites with greater than 60% existing sealed impervious surfaces generally will not require stormwater detention because there is little change in peak flow, and redevelopment will often improve and augment older roof water and stormwater drainage systems. Larger developments must confirm this is the case.

(3) The proposed impervious percentage must be estimated from only the areas affected by the development and must exclude park areas or drainage reserves that may lie within the site catchment as these areas must not drain to a detention system. (This may significantly bias the average imperviousness and does not reflect the intensification of land use and resulting increase in peak flows).

(4) Sites larger than 2ha will need to model the hydrology and estimate stormwater detention requirements and permissible site discharges as required.

(5) The applicable site storage requirements (SSR) and permissible site discharges (PSD) for development are shown in Table 7.5.5A and Table 7.5.5.B and the relevant categories used for estimating the SSR and PSD are:
   (a) Category D1 – sites where the existing impervious surfaces are less than 10% of the proposed developed area, this is generally applicable to greenfield sites;
   (b) Category D2 – sites where the existing impervious area is greater than 10% but less than 40% of the proposed developed area, this is generally applicable to greenfield sites and some infill development;
   (c) Category D3 – sites where the existing impervious area is greater than 40% but less than 60% of the proposed developed area, this is generally applicable to infill development.
Table 7.5.5A—Site storage requirements (SSR) – Deemed to comply solution

<table>
<thead>
<tr>
<th>Proposed impervious percentage (1)</th>
<th>Development site storage requirement (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Category D1 (m³/ha)</td>
</tr>
<tr>
<td>70 or less</td>
<td>320</td>
</tr>
<tr>
<td>82</td>
<td>335</td>
</tr>
<tr>
<td>86</td>
<td>340</td>
</tr>
<tr>
<td>88</td>
<td>345</td>
</tr>
<tr>
<td>90</td>
<td>345</td>
</tr>
<tr>
<td>95 or greater</td>
<td>350</td>
</tr>
</tbody>
</table>

Notes:

(1) The proposed impervious percentage shall exclude park areas, drainage reserves etc that may lie within the site catchment.

(2) These SSR volumes are to be increased by 15% where a non-high early discharge (HED) detention system is used OR where an above ground basin (even with a HED outlet) is used.

(3) Existing impervious area is defined as "sealed impervious surfaces" (driveways, roofs, pavement etc) that would readily generate stormwater runoff.

Table 7.5.5B—Permissible site discharge (PSD) – Deemed to comply solution

<table>
<thead>
<tr>
<th>Existing site</th>
<th>Permissible site discharges (L/s/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50% AEP storm</td>
</tr>
<tr>
<td>Category D1</td>
<td>180</td>
</tr>
<tr>
<td>Category D2</td>
<td>300</td>
</tr>
<tr>
<td>Category D3</td>
<td>370</td>
</tr>
<tr>
<td>&gt; 60% Sealed impervious surfaces</td>
<td>N/A(1)</td>
</tr>
</tbody>
</table>

Note:

(1) No stormwater detention is required if the development is shown to have no adverse impact on any existing properties.

7.5.6 Detention sizing – general considerations

7.5.6.1 General

The following issues must be considered when undertaking the sizing of the detention storage.

7.5.6.2 External catchments

(1) Overland flows that enter the site from surrounding properties must be collected and conveyed through or around the development, but kept isolated from any stormwater detention systems for all storm events.

(2) Runoff from parks and other large pervious areas must also bypass the detention system.

(3) Where bypass is not possible the detention system must account for this additional inflow.
7.5.6.3 Hydraulic control at outlet

(1) On-site detention must be gravity drained. Pumped systems are not permitted for detention.

(2) An important element in preserving the integrity of an on-site detention system is ensuring that the system functions independently of the drainage network.

(3) The stormwater detention facility is not intended to handle surcharge flow from the street drainage network; therefore the starting hydraulic grade line level of the detention system must be set at the top of the kerb and channel at the discharge point to the street system.

(4) The outlet control device must be set above this level regardless of whether the detention system is connected to the underground drainage system or to the kerb and channel, to ensure that the outlet control is unaffected by downstream hydraulic grade line or water surface levels.

7.5.6.4 Distributed detention storage

(1) Distributed detention storages that drain into each other will not perform the same as a single storage as it reduces the effectiveness of the down-slope storages in attenuating flows and may create adverse tail-water conditions. These systems are discouraged and where proposed must be modelled as an integrated system using a hydrological model.

(2) The SSR provided in Table 7.5.5A must be located within a single detention storage; otherwise detailed hydrological modelling will be required to estimate storage requirements of a distributed storage proposal.

7.5.6.5 Site runoff bypassing the storage facility

(1) A portion of the new impervious areas may discharge directly to a lawful point of discharge if it cannot be drained to the detention storage, provided the permissible site discharge (PSD) is reduced to compensate for the bypass flow. The allowable extent of impervious surfaces bypassing the detention facility may not represent more than 25% of the impervious area draining to the detention facility.

(2) For hydrological modelling the bypass areas will not be directed into the storage. However, for the simplified sizing method the modified PSD m$^2$ of catchment will be calculated using the following equation:

\[ \text{Mod. PSD} = \text{PSD} \times \left( \frac{A_t}{A_t + A_b} \right) \]

Where \( A_b \) = impervious area bypassing the storage facility
\( A_t \) = total area draining to the storage facility

7.5.7 Requirements for above ground systems

7.5.7.1 Aesthetics

(1) Once authorised to have a basin in parkland or other Council controlled land, an important design criterion is that the basin does not look like a hydraulic structure but rather has special character. This will involve the use of variable slopes, the retention of upstream gullies, the camouflaging of inlets and outlet structures and the like (a rectangular or geometrically shaped basin is generally undesirable).

(2) Any detention basin proposed in a park or drainage reserve that does not incorporate a “wet” water quality function, is part of a bio-retention basin or has low flow channels, must be designed as a High Early Discharge (HED) system where flows only surcharge into the basin when the outlet capacity is exceeded.

(3) The HED system ensures that:
(a) frequent flows do not spill into the basin thereby minimising maintenance issues associated with waterlogged soils;
(b) are more efficient in their use of storage, requiring less storage volume than a standard detention basin arrangement.

7.5.7.2 Minimum grades

(1) The floor of the above ground detention basin must be well graded to prevent permanent ponding.
(2) Minimum grade of 1.5% applies to landscaped detention areas, and if grassed subsoil drainage will be required.

7.5.7.3 Basin edge treatment

(1) Grassed and landscaped edges must not be steeper than 1V:6H.
(2) Landscaped edges must not be steeper than 1V:4H.
(3) The use of retaining walls must be minimised so that more than 30% of the basin perimeter is battered.
(4) Where boulder retaining walls are required these are to be a maximum height of 900mm unless structurally designed and certified by a RPEQ (structural).
(5) In some instances (e.g. occurrence of rapid drawdown or highly variable standing water levels), geotechnical investigations/designs may be required to assess the embankment stability.

7.5.7.4 Embankments

(1) Embankments holding back floodwaters must be suitably designed to be structurally adequate, certified by a RPEQ (geotechnical) and must be no higher than 1.5m above natural ground level.
(2) Generally, batter slopes of embankments must be no steeper than 1V:4H on the dry side of the embankment, and no steeper than 1V:3H on the wet side to aid in stability, minimise erosion from direct rainfall and provide suitable grades for landscaping.
(3) A minimum 2.5m trafficable embankment width is required to allow access along the embankment for maintenance.

7.5.7.5 Spillways and outlet weirs

(1) High-level outlet structures must cater for the discharge of major or extreme outflows.
(2) Overflow weirs or spillways must be designed to convey the 1% AEP peak discharge, assuming that the basin storage is full and the low-level outlet(s) are blocked.
(3) The overspill must not inundate nor concentrate flows onto adjoining properties.
(4) Spillways need to be designed to ensure they will not scour and are suitably armoured.
(5) Spillways are located as close to natural ground level as possible (e.g. where the embankment crest is lowest).
(6) Minimum freeboard of 300mm above the estimated 1% AEP water level is required to top of embankment level.
7.5.7.6 Safety and amenity

(1) The safety of children moving in and out of the basin during times of inundation must be carefully considered.

(2) The outlet/inlet grates must be designed such that any child will be able to crawl away from the grate under all operating conditions.

(3) Internal batters located adjacent to publicly accessible areas (playgrounds and parks) must have a maximum 1V:6H batter, preferable 1V:20H.

(4) Basins located away from public use areas must incorporate 1V:6H batters within some places in the basin for safe egress from floodwaters.

(5) Signing must be erected at strategic locations alerting people to the possible hazards of the detention basins.

(6) Where detention basins are located directly upstream of a dedicated roadway or residential property, the consequences to road users or residents of basin collapse or overtopping must be carefully evaluated.

7.5.7.7 Access for maintenance

(1) All detention basins are provided with a vehicle access from the nearest public road into the basin to facilitate maintenance. The design vehicle for the driveway is to be a medium rigid vehicle.

(2) For a wet retention basin, the vehicle access ramp must extend at least 500mm below the normal operating water level of the basin.

7.5.7.8 Maximum depth of ponding

The maximum depths of ponding in an above ground detention basin must be limited to minimise safety hazards and preserve amenity values:

(a) public parkland: 5% AEP ponded depth of 1.2m;
(b) parking or paved areas: 2% AEP ponded depth of 0.3m;
(c) unfenced landscaped areas: 2% AEP ponded depth of 0.5m;
(d) safety fenced (pool safe) areas where not a Council asset: No depth limit, but desirable depth of <2m to facilitate access and maintenance.

7.5.7.9 Inlets and outlets

(1) For above ground detention storage, the inlet/outlet pits and grates must be set inconspicuously into the embankments of the basin.

(2) Vegetated screenings must be provided, but these must be located sufficiently away as to not affect the hydraulic performance of the inlet and outlet structures.

(3) Outlets may utilise pits, weirs, pipes and box culverts.

(4) Where the outlet is within a wet retention basin (wetland) or bio-retention basin, a concrete apron should extend at least 1m from these structures to minimise vegetation growing adjacent to it and impacting on the hydraulics of the outlet.

(5) The use of outlet screens that minimise blockages are to be used. This will include Type 1 field inlets as per UMS 337, or a dome cover field inlet (refer to UMS 340).

(6) Outlet structures generally consist of orifice plates (fixed to pipe inlets) or culverts placed at a low level in the basin to cater for the discharge of normal outflows, the diameter of the low flow outlet pipes must not be less than 375mm (or box section with equivalent height). Stepped weirs may also be used as an outlet to control flows.
7.5.7.10 High early discharge systems (HED)
(1) The use of high early discharge pits can reduce storage requirements by allowing the flow at the start of a storm to pass around the basin, thereby ensuring more detention storage is available closer to the peak of the storm.
(2) HED systems typically are only suitable for dry detention basins that do not perform a water quality function as low flows bypass the basin.

7.5.8 Requirements for underground detention systems

7.5.8.1 General
(1) The design of underground detention storage must address a number of public health, safety and pollution issues.
(2) The storage must be self-cleaning, well ventilated, not cause accumulation of noxious gas, and facilitate easy maintenance and inspection.
(3) The following requirements must be met in order to achieve the performance objectives:
(a) the base has a suitable fall to the outlet (minimum grade 0.7%) and is appropriately shaped to prevent permanent ponding occurring;
(b) long term ponding of water over the floor of the basin will not be acceptable;
(c) provision of a minimum 600mm x 900mm maintenance access opening over the tank outlet;
(d) provide additional 600mm x 900mm pits where required to ensure the distance between pits does not exceed 10m;
(e) provide an inspection/access pit (600mm x 600mm) directly over any inlet pipe;
(f) incorporate a child proof locking system for the surface grates;
(g) installation of step irons where pit depth is greater than 1.35m;
(h) where the storage is not sufficiently deep (< 1.2m), access grates should be placed at the extremities of the tank and at intervals not exceeding 3m, which should allow any point in the tank to be flushed or reached with a broom or similar implement, without the need to enter the tank;
(i) the minimum internal clearance height for accessible tanks is 1.2m in roads/driveways and 0.9m elsewhere;
(j) the tank is to be structurally designed and certified to adequately withstand all expected service loads and provide adequate service life;
(k) provide an overflow or bypass outlet ensuring any overflow is not directed into private property;
(l) locate the tank outside of the root zone of trees that must be retained;
(m) in areas of high water tables or floodplains the tank is to be designed to ensure it resists buoyancy effects.

7.5.8.2 Drainage design standard where detention is proposed
(1) Stormwater detention tanks must capture all flows off a development up to the 1% AEP storm, which is a much larger event than the drainage design standard for development. As a result, where the use of an underground detention tank is proposed it will necessitate that the gullies and pipes within the development are sized to capture these flows.
(2) The minor drainage system design where underground detention is proposed is to be the 10% AEP, with additional inlet capacity to 1% AEP provided closer to the detention system to capture flows.

7.5.8.3 Orifice plates
(1) Orifice plates must be manufactured from corrosion resistant stainless steel plate with a minimum thickness of 3mm (5mm where orifice diameter exceeds 150mm), with a central circular hole machined to 0.5mm accuracy.
(2) The orifice diameter must not be less than 35mm and the machined hole must retain a sharp edge.

(3) The plate must be permanently fixed to the pit wall and epoxy sealed to prevent the entrance of water around the edges.

(4) The plates must be engraved with the orifice diameter and an identifying mark, and the orifice diameters certified by the manufactures.

7.5.8.4 Outlet sump

(1) A sump is required in the base of the discharge control pit to assist in minimising turbulence near the pit floor from affecting the hydraulic performance of the orifice outlet.

(2) The sump would also prevent silt and debris from blocking the orifice outlet and facilitate simple installation of the orifice plate.

(3) The invert of the sump must be at least 1.5 times the orifice diameter or 200mm (whichever is greater) below the centre of the orifice outlet and sufficient weepholes must be installed in the sump floor and be kept unblocked.

7.5.8.5 Grates and trash screens

(1) Where an orifice plate is used with an orifice diameter less than 100mm, inflows must be screened to avoid blockage.

(2) Screening (hot dipped galvanised) must be provided at a rate of not less than 50 times the orifice diameter, and incorporate handle(s) for easy removal.

(3) The screens must be fixed at least 150mm from the orifice and positioned as close to vertical as possible.

7.5.8.6 Use of oversize pipes for storage

(1) Oversize pipes will not provide sufficient detention in a drainage system and are likely to adversely impact on drainage design requirements and cause frequent sedimentation.

(2) If oversize pipes for storage are proposed the loss of storage with pipe grade must be considered along with impacts on peak flows, pipe capacity and self cleansing velocities using appropriate hydrological models.

7.5.9 Maintenance requirements for Council and private detention systems

(1) All detention and retention systems must be designed with simple, safe, cost-effective maintenance in mind.

(2) A maintenance plan that documents all the maintenance requirements and responsibilities must be developed for all development application for a material change of use applications (excluding dwelling houses). The plan must describe how the design facilitates maintenance requirements and set out how the system is to be maintained by addressing issues such as inspection, likely clean-out frequency, procedures, access and occupational health and safety requirements. Where a Council owned asset, the maintenance plan must be submitted as part of the on-maintenance documentation and also include the cost estimate for the construction of the detention system and estimate of annual maintenance costs.
7.6 Disposal of property runoff

7.6.1 Lawful point of discharge

(1) The objective of achieving a lawful point of discharge is to ensure that any stormwater discharge will not cause an actionable nuisance (i.e. a nuisance for which the current or some future neighbouring proprietor may bring an action or claim for damages arising out of the nuisance). Section 3.02 of QUDM generally describes how it may be determined whether or not a lawful point of discharge exists.

(2) When land is developed, the roof and surface water runoff from that land and any external catchment (through the development site) must be discharged to a lawful point of discharge, being:

(a) where lawful point of discharge is on Council owned land:
   (i) a Council owned open space asset such as a park or drainage reserve provided the concentration of stormwater does not adversely affect the drainage capacity of the asset and/or impact on adjoining properties; or
   (ii) a road reserve, including the kerb and channel and compliance with the permissible flow width, flow depth and hazard.

(b) where lawful point of discharge is stormwater drainage infrastructure:
   (i) a stormwater drainage easement, where that easement has been designed to incorporate runoff from the development or the additional flow does not adversely affect the drainage capacity of the infrastructure or easement; or
   (ii) an existing enclosed stormwater drainage system (excluding any foul water lines) including a gully pit, stormwater manhole or stormwater pipe or roof water pipe with easement, ensuring that the capacity of that infrastructure is adequate to receive the stormwater runoff; or
   (iii) an existing stormwater drain within the property where that drain has sufficient capacity to receive such runoff without adversely impacting on neighbouring properties.

(c) where lawful point of discharge is on private property with downstream owners permission:
   (i) through adjoining private property at the rear of an allotment to concrete kerb and channel or existing enclosed stormwater drainage system abutting the allotment providing the stormwater system has sufficient capacity;
   (ii) an existing stormwater drain in adjoining properties where that drain has sufficient capacity to receive such runoff.

(3) Where permission from down-slope adjoining owners is required, written consent is to be provided using Council’s standard form CC10835 “Property Owner’s Statement of Consent or Refusal to allow a lawful point of discharge for a proposed development”.

(4) Where the existing stormwater drainage system has insufficient capacity to convey the additional flows the development may need to provide infrastructure on the downstream property which mitigates the adverse effects of the increased flow.

(5) Pump-out systems for stormwater disposal will only be considered for privately owned drainage systems (i.e. material change of use applications) in development where gravity drainage systems cannot work. The roof water will need to be directed to kerb and channel or an existing enclosed drainage system higher than the allotment from a drainage pit within the site via pumping. The pump design solution will need to address design requirements outlined in Section 7.6.6.

7.6.2 Roof water disposal in residential areas

(1) All lots that do not fall directly towards the road must be provided with a rear allotment roof water drainage system. The inter-allotment drains should generally be placed in the allotments which they serve directly. This system is detailed in UMS 351 and UMS 352.

(2) Roof water drainage systems are classified as private drains with the responsibility for future maintenance lying with the property owners.
(3) In local residential streets, an approved full height kerb adaptor must be provided in the kerb, 400mm from the projected low side boundary for each lot.

(4) In streets where footpaths will be constructed, kerb adaptors as per above with a length of UPVC pipe (sewer class SN8) extended from the adaptor to beyond the concrete footpath is required as per UMS 354.

(5) All roof water pipes >150mm nominal diameter are to connect to a stormwater gully or manhole.

7.6.3 Stormwater discharge to road reserves

7.6.3.1 Connection to kerb and channel

(1) The maximum permissible discharge to the kerb and channel must be limited to 30 L/s (i.e. maximum 2-3 single house lots dependant on roof area), and twin 100mm diameter pipes (equivalent 150mm diameter) with approved kerb adaptors.

(2) For development that is a material change of use (i.e. other than (1) above), Level III drainage (connection to kerb and channel) is only permitted if the total discharge from the development including any external catchment does not exceed 30L/s. Multiple hot dip galvanised rectangular hollow sections (RHS) 125/150/200mm wide x 75mm or 100mm high must be used (refer to UMS 353).

(3) Only approved full height kerb adaptors, complying with UMS 354 are permitted. The kerb adaptors must be placed in a location where service pits on the footpath will not conflict with the future pipe location.

(4) Discharge into the high side kerb of a one-way cross fall street is generally not permitted for any development other than a single house dwelling.

7.6.3.2 Connection to existing manhole

Connecting to an existing manhole can only be used where the diameter of the entry pipe is ≤ 675mm. For the larger diameter entry pipes, new manholes must be constructed. Refer to UMS 321 through to UMS 329 for manhole design details.

7.6.3.3 Connection to existing gully pit

(1) Connection to an existing gully pit is permitted where the diameter of the entry pipe is ≤ 300mm and surcharge of the gully does not occur.

(2) The pipe connection must be located below the gully lintel and within the top third of the gully pit to reduce the potential of backflows into private property.

7.6.3.4 Connection to an existing stormwater pipe

(1) Connection to existing stormwater pipe is only acceptable where the diameter of the entry pipe is less than 200mm, and the host pipe diameter is at least 4 times larger than the entry pipe diameter.

(2) The drainage design is in accordance with UMS 353.

7.6.4 Piping across a public road

Piping the property system across the road is not permitted. However extending Council’s stormwater system across the public road to facilitate disposal of stormwater from the property is allowable subject to ensuring hydraulics of the existing system are not adversely affected.
7.6.5 Provision of drainage for future upslope development of a neighbouring property

(1) Provision must be made for the future orderly development of upstream properties with respect to pipe drainage.

(2) If a drainage connection is provided for upslope development the drainage infrastructure must fully extend to the boundary of the upslope site to ensure that the upslope property owner does not have to undertake works in the down-slope property to connect to this stormwater infrastructure.

(3) Where a pipe is used to facilitate an upslope stormwater connection (now or in future) the minimum pipe size is 225mm nominal diameter for any development. This stormwater pipe must be connected to a lawful point of discharge.

(4) The development is to design any upslope connection for fully developed catchment flows.

7.6.6 Pumped stormwater drainage

7.6.6.1 General

(1) A pumped drainage system is only permitted in developments involving a material change of use such as commercial or industrial developments. Council will only consider a pumped stormwater drainage system for development comprising a material change of use or where involving a community title scheme if:
   (a) no engineering solution is available to use a gravity system to discharge stormwater to a lawful point of discharge;
   (b) letters of refusal are received from all property owners through which the roof water line could be taken by gravity to the street;
   (c) it is part of a comprehensive stormwater recycling system incorporating rainwater tanks with reuse.

(2) In addition, all pumped stormwater systems must be designed to manage overflows in case of malfunction or flow rates in excess of design capacity by:
   (a) ensuring that the overspill can take the form of sheet flow and reflect pre-development conditions when the pump capacity is exceeded;
   (b) demonstrate that in the event of malfunction, there is no adverse impact to neighbouring properties. For example overflows must leave the site in a safe manner and not inundate habitable or non-habitable areas within and external to the site.

(3) The need for future developments having to resort to pumping of stormwater to a lawful discharge point rather than by gravitational drainage must be avoided when possible. If drainage to a lawful point of discharge cannot be gained by a gravity system a pump system will be required.

7.6.6.2 Pumps and storage design

(1) The design of pump well storage and pump design must generally be in accordance with AS/NZS 3500.3:2003 Plumbing and drainage - Stormwater drainage where the system is not providing a lawful point of discharge for the development.

(2) Where the pump system is providing a lawful point of discharge for the development, the design of the pump storage is to be no less than the runoff from a 120 minute duration 5% AEP storm. This will necessitate approximately 9,500L of storage per 100m² of roof area. Other design requirements are to be as per AS/NZS 3500.3:2003 Plumbing and drainage - Stormwater drainage.

(3) Pumped systems must discharge directly to a gully, a manhole or a drainage line. Direct discharge to a kerb and channel is not permitted. Where the kerb and channel is the only lawful point of discharge, the outlet from the pump must feed to a storage manhole which then drains by gravity to the kerb and channel. Regardless of these disposal methods, a check of road capacity and existing drainage system is required to demonstrate that there are no adverse impacts.
(4) All pump systems must provide an overflow (in case of failure) to a soakage trench located along the boundary of the lowest part of the site. The trench must be designed as per section 7.6.8.

(5) The pump well design must consider the following factors:
   (a) minimise deposition of solids;
   (b) excessive foaming and air entrainment (usually caused by stormwater dropping from a high level inlet pipe) in the wet well to be avoided;
   (c) structural design to resist uplift, soil and water pressures;
   (d) suitable openings to enable pump removal, and for electrical and pipe work access;
   (e) sufficient space provided around the chamber for maintenance access and sufficient headroom for lifting tackle to be erected so as to raise the pumps if necessary.

(6) The pump design must consider the following factors:
   (a) in addition to the operating duty pump, an equivalent standby pump (i.e. of equal size to duty pump) must be installed to safeguard against mechanical failure;
   (b) in order to assure reliability of the standby pump, the pumping system must be set up by automatic rotation to ensure that the hours run by both the duty and standby pumps are approximately similar;
   (c) the most likely stormwater pump station configuration is usually the submersible wet well centrifugal type pumps normally employed in the wastewater industry. These pumps are available off the shelf and come in an extensive range of sizes and configurations. They are also not self priming i.e. they require a positive head at their inlet in order to commence pumping without initial priming (removal of air from the pump casing);
   (d) the inclusion of uninterrupted power supply.

(7) The property owner is responsible for all costs associated with installation, operation and maintenance and is liable for all damages as a result of system malfunction.

7.6.6.3 Basement drainage considerations

(1) Where the use of a sump and pump system for managing subsoil flows is proposed as part of the stormwater management system in an area subject to the Flood overlay code, consideration needs to be given to backflow devices and ensuring the pump discharge location is above any flooding source.

(2) Subsoil drainage and pump design in basements will need to allow for expected flow rates through these systems due to total water head from flooding sources. During floods, the actual flow into a drainage sump via subsoil drains can be orders of magnitude greater than flows expected in flood free areas.

(3) Roof water should not be directed into the sump in a basement. Instead it should gravity drain to the kerb and channel or road stormwater piped drainage system.

(4) Where roof water drainage must pass within or under the basement, the stormwater design will need to:
   (a) provide appropriate protection of stormwater pipes from vehicle impacts in the basement that may crack or dislodge any sealed joint in such pipes (this may require the use of steel pipes, or suitable encasement/protection);
   (b) avoid the use of any pits in the basement that connect to a roof water line that may become pressurised due to a high tailwater condition;
   (c) consideration shall be given to additional ponding (and pressure) within downpipes and ensuring overflows from rainwater tanks have no possibility of flowing into the basement.

7.6.7 Existing pipe drainage within property

7.6.7.1 Existing pipe drainage systems

(1) Where the existing underground pipes that service the external catchments traverse the site, these pipes must be preserved from damage or structural loading.
Where the existing drainage system does not meet Council’s desired standard of service or the design criteria of this planning scheme policy, the developer is generally responsible for upgrading the pipe drainage.

7.6.7.2 Foulwater lines

(1) New stormwater connections to existing foulwater lines are not permitted, nor is it acceptable to assume that these lines are redundant.

(2) Development must not damage these lines and any proposed diversion must connect to the existing stormwater system or a lawful point of discharge.

7.6.8 Soakage systems

(1) Soakage systems (absorption trenches etc) may only be used as:
   (a) a lawful point of discharge for a dwelling house when permission of the downstream owner cannot be obtained;
   (b) part of an emergency overflow system from a pump-out system.

(2) The acceptable solution for a dwelling house may include soakage trenches or a combination of gravity feed pipe via a charged line to the kerb and channel and/or rainwater tank for the house.

(3) In less permeable soils (clay based parent soils) the soakage system design:
   (a) incorporates a minimum 1m wide trench along at least 8m length of the lowest boundary;
   (b) setback 1.5m from the lowest boundary;
   (c) located at least 3m from any building;
   (d) provides every opportunity for the stormwater to sheet flow across the lawn rather than concentrate flow in one particular area.

(4) The removal of stormwater by adsorption or infiltration into permeable soils (sand based parent soils) may allow soakage systems that must be designed to suit the topography and soil type.

7.7 Road drainage and open channels

7.7.1 Road drainage standards

Major and minor drainage system design standards for different types of roads and are set out in Table 7.7.1A.

Table 7.7.1A—Drainage design standards for major/minor roads

<table>
<thead>
<tr>
<th>Road category</th>
<th>Design parameter</th>
<th>Drainage design standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major roads (district, suburban route, arterial, freight/freight dependant development)</td>
<td>Minor drainage system</td>
<td>Minimum 10% AEP</td>
</tr>
<tr>
<td></td>
<td>Cross drainage (culvert) flow</td>
<td>2% AEP where crossing overland flow flooding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1% AEP where crossing creek/waterway flooding</td>
</tr>
<tr>
<td></td>
<td>Roadway flow width and depth limits and hazard</td>
<td>Refer to QUDM</td>
</tr>
<tr>
<td>Minor roads (local, neighbourhood, freight/freight dependant development)</td>
<td>Minor drainage system</td>
<td>Refer to relevant development category minimum 50% AEP</td>
</tr>
<tr>
<td></td>
<td>Cross drainage (culvert) flow</td>
<td>2% AEP where crossing overland flow flooding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1% AEP where crossing creek/waterway flooding</td>
</tr>
</tbody>
</table>
Notes:

- The design of the minor and major system in roads should be designed in all cases to ensure the major flows can be conveyed safely. This may require increasing the capacity of the minor system above that shown in this table.
- The use of a concrete surface drain across a road intersection (generally along the line of the through street) is not permitted. Instead, the road geometry must be designed to capture minor system flows at gullies and pipe within an underground drainage system.

7.7.2 Hydrology and hydraulic calculations

Refer to QUDM section 7.16. Hydraulic calculations for design of stormwater infrastructure must be included on all drawings in tabular form, generally in accordance with Figure 7.7.2.a.

Figure 7.7.2.a—Drainage calculations
7.7.3 Open channel or watercourse

(1) For major open channel drainage systems (particularly with short times of concentration), draining to tidal systems in the Brisbane River and Moreton Bay, consideration needs to be given to coincident flooding occurring with storm tide (drowned outlets in non-tidal areas are not permitted).

(2) If open cut channels and natural watercourses are permitted within the site, easements including access areas adjacent to the channel are required.

(3) Where construction of new open channels is proposed, Council requires the use of natural channel design and water sensitive urban design principles.

(4) Where hydraulic constraints exist that prevent a fully vegetated channel, the use of grass lined channels is considered and the aesthetic value of these channels is enhanced by the liberal inclusion of native canopy trees with the species and planting density selected to enable:
   (a) easy maintenance (mowing);
   (b) sufficient light penetration to sustain the grass cover and minimise weed growth.

(5) Landscaping of the open channel is very important from a visual amenity perspective and for future maintenance. The developer must submit landscape plans prior to hydraulic calculations commencing so Council is satisfied that the channel will be a feature and not merely ‘a drain’. The preferred treatment for designed open channels must be in accordance with the publication Natural channel design guidelines.

(6) Any road crossing of an open channel or watercourse that is within the Waterway overlay code must consider aquatic fauna movement and terrestrial fauna movement in the design of the culvert. This will at a minimum necessitate the use of bridges, arches or box culverts to provide a natural creek bed in the low flow area.

7.7.3.1 Natural channel design

(1) The basic principles of Natural Channel Design (NCD) are to minimise erosion, flooding and maintenance of engineered or modified drainage channels, while improving environmental values.

(2) NCD is important in all waterways (whether natural in formation or constructed to appear and operate as natural channels), especially where the waterway provides a link with bushland reserves or forms an important part of an aquatic or terrestrial movement corridor. Refer to QUDM sections 8 and 9.06, for details on design principles and application.

(3) Concrete lining of any new proposed channel is unacceptable as this solution does not consider whole of life costs nor protect/ enhance environmental values. Attributes to be considered in the design include:
   (a) the use of linear wetlands, pond-riffle systems and off-line wetlands;
   (b) for batters, landscaping and maintenance access, the side slope of the channel banks must not be steeper than 1V:4H (vegetated);
   (c) intermittent use of 1V:6H or flatter (grassed or vegetated) batters for emergency egress by people;
   (d) boulders can be provided intermittently in localised areas to improve the aesthetic appearance of the channel;
   (e) intermittent use of retaining walls where batter grades could not be achieved, less than 1m in height.

(4) Rock riprap packed with soil and planted is preferred as a channel lining to minimise scour, although the design must limit scour velocity to reduce the need for riprap where possible.

(5) An extended maintenance period (minimum 24 months) is required until the channel has sufficiently stabilised and vegetative cover is well established, as a channel will take at least two growing seasons to stabilise via vegetation and a number of rainfall events will be required to show signs of any design or construction deficiencies.
(6) Culvert crossings of a natural channel are to be arches or box culverts (with link slab across low flow channel) to provide a natural creek bed in the low flow area to scour and maintenance requirements.

7.7.3.2 Velocity limitations for open channels

(1) An open channel with critical or supercritical conditions is not acceptable.

(2) The velocity in an open channel must be limited to less than 90% critical velocity in the major storm event.

(3) The maximum average velocity allowed in new vegetated channels is set out in QUDM section 9.05 and must not exceed 1.6 m/s in the major storm event for the design manning’s roughness (typically n=0.08). For bank-full flows (usually <50% AEP storm) the maximum average velocity must be no greater than 1.0 m/s for a manning’s value of 0.15 (fully vegetated). Refer to the Council publication Natural channel design guidelines for more details.

(4) Channel velocity checks must assume that undersized culverts will be upgraded to current design standards at some time in the future.

(5) Box culverts should be used for culvert crossings of creek/waterways or other natural channels (proposed or existing) to reduce outlet velocity, minimise the need for energy dissipaters, reduce the potential for blockages by debris and minimise maintenance costs.

(6) Where velocity is excessive and cannot be reduced by modifying the channel geometry, armouring of the channel will be required (e.g. use of rock riprap).

7.7.3.3 Maintenance access

(1) Where any new channel is proposed it is provided with suitable access for vehicle maintenance by providing a 4m berm along each side of the open channel. This berm will also provide a buffer for environmental, water quality and recreational purposes.

(2) Access to potential high maintenance locations such as stormwater outlets within the channel must be provided.

7.7.3.4 Consideration of siltation in channel design

(1) If a channel is proposed in a low lying area where grades are relatively flat (minimum velocity 0.6 m/s), the design must consider the sensitivity of the proposed waterway/channel to siltation which may cause eventual flooding of surrounding land.

(2) The hydraulic analysis must include the effects of siltation in the order of 150mm having been deposited to the channel bed.

7.7.3.5 Design Manning’s roughness values

(1) The design guidelines for floodplain revegetation density for Manning’s roughness values are stated in Table 7.7.3.5A.

(2) Roughness assumptions for new stormwater swales or channels should refer to Figure 7.7.2.a.

Table 7.7.3.5A—Floodplain revegetation density guidelines for various Manning’s roughness values

<table>
<thead>
<tr>
<th>Manning’s ‘n’</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
<td>Short grass with the water depth &gt;&gt; grass height.</td>
</tr>
<tr>
<td>0.04</td>
<td>Short grass with the water depth &gt;&gt; grass height on a slightly irregular earth surface. Trees at 10m spacing and areas are easy to</td>
</tr>
<tr>
<td>Manning's ‘n’</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>0.05</td>
<td>Long grass on an irregular (bumpy) surface with few trees and irregular ground could make grass cutting difficult. Alternatively, trees at 8m spacing on an even, well grassed surface, no shrubs, no low branches.</td>
</tr>
<tr>
<td>0.06</td>
<td>Long grass, trees at 6m spacing, few shrubs. Easy to walk through vegetation. Area not mowed, but regular maintenance is required to remove weeds and debris.</td>
</tr>
<tr>
<td>0.07</td>
<td>Trees at 5m spacing, no low branches, few shrubs, walking may be difficult in some areas.</td>
</tr>
<tr>
<td>0.08</td>
<td>Trees at 4m spacing, some low branches, few shrubs, few restrictions to walking.</td>
</tr>
<tr>
<td>0.09</td>
<td>Trees at 3m spacing, weeds and long grasses may exist in some locations. Walking becomes difficult due to fallen branches and woody debris.</td>
</tr>
<tr>
<td>0.10</td>
<td>Trees at 2m spacing, low branches, regular shrubs, no vines. Canopy cover possibly shades weeds and it is difficult to walk through.</td>
</tr>
<tr>
<td>0.12</td>
<td>Trees at 1.5m spacing with some low branches, a few shrubs. Slow to walk through.</td>
</tr>
<tr>
<td>0.15</td>
<td>Trees at 1m spacing, some vines, low branches, fallen trees, difficult and slow to walk through. Alternatively, a continuous coverage of woody weeds with sparse leaves and no vines.</td>
</tr>
<tr>
<td>0.20</td>
<td>Trees and shrubs at 1m spacing plus thick vine cover at flood level and fallen trees, very difficult to walk through. Alternatively, a continuous coverage of healthy shrubs and woody weeds from ground level to above flood level.</td>
</tr>
</tbody>
</table>

7.7.4 Service crossings of channels and creeks

(1) Service crossings above channel bed will need to consider the following:
(a) isolated service pipe crossings located above the bed are not allowed where such a structure will affect visual amenity or create adverse hydraulic impacts;
(b) if Council is satisfied that visual amenity is not compromised, afflux from the structure must not exceed 150mm within the immediate area of the service crossing and does not impact any private property;
(c) it is preferable that the level of the crossing be as low as possible or above the 1% AEP flood level;
(d) the crossing must be designed to avoid debris collection and to take account of scour at the bank entry or in the bed below the pipe;
(e) manholes must not be located on the assumption that the creek morphology is stable. In sand based creeks any exposed service crossing must be avoided as the bed and banks of the creek are highly susceptible to movement. Such services must be below the expected future scour level of the creek.

(2) For service crossings below channel bed:
(a) pipe crossings which are located below the bed of an unlined channel have at least one metre clear cover or additional scour protection may need to be provided along the open channel in the vicinity of a pipe crossing;
(b) if mitigation works have already been undertaken on the watercourse or if the channel is in a stable condition (and not a sand parent material based creek), the requirement in paragraph (a) may be relaxed at the discretion of Council's Delegate, provided appropriate protection works are undertaken;
(c) engineering drawings must include a plan and cross section of the proposed works and a longitudinal section of the bed and supporting evidence of potential creek scour depths.

7.8 Stormwater outlets and scour protection

7.8.1 Drainage outlets into creeks and channels

(1) Pipe drainage outfalls to open channels and natural creeks must be designed to control the discharge velocity and spread the concentrated discharge to avoid erosion to the bed and banks and to enhance the water quality by stripping contaminants.

(2) Wherever practical vegetated swales must be provided downstream from the pipe outlet to provide scour protection to the main creek/waterway or flow path and provide treatment of stormwater runoff.

(3) The location of any proposed stormwater outlet must not be located:
(a) on or near highly mobile creek or river banks;
(b) on or near the outside of erodible watercourse bends;
(c) in areas where there is a bank or bend directly in front of the outlet.

(4) All outlets are set back a distance of more than three times the bank height measured from the toe of a watercourse bank and angled into the direction of main channel flow.

(5) All stormwater outlets are located a minimum 150mm above the invert level of any adjacent waterway or drain to allow for sedimentation. Where high sediment loads are expected or the receiving creek/waterway is flat (<1%), the invert of the outlet is at least 300mm (but no greater than 1m) above the invert level of the receiving waterway.

7.8.2 Drainage outlets into parks

Where the stormwater discharge is across a public space designated for active recreation, piped drainage must be provided for the minimum 100% AEP storm to ensure that the function of the amenity is not diminished (note the design must also consider the park standard of service in regard to flood immunity). Reference must also be made for design guidance to the publication Stormwater Outlets in Parks and Waterways Guidelines (Brisbane City Council, 2003) which forms part of this planning scheme policy.

7.8.3 Energy dissipaters and scour protection

(1) Generally plunge pools with rock bottoms lying over a riprap layer are preferred over baffle blocks, as the latter may pose a safety hazard if any children are trapped in the stormwater drain during a storm. Plunge pools are also more desirable at outlets on environmental and aesthetic grounds.

(2) Plunge pool energy dissipaters must be free draining. Where designs allow permanent ponding, they will need to consider health and maintenance aspects, and incorporate riffles and pools to enhance environmental values.

(3) The spacing between blocks transverse to the flow would normally be at least 1.5 times the block width, and the spacing between consecutive baffle blocks parallel to the direction of flow at least 4 times the block height if fully drowned conditions are assumed to occur around the blocks. It should be noted that wide baffle blocks would trap less debris than narrow blocks.

(4) All stormwater outlets must be provided with scour protection with a length either the greater of 1.5 m or 3 times the pipe diameter to ensure the ground is not subject to scouring velocities.

(5) The use of energy dissipaters must be provided at the outlet under any one of the following conditions:
(a) average outlet velocity exceeds 2.0m/s for the design minor storm;
(b) the distance between the outlet and a channel bank located in alignment with the outlet jet is less than 10 times the pipe diameter for a single pipe outlet, or 13 times the maximum pipe diameter for a multi-pipe outlet.

7.8.4 Rock riprap sizing and treatment

(1) The thickness of all riprap rock protection is 1.5 times the nominal (d50) rock size. Concrete grouting rocks will not be accepted as an alternative.

(2) The nominal (d50) rock size for all riprap at stormwater outlets must be 300mm, or larger as required by the design. This will necessitate a total rock riprap depth of 450mm.

(3) All rock voids are to be packed with topsoil and planted into with riparian plant species.

7.8.5 Drop structures

(1) Drop structures may be divided into two categories (i.e. high drop when the depth of flow < drop height or low drop when the depth of flow > drop height).

(2) Generally drop structures must be avoided where environmental concerns are an issue, for example, where aquatic life, migratory routes, and fauna corridors are maintained within a creek.

(3) Drop structures in publicly accessible areas must also be avoided wherever possible for safety reasons.

(4) The use of trapezoidal or irregular shaped channels can introduce a three-dimensional flow pattern if the approach flow is allowed to accelerate toward the drop. This flow pattern can significantly reduce the efficiency of the downstream hydraulic jump, resulting in a submerged jet that is unable to be modelled by simple hydraulic calculations.

(5) It must not be assumed that a hydraulic jump would occur downstream of a non-rectangular drop structure. Similarly it must not be assumed that uniform flow conditions exist near any drop structure.

(6) Fully drowned drop structures can be analysed by a simple backwater analysis using appropriate expansion/contraction loss coefficients and representative cross sections.

(7) Guidelines (if applicable) for the design of drop structures must be obtained from the following references which form part of this planning scheme policy:
   (a) Brisbane City Council, 2004, Erosion Treatments for Urban Creek Guidelines;
   (c) Training Workshop on Integrated Urban Stormwater Management Vol 3, AWWA Canberra Branch and Hydrological Society, Canberra Ed. Brett C. Phillips;

(8) Where several drop structures are required to descend a steep grade reference must be made to the design of stepped spillways. A suitable reference being, Hydraulic Design of Stepped Spillways. CIRIA Report 33 I.T.S. Essery and M.W. Horner.

(9) All drop structures are constructed from cast in situ reinforced concrete or natural rocks lying on top of a rock riprap filter layer.

(10) Rock filled mattress type protective works are not permitted due to whole of life cost/maintenance issues.
7.9 Water cycle management

7.9.1 General

(1) Protecting the environmental values and uses of urban waterways requires an integrated or waterway health-based adaptive approach directed at managing the volume and rate of catchment run-off, the quality of the run-off, and protecting the riparian vegetation and the habitats necessary for supporting aquatic ecosystem health. In contrast there is evidence that solely managing stormwater quality using a best practice approach is insufficient to adequately mitigate all the impacts of urbanisation.

(2) Flood management and public safety remain as fundamental objectives of stormwater system planning and design. Stormwater management measures for waterway health enhancement should in no way compromise these objectives.

(3) Stormwater management should be based on the following hierarchy of control mechanisms:
   (a) preserving existing valuable elements of the natural stormwater system, such as natural channels, wetlands and riparian vegetation.
   (b) helping to protect environmental values through avoiding impacts on urban stormwater quality flow with early and comprehensive forward planning;
   (c) limiting changes to the quantity and quality of stormwater at or near the source of potential contaminants or changes to flow such as by using WSUD principles and erosion controls. Refer to Chapter 2 of the USQPG 2010 or latest version;
   (d) managing any remaining impacts after preservation, keeping water pollutants on the development site and managing flows adequately through proper source controls;
   (e) using structural measures, such as treatment techniques or retention basins, to improve water quality and control run-off;
   (f) applying structural treatment measures on or off site before the run-off enters a waterway is required to capture mobilised pollutants, and mitigate geomorphic stream damage;
   (g) as a last line of control, the receiving water should be managed to maintain its environmental values in consideration of any residual impacts from stormwater pollutants or flows.

(4) The local government is committed to minimising erosion and sedimentation, and the degradation of surface and groundwater quality which can result from development, both during and after construction.

(5) Effective water quality control involves:
   (a) implementation of stormwater quality best management practices and water quality outcomes defined in Chapter 2 Urban Stormwater Quality Planning Guidelines 2010 (USQPG);
   (b) integration of water quantity, water quality, stream stability, frequent flow management and waterway corridor issues into the design of both permanent and temporary water quality control measures. Refer to Chapter 2 of the USQPG 2010 or the latest version;
   (c) staging and programming of works to minimise erosion potential;
   (d) commitment to the monitoring and maintenance of water quality control measures.

7.9.2 Temporary methods of water quality control

(1) Temporary water quality controls used for development are typically erosion and sediment control measures that are the first items constructed when work begins. They are used to control and filter the runoff from areas disturbed during construction.

(2) Erosion and Sediment Control (ESC) Standard (Appendix 1) explains Council's requirements for the protection of waters from the impacts of land and infrastructure development (soil erosion and sediment control) and provides guidance on low, medium and high risk development requirements. The purpose of the ESC Standard is to prescribe environmental performance standards for land-disturbing development, which when applied, will achieve protection of waters from the impacts of land and infrastructure development (erosion and sediment control).
7.9.3 Permanent methods of water quality control

(1) Permanent water quality controls are implemented to control runoff water quality beyond the initial construction and maintenance stages and need to be described within a Site Based Stormwater Management Plan (SBSMP).

(2) A SBSMP is a plan that sets out how water quality, water quantity and waterway corridor management issues are to be managed during all stages of a specific development. Such a plan may be required as a result of development being assessed against Council’s Stormwater code, or to fulfil a condition of development.

(3) A SBSMP is to be prepared by a suitably qualified person as defined in State Planning Policy 4/10 Healthy Waters – Appendix 2. The Urban Stormwater Quality Planning Guidelines 2010 (USOPG) Chapter 3 and Appendix 3 give guidance for the preparation of Stormwater Quality Management Plans.

(4) The provision of a SBSMP for development should:
   (e) conform with principles of ecologically sustainable development;
   (f) demonstrate that the development is occurring on the appropriate land capability class;
   (g) maximise the social value of stormwater and stormwater infrastructure;
   (h) protect riparian zones from disturbance;
   (i) adopt water conservation and recycling principles;
   (j) not cause or worsen flooding, or create nuisance ponding;
   (k) minimise the cost to the Council of maintaining permanent stormwater infrastructure.

(5) Water Quality Objectives for methods to achieve the minimum reductions in total pollutant load, for the post developed case for a High Risk site shall be in accordance with Table 2.2 of Urban Stormwater Quality Planning Guidelines 2010 (DERM) and shall be identified in the SBSMS.

(6) The water quality treatment strategy and design solution provided in the SBSMP may be derived either by:
   (a) Computer Modelling Software (MUSIC) where reporting follows the procedures detailed in chapter seven of the Water by Design publication ‘MUSIC Modelling Guidelines’; or
   (b) Adoption of a relevant solution from the Healthy Waterways publication ‘Deemed to Comply Solutions – Stormwater Quality Management (South-East Queensland)’.

(7) The design of the permanent water quality controls is to be in accordance with the following publications:
   (a) Urban Stormwater Quality Planning Guidelines 2010 (DEHP);
   (b) Environmental Planning (Water) Policy 2009;
   (c) Publications by Healthy Waterways including Water Sensitive Urban Design Technical Design Guidelines (WSUD TDG) for South East Queensland;
   (d) QUDM 2007.

7.9.4 Asset hand-over

(1) Council is required to accept responsibility of stormwater quality control/management infrastructure that is, or will be, located on public land such as in parks, drainage reserves and road reserves. Where the asset is located in a park or drainage reserve the minimum maintenance period will be 24 months.

(2) Water quality assets entirely located within road reserves will only require a 12 month maintenance period. These normally constitute swales, small bio-retention systems, street tree bio-retention treatments and gross pollutant traps.

(3) Where the bio-retention basin is protected by a geo-textile and turf to protect the asset during construction, the planting of the basin will be required 12 months after initial on-maintenance with a following 12 months maintenance period for the planting. This would require an uncompleted works bond to cover removal of turf and geo-textile and planting/landscaping.
7.9.5 Water quality asset maintenance plan

(1) A Water quality asset maintenance plan will be required for bio-retention basins located in parks or drainage reserves.

(2) A Water quality asset maintenance plan sets out how the proposed methods of water quality control are to be maintained addresses such issues as:
(a) inspection frequency;
(b) likely clean-out frequency;
(c) dewatering and waste disposal procedures;
(d) access;
(e) consumables (e.g. oil absorbing pillows);
(f) staff training and equipment needs;
(g) occupational health and safety requirements;
(h) likely annual maintenance costs;
(i) performance monitoring.

(3) A Water quality asset maintenance plan will be required for bio-retention basins located in parks or drainage reserves.

(4) A Water quality asset maintenance plan sets out how the proposed methods of water quality control are to be maintained addresses such issues as:
(a) inspection frequency;
(b) likely clean-out frequency;
(c) dewatering and waste disposal procedures;
(d) access;
(e) consumables (e.g. oil absorbing pillows);
(f) staff training and equipment needs;
(g) occupational health and safety requirements;
(h) likely annual maintenance costs;
(i) performance monitoring.

7.9.6 Water quality monitoring

(1) Water quality monitoring will give an indication as to whether the design predictions were accurate, the pollutant removal performance of the water quality control methods, and whether alternative or additional stormwater quality management practices may need to be employed.

(2) The approved SBSMP will nominate whether water quality monitoring is required for the proposed development. Refer to Table 6.2 in the Urban Stormwater Quality Planning Guidelines 2010 (USQPG) for monitoring requirements and assessment criteria.

(3) Water quality monitoring programs are to be prepared in accordance with Table 6.2 in the Urban Stormwater Quality Planning Guidelines 2010.

7.10 Title encumbrances

7.10.1 Drainage easements

Easements in favour of Council are often required when land is developed. Council requires easements associated with stormwater infrastructure in the following instances.

7.10.2 Roof water reticulation and underground drainage

(1) This easement allows for the construction and/or maintenance of underground drainage. Easements will be required in the following circumstances:
(a) newly constructed roof water lines in new subdivisions where the pipe nominal diameter is 225mm or larger;
(b) where new stormwater lines will at some point in the future provide a drainage connection for a development located either upslope or adjacent to the site;
(c) over an existing stormwater line that is owned or maintained by Council;
(d) newly constructed roof water lines providing a connection to more than two allotments.

(2) The minimum easement width required over any stormwater line that will provide a drainage connection for future development in upslope or adjoining properties is 1.5m regardless of pipe size.

(3) The minimum easement width for any roof water drainage reticulation pipes of 225mm and 300mm diameter must be 1.5m.

(4) The minimum easement width required for 375mm to 900mm diameter/wide underground pipe drainage that will be maintained by Council is 3m.

(5) The minimum easement width required for 1050mm or greater diameter/wide underground pipe drainage that is or will be maintained by Council must be the outside pipe diameter/culvert box width plus 1m from each edge of pipe/culvert.

7.10.3 Overland flow

(1) These easements identify overland flow paths through a site and provide for passage of stormwater along the easement. Unless approved by Council the easement prohibits the erection of structures, the alteration of surface levels, and any activity within the easement which may obstruct the flow of runoff (e.g. debris retentive fences, landscaping, walls, filling).

(2) The easement for overland flow must extend over the 2% AEP flood extent.

(3) If a volumetric easement is sought it must extend to the underside of any building suspended over/near the overland flowpath (to protect undercroft areas ability to convey floodwaters), or the PMF level, whichever is higher. This is because all open easements provide some ability to convey floodwaters from storms larger than the design event in the vertical space above an easement.

7.10.4 Land subject to creek/waterway inundation

An easement over the 1% AEP inundation extent is required to preserve hydraulic conveyance and floodwater storage for areas inundated by creek/waterway flooding and allows Council to assess any proposal for development or modification of the easement.

7.10.5 Access

Access easements permit Council to gain access from a public road to a property to facilitate maintenance of the stormwater drainage network (unless agreed otherwise by the property owner, the access is usually the most direct route through the property). These easements are usually combined with any of the other easement types.

7.10.6 Combined underground/aboveground drainage

Combinations of the above easement types will often be required (e.g. underground and overland flow) where there is an overland flow associated with piped drainage.

7.10.7 Open cut drainage

This type of easement allows for the construction and maintenance of an open drain or channel within the easement and is wide enough to incorporate the 2% AEP or 1% AEP flood inundation extent and any maintenance berm along the top of the open channel.

7.10.8 Stormwater outlets from road reserves

Easements are required over drainage outlets from road reserves for maintenance purposes where that land is not owned by Council.
7.11 Erosion sediment control

7.11.1 Qualifications

(1) Erosion Hazard Assessment and Certification must be undertaken by a suitably qualified and experienced professional as defined in the most current version of the Brisbane City Council Erosion Hazard Assessment (EHA) form and Supporting Technical Notes.

(2) Concept Erosion and Sediment Control Plans, Erosion and Sediment Control Plans, Erosion and Sediment Control Programs, Design Certificates and Inspection Certificates must be prepared and certified by a suitably qualified and experienced professional. This person must have successfully completed an advanced specialised training course in erosion and sediment control, provided under the auspices of a reputable body such as the International Erosion Control Association (IECA), and be able to provide documentary evidence of such training to the Council upon request.

(3) Brisbane City Council also recognises the IECA’s Certified Professional in Erosion and Sediment Control (CPESC) accreditation as meeting this requirement.

(4) Where engineering structures (either temporary or permanent) such as inlets, outlets, spillways and sediment basin embankments forms part of an Erosion and Sediment Control Plan/Program, the design certification and inspection of such structures must be undertaken and certified by a Registered Professional Engineer of Queensland (RPEQ).

7.11.2 Information Required

7.11.2.1 Information required in support of a development application

All applications, including:
- Material change of use;
- Reconfiguration of a lot;
- Operational works (where not previously addressed as part of MCU/RoL application).

which will result in land disturbance and/or exposure of soil and involve an Issue listed in Column 1 of Table 7.11.2.1.A, are required to submit the information summarised in Column 2 at the time specified in Column 3. Further detail of the information required is provided below.

Table 7.11.2.1.A

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Applications</td>
<td>Submit a completed Erosion Hazard Assessment (EHA) form. See below for additional requirements.</td>
<td>With Development Application</td>
</tr>
<tr>
<td>EHA Low Risk (i.e. Score &lt; 17 and no triggers)</td>
<td>If not triggering SW Code or HW Code, submit completed EHA form; (Note: Generally no additional information required at this stage)</td>
<td>With Development Application.</td>
</tr>
<tr>
<td></td>
<td>If does trigger SW Code and/or HW Code, submit completed EHA form; (Note: Generally no additional information required at this stage)</td>
<td>With Development Application.</td>
</tr>
<tr>
<td>EHA Medium Risk (i.e. Score either &lt; 17 and one or more triggers or Score ≥17 to 26)</td>
<td>If not triggering SW Code or HW Code, submit completed EHA form; (Note: Generally no additional information required at this stage)</td>
<td>With Development Application.</td>
</tr>
</tbody>
</table>

With Development Application.
| EHA High Risk (i.e. Score >26) | If not triggering SW Code or HW Code, submit completed EHA form and **Concept ESC Plan** [refer section 4.1.1 for requirements]; | With Development Application |
| If does trigger SW Code or HW Code, submit completed EHA form and **Concept ESC Plan** [refer section 4.1.1 for requirements]; | With Development Application |

### and/or where the development proposal involves any of the following issues as described below

| Applications involving the endorsement of a staging plan. | Submit a completed EHA form and **Concept ESC Plan** [refer section 4.1.1 for requirements] which demonstrates that the proposed staging will facilitate provision of effective ESC during construction. See below for additional requirements. | With Development Application |
| Applications proposing works below the 1 in 5 year ARI flood level | Submit a completed EHA form and **Concept ESC Plan** [refer section 4.1.1 for requirements] which demonstrates that conventional ESC infrastructure is able to be provided to treat runoff from the development site and that exposed areas and ESC infrastructure will not be inundated with flood waters for at least the flood event having a 1 in 5 year ARI. See below for additional requirements. | With Development Application |
| Applications involving works which cross a waterway and/or are located within a waterway corridor mapped within the City Plan | Submit a completed EHA form and **Concept ESC Plan** [refer section 4.1.1 for requirements] which demonstrates how impacts on the waterway have been minimised through appropriate route selection and type of crossing and how construction of the crossing will be managed in accordance with a current best practice manual such as IECA 2008, Best Practice Erosion and Sediment Control – Appendix 1. See below for additional requirements. | With Development Application |
| Applications for which 1ha or greater external catchment area contributes stormwater runoff to the subject site | Submit a completed EHA form and **Concept ESC Plan** [refer section 4.1.1 for requirements] which demonstrates that clean stormwater from upslope external catchment(s) can be diverted around or through the site without causing either an increase in sediment concentration of the flow, or erosion on site or offsite. Alternatively, if it is not feasible to divert clean stormwater from upslope external catchment(s) around or through the site the **Concept ESC Plan** must demonstrate that there is sufficient land area available to install and operate a sediment basin which is sized to accommodate the stormwater runoff from the whole upslope catchment. See below for additional requirements. | With Development Application |
| Applications for which 1ha or greater of land disturbance will occur. | Submit a completed EHA form and **Concept ESC Plan** [refer section 4.1.1 for requirements] which demonstrates that:
(a) There is sufficient land area available to install and operate an appropriately sized sediment basin
(b) The runoff from all disturbed areas can be directed to a sediment basin throughout construction and until such time as the upslope catchment is adequately stabilised against erosion.
See below for additional requirements. | With Development Application |
|---|---|---|
| Applications proposing works below 5m AHD | Submit a completed EHA form and **Concept ESC Plan** [refer section 4.1.1 for requirements] which demonstrates that:
The runoff from all disturbed areas can be directed to a sediment basin throughout construction and until such time as the upslope catchment is adequately stabilised against erosion.
It is feasible to install sediment basins which will have sufficient storage volume to contain the design storm event i.e. the sediment basin will not be inundated with groundwater.
See below for additional requirements. | With Development Application |
| Applications proposing works on land having a slope of greater than 15% | Submit a completed EHA form and **Concept ESC Plan** [refer section 4.1.1 for requirements] which demonstrates that:
(a) There is sufficient land area available to install and operate an appropriately sized sediment basin
(b) The runoff from all disturbed areas can be directed to a sediment basin
(i) **Preliminary engineering sections** of proposed sediment basins showing that they may be practically implemented on the slopes proposed
(ii) **Preliminary earthworks plan** showing proposed extent of land disturbance
(iii) **Geotechnical Report** which assesses the probability of landslip instability as a result of the construction phase ESC measures. | With Development Application |
| All development other than identified above | For development not meeting the criteria in Table 7.11.2.1.A, no **Concept ESC Plan** is required with the application. | Not required |

### 7.11.2.2 Concept Erosion and Sediment Control (ESC) Plans

Concept ESC Plans are submitted with development applications where identified in Table 7.11.2.1.A, to assist Council in deciding the application. The purpose of Concept ESC Plans is to demonstrate the feasibility of implementing the required level of protection to receiving waters from the potential impacts of the development using best practice ESC. Normally Concept ESC Plans do not contain engineering drawings of structures, unless specified in Table 7.11.2.1.A.

In addition to the information required by Table 7.11.2.1.A, Concept ESC Plans must demonstrate the following:
(a) The design, intensity, configuration and establishment of development, is compatible with the physical constraints of the site and receiving environment;
(b) The feasibility of effective ESC measures being implemented is substantiated, throughout construction including consideration of the impacts of the overall development until permanent stabilisation of the site occurs, providing a drawing(s) showing a conceptual treatment train, and giving preliminary calculations for the sizing of a sediment basin or basins;
(c) A contoured site plan(s) showing natural features and location of the proposed control structures, including clean water diversions, sediment basins, temporary drainage to sediment basins and an overview strategy for the site outlining the sequence of development, and temporary and permanent management mechanisms, until commissioning of permanent water sensitive urban design features.

7.11.3 Information required in support of Operational Works phase and construction phase

All development involving:
- a total area in excess of 1000m² of either land disturbance and/or exposure of soil; and
- an issue listed in Column 1 of Table 7.11.3.A

is required to submit the information summarised in Column 2 at the time specified in Column 3. Further details of the information required is provided in (i) to (vi) below.

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>All works subject to an Operational Works Development Permit</td>
<td><strong>Erosion and Sediment Control Plan(s)</strong> - See (i) below for requirements.</td>
<td>As indicated in the condition timing of the development approval.</td>
</tr>
<tr>
<td></td>
<td><strong>Soil testing</strong> – See (iii) below for requirements</td>
<td>As indicated in the condition timing of the development approval.</td>
</tr>
<tr>
<td></td>
<td><strong>Design Certificate</strong> - See (iv) below for requirements and Appendix 1 for Certificate</td>
<td>As indicated in the condition timing of the development approval.</td>
</tr>
<tr>
<td>All works subject to an Operational Works Development Permit and involving: (a) a total disturbance area of greater than 5000m² and/or (b) an issue listed in Column 1 of Table 7.11.2.1.A</td>
<td><strong>Erosion and Sediment Control Program</strong> See (ii) below for requirements</td>
<td>As indicated in the condition timing of the development approval.</td>
</tr>
<tr>
<td></td>
<td><strong>Soil testing</strong> – See (iii) below for requirements</td>
<td>As indicated in the condition timing of the development approval.</td>
</tr>
<tr>
<td></td>
<td><strong>Design Certificate</strong> – See (iv) below for requirements and Appendix 1 for Certificate</td>
<td>As indicated in Section 4.2(iv) below.</td>
</tr>
<tr>
<td></td>
<td><strong>Inspection Certificates</strong></td>
<td>As indicated in Section 5.2</td>
</tr>
<tr>
<td></td>
<td><strong>Schedule of Registered Business Names</strong></td>
<td>At the pre-start meeting or prior to works commencing</td>
</tr>
<tr>
<td></td>
<td>See (v) below for requirements</td>
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<tr>
<td></td>
<td>See (vi) below for requirements</td>
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</tbody>
</table>
7.11.3.1 Erosion and Sediment Control Plans

The primary purpose of erosion and sediment control plans (ESC Plans) is to inform those persons constructing the development on what controls need to be implemented throughout all stages of the development from site establishment to project completion. Typically a separate ESC Plan is required for each phase of the development including the bulk earthworks, civil construction (typically roadworks and stormwater drainage), services installation, final stabilisation and the decommissioning of construction phase sediment basins. These plans could be considered an element of complying with the general environmental duty, that is, doing all that is reasonable and practicable to prevent or minimise environmental harm (s319 Environmental Protection Act 1994).

ESC Plans must:

(a) be prepared by a suitably qualified and experienced professional;
(b) be consistent with this Standard and a current best practice document (such as the IECA 2008 Best Practice Erosion and Sediment Control). For issues where a document (i.e. manual or guideline) is not consistent with this Standard, this Standard prevails to the extent of the inconsistency;
(c) be based on an assessment of the physical constraints and opportunities of the development site, including those for soil, landform type and gradient, and hydrology;
(d) be supported by onsite soil testing (See (iii) below);
(e) provide a set of contour drawings showing existing and design contours, the real property description(s), north point, roads, site layout, boundaries and features. Contours on, and surrounding, the site should be shown so that catchment boundaries can be considered;
(f) be at a suitable scale for the size of the project (as a guide around 1:1000 at A3 for a 2 hectare development and 1:500 at A3 for a 3000m2 development);
(g) provide background information including site boundaries, existing vegetation, location of site access and other impervious areas and existing and proposed drainage pathways with discharge points also shown;
(h) show the location of lots, stormwater drainage systems;
(i) details on the nature and specific location of works and controls (revegetation, cut and fills, run-off diversions, stockpile management, access protection), timing of measures to be implemented and maintenance requirements (extent and frequency as defined in IECA 2008, Chapter 6.8);
(j) show all areas of land disturbance, the way that works will modify the landscape and surface and subsurface drainage patterns (adding new, or modifying existing constraints).
(k) for each phase of the works (including clearing, earthworks, civil construction, services installation and landscaping) detail the type, location, sequence and timing of measures and actions to effectively minimise erosion, manage flows and capture sediment;
(l) describe the scheduling of progressive and final rehabilitation as civil works progress, including the stabilisation of upslope catchments prior to sediment basin removal;
(m) identify the riparian buffers and areas of vegetation which are to be protected and fenced off to prevent vehicle access;
(n) indicate the location and provide engineering details with supporting design calculations for all necessary sediment basins and ESC-related drainage structures;
(o) the location and diagrammatic representations of all other necessary erosion and sediment control measures;
(p) identify the clean and disturbed catchments, and flow paths, showing:
   (i) diversion of clean runoff;
   (ii) collection drains and banks, batter chutes and waterway crossings;
   (iii) location of discharge outlet points; and
   (iv) water quality monitoring locations.
(q) show calculated flow velocities, flow rates and capacities, drain sizing and scour/lining protection, and velocity/energy checks required for all stormwater diversion and collection drains, banks, chutes, and outlets to waterways;
(r) show waterways (perennial and non-perennial) and detail of stabilisation measures for all temporary waterway crossings;
(s) locate topsoil and/or soil stockpiles;
(t) prescribe non structural controls where applicable, such as minimising the extent and duration of soil exposure, staging the works, identifying areas for protection, delaying clearing until construction works are imminent etc;
(u) include a maintenance schedule for ensuring ESC and stormwater infrastructure is maintained in effective working order (refer IECA 2008, Chapter 6 and Chapter 7);
(v) include an adaptive management program to identify and rectify non-compliances and deficiencies in environmental performance (refer IECA 2008, Chapter 6 & Chapter 7);
(w) provide details of chemical flocculation proposed, including equipment, chemical, dosing rates and procedures, quantities to be stored and storage location, and method of decanting any sediment basin; and
(x) show how post-construction WSUD bio-retention devices will be adequately protected against sediment ingress during land-disturbing activities, including where applicable the transition from construction-phase sediment basins to post-construction phase bio-retention basins.

7.11.3.2 Erosion and Sediment Control Program

A construction phase Erosion and Sediment Control (ESC) Program is a set of management strategies, supporting documents and ESC Plans that describes what controls are required throughout all stages of the construction of the development, including the integration and protection of post construction stormwater management infrastructure (e.g. WSUD bio-retention devices).

In addition to the provision of ESC Plans (refer section 4.2(i) for requirements) for each phase of the development as described above, the ESC Program must also:

(a) be consistent with this Standard and a current best practice document such as the IECA 2008, Best Practice Erosion and Sediment Control. For issues where a current best practice document is not consistent with this Standard, this Standard prevails to the extent of the inconsistency;
(b) be supported by onsite soil testing and analysis (See (iii) below);
(c) include contingency management measures for the site, for example to ensure ESC measures are effective at all times, particularly just prior to, during and after wet weather;
(d) be consistent with current best practice standards, taking into account all environmental constraints including erosion hazard, season, climate, soil characteristics, and proximity to waterways;
(e) be prepared to a sufficient standard and level of detail such that compliance with this Standard will be achieved if the construction phase ESC Program is correctly implemented on-site;
(f) include an effective monitoring and assessment program to identify, measure, record and report on the effectiveness of the erosion and sediment controls and the lawfulness of water releases (refer IECA 2008, Chapter 6 and Chapter 7).

7.11.3.3 Soil Testing

Proper assessment of site soil conditions is an integral component of best practice civil construction and erosion and sediment control.

Proper assessment of site soil characteristics is necessary to objectively inform the selection and design of site ESC measures, the suitability of insitu soils for fill embankment construction and stability, construction-phase water quality treatment (such as for dispersive soils), future asset protection (such as stormwater outlet protection), topsoil fertility and amelioration requirements to ensure successful vegetative stabilisation and revegetation.

Soil testing compliant with this Standard is undertaken in accordance with IECA 2008, Chapter 3.5 and Appendix C, and as varied below:

(a) For Chapter 3.5.4 provide full particle size grading including hydrometer analysis (AS 1289-3.6.1 and AS1289-3.6.3). Refer Table 3.4a, Table 3.4b, and Table 3.4c for testing frequency and assessment levels;
(b) For Table 3.4a and Table 3.4b - Dispersion Index (AS1289-3.8.2) applies to samples returning an Emerson class number of 1 or 2. Refer to Tables for testing frequency and assessment levels;
(c) For Table 3.4c - Particle size distribution (AS1289 3.6.1) applies to representative subsoil samples. Refer to Table for remaining requirements
7.11.3.4 Design Certificate

The Design Certificate for Erosion and Sediment Control must be completed using the form provided as Appendix 1 and submitted to BCC in accordance with the development approval condition timing.

7.11.3.5 Inspection Certificate

See 7.11.4.2 Quality Assurance

7.11.3.6 Schedule of Registered Business Names

The name and contact details of the Land Owner, Superintendent and Principal Contractor, for the purposes of compliance with the conditions of the development approval, must be provided to Council’s representative at the pre-start meeting in writing. The details must include the registered business name and ABN/ACN for each party. Any changes to these parties during construction must be notified to Council in writing within 5 business days of the change occurring.

7.11.4 Protecting waters from the impacts of development

7.11.4.1 Land Owner Responsibilities

The land owner of the site is responsible for ensuring that matters pertaining to the environmental management of the site are either:

(a) in compliance with the requirements of this Standard, or

(b) not in compliance with (i) above and that specific actions are taken, which if implemented, will achieve compliance with this Standard.

The land owner must document the steps he/she/it takes to ensure compliance with this Standard beyond merely entering into a contract with experienced engineers, superintendent and/or contractors. Such documentation is to be provided to Council upon request.

For subdivision works (i.e. reconfiguration of a lot), the land owner is responsible for ensuring that all soil surfaces associated with the development remain effectively stabilised against erosion and that sediment is prevented from entering waters. This requirement applies throughout the development works and until such time as the Council accepts the development ‘off maintenance’ (e.g. for contributed council assets such as parkland, roads and stormwater drainage) and whilst future private allotments remain under the land owner’s legal control (i.e. until sold).

7.11.4.2 Quality Assurance Certification

The certification requirements of this section do not apply to developments which have a low ‘erosion risk’ under the BCC Erosion Hazard Assessment system.

The land owner must ensure that certification is provided to the Council, at the intervals specified below, verifying that matters pertaining to the environmental management of the development are either:

(a) in compliance with this Standard, or

(b) not in compliance with (i) above and that specific advice has been given to the land owner, which if implemented, will achieve compliance with this Standard.

Certification must:

(a) be on the approved form (Appendix 2);

(b) be undertaken by a suitably qualified and experienced professional, not directly employed by the Principal Contractor;

(c) be undertaken at the following minimum intervals:

(i) Prior to the commencement of bulk earthworks. This shall be a Hold Point (HP) in construction;

(ii) Prior to live connection of new stormwater drainage infrastructure works to the existing stormwater/ waterway system;
(iii) Prior to any instream works or disturbance within a waterway. **This shall be a Hold Point (HP) in construction;**

(iv) Prior to decommissioning of any sediment basin and/or transitioning from a sediment basin to a WSUD bio-retention device. **This shall be a Hold Point (HP) in construction;**

(v) Prior to any request for survey plan sealing, on maintenance or off maintenance inspection; and

(A) At intervals not exceeding 1 month;

(B) be provided to the Land Owner, Superintendent, the Principal Contractor and BCC in writing within 5 business days of the inspection;

(C) be true and accurate assessments of the findings; and

(D) be kept available (copies) onsite together with copies of all specific directions issued in relation to the certification, for inspection by Council Officers.

This requirement does not diminish the responsibility of any person involved in the development to do all that is reasonable and practicable to ensure effective environmental management is implemented onsite at all times and in accordance with the requirements of the applicable Development Approval conditions, Development Permits and the *Environmental Protection Act 1994*.

### 7.11.4.3 Hold Points

The construction Hold Points listed in Section 7.11.4.2 are mandatory. The land owner must ensure that these Hold Points are observed. Refer to IECA 2008 Chapter 7.8 for discussion on Hold Points and the use of Inspection and Test Plans (ITPs).

Note: Refer to Glossary of Terms for explanation of Hold Points.

### 7.11.4.4 Avoiding and minimising releases, flow and discharges of prescribed water contaminants

Prescribed Water Contaminants (as defined in the *Environmental Protection Act 1994*) must not be released from the site, or be likely to be released from the site, unless all reasonable and practicable measures are taken to prevent or minimise the release and concentration of contamination.

Performance standards, principles and measures must include as a minimum, but are not limited to, the following:

### 7.11.4.5 Erosion Control Standard

The design and implementation of best practice erosion control principles and practices will be based on **monthly rainfall erosivity** ratings as defined within IECA 2008 Table 4.4.1 and Table 4.4.4 unless noted otherwise in this Standard.

**Minimising soil exposure**

(a) Ensure non-essential exposure of soil is avoided by:

(i) restricting the extent of clearing to that necessary for access to, and safe construction of the approved works;

(ii) protecting vegetation in all other areas of the site;

(iii) minimising the duration of soil exposure by:

(A) only clearing vegetation immediately prior to an area being actively worked;

(B) staging the works to minimise the area of soil exposed at any one time;

(C) effectively stabilising cleared areas if works are delayed or works are not intended to occur immediately. **See Explanatory Note 1;**

(D) effectively stabilising areas at finished level without delay and prior to rainfall; and

(E) effectively stabilising steep areas, such as stockpiles, batters and embankments, which are not being actively worked and prior to rainfall.
7.11.4.6 Drainage Control Standard

The design and implementation of best practice drainage control principles and practices will comply with IECA 2008 Table 4.3.1 unless noted otherwise in this Standard.

Managing stormwater

(a) Ensure clean stormwater is diverted or managed around or through the site without increasing the concentration of total suspended solids or other contaminants in the flow and without causing erosion (onsite or offsite). If it is not feasible to divert all areas discharging clean stormwater around or through the site, manage the clean stormwater as for contaminated stormwater, and ensure that sediment basins are sized to capture and accommodate the additional volume of runoff. See Explanatory Note 2;

(b) Ensure sheet flows of stormwater are managed such that sheet and rill erosion is prevented or minimised;

(c) Ensure that all concentrated stormwater flows including drainage lines, diversion drains, channels, spillway and batter chutes are managed onto, through, and at release points from the site in all rain events up to and including the average recurrence interval (ARI) event defined within IECA 2008 Table 4.3.1 without causing:
   (i) water contamination, or
   (ii) sheet, rill or gully erosion, or
   (iii) sedimentation, or
   (iv) damage to structures or property.

7.11.4.7 Sediment Control Standard

The design and implementation of best practice sediment control principles and practices will be based on monthly rainfall erosivity ratings as defined within IECA 2008 Table 4.5.2 unless noted otherwise in this Standard.

(1) Sediment basins

(a) In accordance with Best Practice Erosion and Sediment Control, Appendix B – Sediment basin design and operation, IECA (2008);

(b) Ensure each sediment basin has the capacity to treat flows to current best practice standards (see Explanatory Note 3) and as a minimum to contain all the stormwater runoff from the 
\[ R_{(\%5\text{-day})} \] rainfall depth equal to 40mm, unless a higher standard is prescribed in the development approval condition(s);

(c) Provide sediment storage volume in accordance with Table B8 (Appendix B, IECA 2008) or as a minimum store at least 2 months sediment from the receiving catchment, as determined using the Revised Universal Soil Loss Equation (RUSLE);

(d) Ensure sediment basins are maintained with sufficient storage capacity to capture and treat the runoff for the design rainfall depth. Where sediment basins are proposed to be oversized for storage of captured water for re-use, install survey markers in each such basin to clearly indicate the level that water within the basin must be lowered to, in order to meet the storage capacity specified in requirement (c) above;

(e) Ensure sediment basins are dewatered to the appropriate level as soon as practicable after each rainfall event and no longer than 5 days after a rainfall event (See also below);

(f) Ensure stormwater captured in sediment basins is treated prior to discharge to minimise the concentration of contaminants released from the site, having due regard to forecast rainfall, and ensuring that releases are in accordance with the release limits specified in Section 5.6. See Explanatory Note 4;

(g) Ensure sediment basins and associated structures such as inlets, outlets and spillways are effectively stabilised and structurally sound for ARI rainfall events defined within Table B12 (Appendix B, IECA 2008); and

(h) Ensure accumulated sediment from basins and other controls is removed and disposed of appropriately without causing water contamination.

(2) Erosion and sediment controls (other than sediment basins)

(a) Ensure measures have been implemented such that the runoff from all disturbed areas flows to a sediment basin or basins. Where it is not feasible to divert runoff from small disturbed areas of the site to a sediment basin, implement compensatory erosion, drainage and sediment controls prior to rainfall to ensure that erosion of those of areas does not occur,
including erosion caused by either splash (raindrop impact), sheet, rill or gully erosion processes. **See Explanatory Note 5:**

(b) Where it is not feasible to effectively stabilise cleared areas of exposed soil, such as areas being actively worked, implement a full suite of erosion and sediment controls, to maximise sediment capture in those areas and minimise erosion such that all forms of erosion, other than splash erosion (raindrop impact) and sheet erosion, does not occur;

(c) In areas of exposed soil where it is not feasible to either effectively stabilise the surface or implement a full suite of erosion and sediment controls, for example in the areas being actively worked and where the implementation of some erosion and sediment controls would impede construction activities, ensure contingency measures are available on site and are implemented, prior to rain, to maximise sediment capture in those areas and minimise erosion such that all forms of erosion, other than splash erosion (raindrop impact) and sheet erosion, does not occur;

(d) **Note: this does not apply to major erosion and sediment controls such as sediment basins. Major controls should be installed before other works commence.**

(e) Effectively stabilise all stockpiles, batters and embankments without delay. Where it is not feasible to effectively stabilise a stockpile, batter or embankment, such as areas being actively worked, ensure that sediment controls are installed and surface stormwater flows are managed such that erosion of stockpiles, batters or embankments is not caused by concentrated stormwater flows; and

(f) Ensure sediment does not leave the site on the tyres of vehicles.

### 7.11.4.8 Work within waterways

(a) Waterways, including ephemeral and permanent waterways, must not be altered, nor riparian vegetation disturbed without prior written approval of the relevant administering authority;

(b) Work within waterways:
   (i) should only be undertaken during the lower rainfall hazard months and;
   (ii) must be promptly rehabilitated conforming to the natural channel form, substrates and riparian vegetation as far as possible;
   (iii) are to be undertaken in accordance with IECA 2008 Best Practice Erosion and Sediment Control, Book 3 Appendix I – Instream works.

(c) Temporary vehicular crossings of waterways must be designed and constructed to convey minimum pipe flows as defined within IECA 2008 Table 4.3.1, and remain structurally stable for all rainfall events up to the 10-year average recurrence interval (ARI) event of critical duration;

(d) Erosion and sediment controls must not be constructed within the riparian zone, unless it is not feasible to site them elsewhere; and

(e) Where waterways and drains must be modified or disturbed as part of permanent works, refer to *Erosion Treatment for Urban Creeks – Guidelines for Selecting Remedial Works* (BCC 1997 or later version).

### 7.11.4.9 Effective Stabilisation and Plan Sealing

Prior to the sealing of the plan of survey for the development all site surfaces must be effectively stabilised using methods which will continue to achieve effective stabilisation in the medium to long-term. For the purposes of this requirement, an effectively stabilised surface is defined as one that does not, or is not likely to, result in visible evidence of soil loss caused by sheet, rill or gully erosion or lead to sedimentation, or lead to water contamination.

A site is determined to be “effectively stabilised” if at the time of the plan sealing inspection:

(a) Methods of stabilisation are:
   (iv) appropriate for slopes and slope lengths;
   (v) consistent with best practice environmental management practices such as in IECA 2008; and
   (vi) providing a minimum of 70% soil coverage (when viewed perpendicular to the soil surface) across any square metre of the site disturbance area.
(b) Stormwater runoff from the site is not currently, and is not likely to result in visible evidence of sedimentation or erosion, or lead to water contamination, in the short, medium and long term.

If at the time of request for plan sealing, the method of stabilisation has not achieved a stability that has a high probability of enduring in the medium to long term, for example, inadequate grass cover or permanent approved landscape works are incomplete, the following will be taken into consideration in determining whether the site is capable of achieving medium to long-term stability:

(i) Evidence of appropriate soil testing and amelioration having been adequately undertaken;
(ii) Evidence of an adequate seed mix of annual and perennial grass species being applied at an adequate rate;
(iii) Evidence that appropriate grass strike and growth has been achieved for the type of stabilisation method selected.

For example, while hydromulch can provide an immediate and effective stabilising cover to soils, the protective cover can be relatively short-lived if vegetation fails to establish before the thin layer of mulch decomposes. Similarly where the hydromulch specification and application rate (i.e. t/ha) provides insufficient coverage and binding of the soil to prevent erosion whilst vegetation establishes, then the site will not be considered “effectively stabilised”.

Therefore if hydromulch is selected as the method of temporary stabilisation, it is important that perennial as well as annual grasses are well established at the time of plan sealing to reduce the risk of instability of the site in the medium to long term.

Note: The bonding of uncompleted works relating to erosion and sediment control (i.e. Bonding of environmental outcomes) is not permitted where it is contrary to the Purpose of this Standard (i.e. the protection of Waters from the impacts of land and infrastructure development). This situation can be avoided through progressive stabilisation, supplementary watering and effective site management.

7.11.4.10 Release limits

(1) All releases of stormwater captured in a sediment basin, unless otherwise noted in this Standard, must not exceed the following limits:
   (a) 50 milligrams per litre (mg/L) of Total Suspended Solids (TSS) as a maximum concentration;
   (b) turbidity (NTU) value less than 10% above background;
   (c) pH value must be in the range 6.5 to 8.5 except where, and to the extent that, the natural receiving waters lie outside this range.

Note: It is recommended that a site specific relationship between turbidity and suspended solids is determined for each sediment basin. Once a correlation between suspended solids and turbidity has been established for a sediment basin, testing stormwater for compliance with release limits, prior to release, can be done on site with a turbidity tube or calibrated turbidity meter. This has the advantage of providing immediate assessment to justify a release rather than waiting for laboratory results to confirm concentration levels and compliance. Note that post-release TSS validation is appropriate to demonstrate that the NTU/TSS correlation is being maintained.

Note: Background refers to receiving water quality immediately upstream of the site location release point at the time of the release. Where there is no immediate upstream receiving water at the location and time of the release then the Turbidity release limit (NTU) will be equal to the release limit for 50mg/L Total Suspended Solids (TSS) based upon the onsite correlation between TSS and NTU.

(2) The concentration of TSS released by dewatering may only exceed 50mg/L where it can be demonstrated and supported through documentation that:
   (a) further significant rainfall is forecast to occur before the TSS concentration is likely to be reduced to 50mg/L; and
   (b) releasing a higher concentration of total suspended solids will result in a better environmental outcome by providing storage for the capture and treatment of runoff from the imminent rainfall and runoff; and
   (c) all reasonable and practicable steps have been taken to treat the water within best practice timeframes; and
   (d) floculent has been appropriately applied and the concentration of TSS in the captured water has already significantly decreased.
(3) For all other stormwater releases, flows and discharges from the site, the release limits prescribed in (a) above must not be exceeded unless the development is in full compliance with this Standard.

7.11.5 Explanatory Notes

(1) In this Standard, an effectively stabilised surface is defined as one that does not:
(a) have visible evidence of soil loss caused by sheet, rill or gully erosion; or
(b) lead to sedimentation; or
(c) lead to water contamination.

(2) Diverting clean stormwater runoff into a sediment basin is an inferior option to diverting clean stormwater around or through the site because it will cause an increase in the volume and frequency of contaminated releases from the sediment basin. For this reason, diverting clean stormwater into a sediment basin is not acceptable unless the proponent demonstrates that diverting clean stormwater around or through the site is not feasible.

(3) Research has shown that sediment basins designed on a “batch” or total storm capture approach are only capable of treating a small percentage of the annual runoff volume without basin size becoming excessive. Innovation in sediment basin design to incorporate continuous flow treatment is likely to occur in the future and as this technology becomes available in best practice guidelines it is required that this technology be adopted where a better water quality outcome will result. In the interim the minimum basin size is as specified in Section 7.11.4.7.

(4) Dewatered flows from sediment basins should be compliant with the release limits specified in Section 7.11.4.10, unless it can be demonstrated that a non-compliant release occurred to facilitate a better environmental outcome. For example, higher total suspended solids concentrations may be acceptable in circumstances where further rain is imminent and it can be substantiated that releasing partially treated basin water, which has a TSS concentration exceeding the release limit, would minimise the total contamination released from the site, by providing for the capture and treatment of expected runoff. However, releasing waters from sediment basins without treatment is not acceptable.

(5) Compensatory controls are erosion controls, drainage controls and sediment controls which compensate for the lack of sediment basin and are applied such that the type, timing, placement and management of controls minimise the potential for water contamination and environmental harm. This is primarily achieved by reducing the risk of erosion and subsequent sediment release, for example by turfing or mulching and managing concentrated flows in the area.

7.11.6 Reference Documents

The following documents are referenced to provide interpretive guidance and detailed design information, where appropriate, to be taken into account to achieve compliance with this Standard:
(a) Queensland Urban Drainage Manual (QUDM);
(b) Australian Rainfall and Runoff (AR&R);
(c) Best Practice Erosion and Sediment Control, Books 1 to 5 inclusive, International Erosion Control Association, November 2008 or later version; (IECA, 2008);
(d) Erosion Hazard Assessment form and Supporting Technical Notes, Brisbane City Council, 2010, or later version;

Note: Brisbane City Council has adopted IECA 2008 as the default best practice ESC reference document for land disturbing activities within Brisbane City. This document is considered the ‘minimum standard’ for ESC and shall be used for those activities subject to, and as varied by, this Standard. Use of any alternative best practice ESC reference document that specifies a lower performance standard than IECA 2008 does not permitted.