REDLAND CITY COUNCIL

Lower Tingalpa Creek Stormwater Infrastructure Plan






May 2013

M8000_015

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M8000_015 Tingalpa Creek Structure Plan					
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Appendix A MUSIC Model Cost Estimation Screenshots

1. INTRODUCTION

Redland City Council (RCC) has commissioned Engeny to develop a stormwater infrastructure plan for the Capalaba Activity Centre which resides in the Tingalpa Creek catchment area.

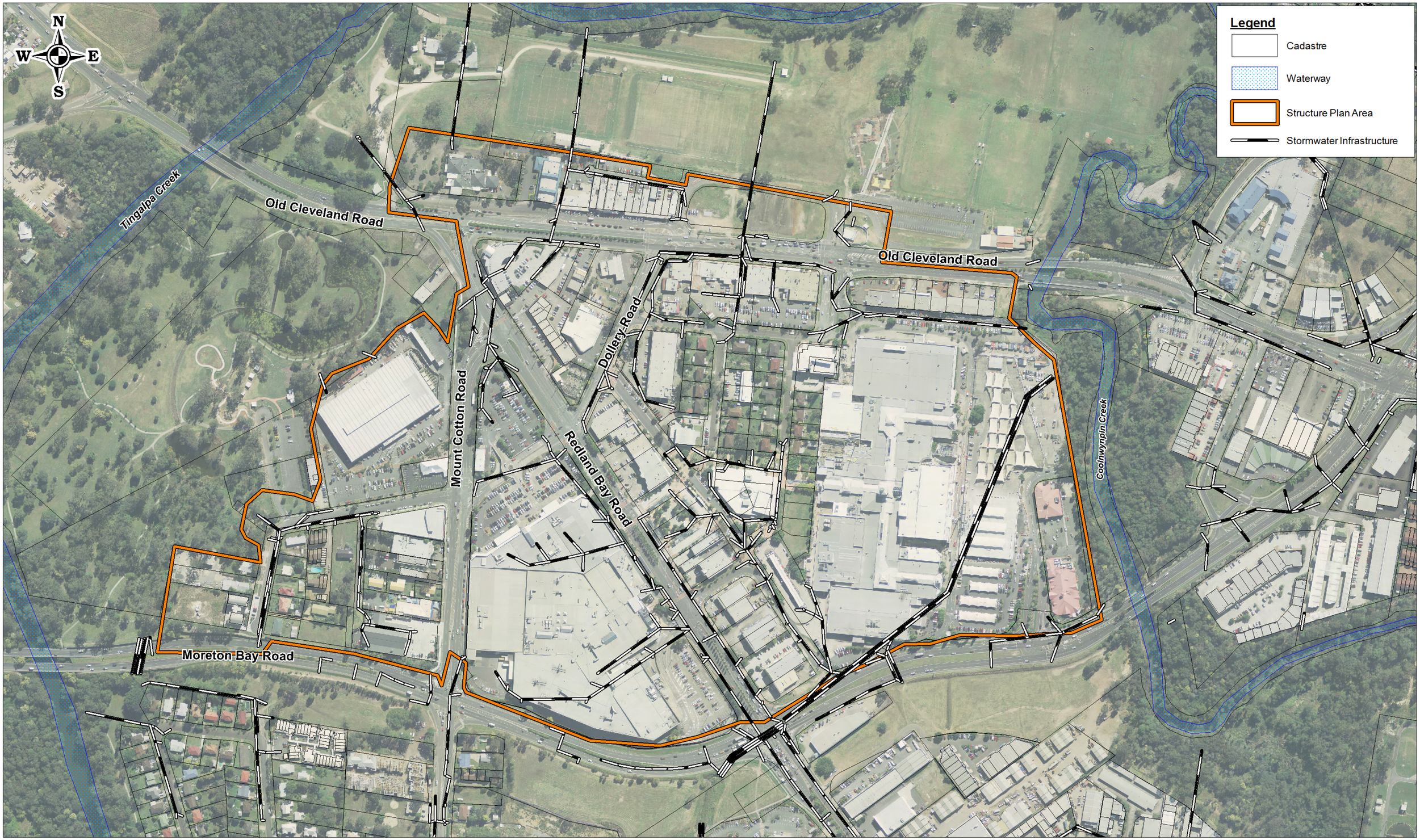
The purpose of this study is to determine the integrated stormwater quantity and quality trunk infrastructure requirements and associated costs for the proposed infill development area. The stormwater infrastructure plan will assist Council in applying appropriate planning and acquisition principles for servicing forecasted demands. Refer to the Figure 1.1 (Locality Plan) which illustrates the extent of the Capalaba Master Plan Area (study area).

The South East Queensland Regional Plan 2009-2031 included Capalaba Activities Centre as a Principal Activities Centre which includes concentrations of commercial and retail development as well as single detached dwellings and light industrial uses.

A number of studies previously undertaken for the catchment have been used by Engeny to provide background information to this study. The previous studies include:

- Capalaba Regional Park Landscape Concept Plan (Tract Consultants, 2009);
- Capalaba Activity Centre Master Plan (Urbis, 2001).

The investigation has adopted a design approach consistent with the Queensland Government's Guide to Planning Stormwater Trunk Infrastructure (March, 2010), Statutory Guideline 01/09, Queensland Urban Design Manual (QUDM) and relevant Council policies for stormwater management.



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Lower Tingalpa Creek Stormwater Infrastructure Plan

Locality Plan

Figure 1.1

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2. SCOPE OF WORKS

The scope of works for this study has included stormwater quantity and quality analysis works, including determination of infrastructure requirements and associated construction costs as well as reporting. Specifically, the technical scope of works included the following:

Stormwater Quantity

- Development of an ultimate case XP-RAFTS hydrologic and existing case TUFLOW hydraulic models representing the ultimate land use conditions and existing stormwater infrastructure throughout the study area;
- Simulate the hydrologic and hydraulic models for the 2, 10, 50 and 100 year ARI design event to determine the ultimate design flows and assess the hydraulic capacity of the existing stormwater infrastructure;
- Review of flood results to identify impacts associated with the proposed ultimate development under existing hydraulic conditions. It was identified that the existing stormwater drainage system adequately serviced the ultimate land use and therefore no mitigation measures were required.

Stormwater Quality

- Development of a MUSIC Version 5.0 model for the catchment to represent the ultimate development unmitigated scenario. This model allows for a quantitative assessment of stormwater runoff quality for the proposed development plan (proposed ultimate land use);
- Amend the ultimate development unmitigated MUSIC model to include the appropriate treatment measures required to achieve the prescribed water quality objectives from the catchment. This model represents the ultimate mitigated scenario for the proposed development area and enables the appropriate water quality treatment infrastructure to be defined;
- Concept design of the proposed stormwater quality mitigation measures including estimation of construction costs for the proposed water quality trunk infrastructure requirements for the proposed development.

3. CATCHMENT DESCRIPTION

Lower Tingalpa Creek covers the area of waterway between Leslie Harrison Dam and Waterloo Bay at the mouth. The majority of the catchment is already developed with little change in the ultimate land use for the catchment. The area that is currently known as Capalaba CBD has been earmarked as a Regional Activities Centre in the SEQ Regional Plan and is therefore the focus of this study.

The Centre covers a total area of fifty (50) hectares of land which is bound by John Fredrick's Park in the North, Coolnwynpin Creek in the East, Moreton Bay Rd in the South and Capalaba Regional Park in the West.

The majority of the proposed ultimate land use within the catchment will remain similar to its current commercial use. The topography of the site is relatively flat with the catchments to the west and north discharging to Tingalpa Creek and the catchments to the east and south discharging to Coolnwynpin Creek. An external catchment enters the study area to the south which is then conveyed via a set of large box culverts, eventually discharging into Coolnwynpin Creek. Figure 1.1 shows the location of the study area and adjacent waterway corridors.

4. STORMWATER QUANTITY ASSESSMENT

4.1 Introduction and Approach

The increase in impervious areas associated with urban development generally leads to increased runoff volumes, reduced infiltration to groundwater and increased rates of runoff and stream flow. Hydrologic and hydraulic modelling has therefore been undertaken to assess the impacts associated with the proposed development of the Tingalpa Creek Development Area. In particular, this includes assessment of stormwater infrastructure throughout the study area for ultimate development conditions.

These works have been undertaken to determine whether stormwater infrastructure upgrades are required as a result of the increase in flow due to the ultimate development conditions.

4.2 Catchment Hydrology

Hydrologic modelling of the catchment was undertaken using the XP-RAFTS rainfall-runoff routing model. The XP-RAFTS software is an industry standard rainfall-runoff routing analysis package capable of modelling changes in development for both rural and urban sub-catchments. The hydrologic model calculates flood hydrographs at various locations throughout a catchment for design flood events for input into the hydraulic model.

Flood hydrographs have been determined for a range of design rainfall events including the 2, 10, 50 and 100 year ARI design flood events under ultimate development conditions. These flood hydrographs are used as the key input for the hydraulic model to predict stormwater network and overland flood behaviour.

4.2.1 Model Setup

The XP-RAFTS estimates the runoff hydrograph from individual sub-catchments based on a number of input parameters including rainfall intensity, rainfall losses, fraction impervious, catchment slope, Manning's 'n', temporal patterns and catchment area.

4.2.2 Catchment Characteristics

Model parameters for each sub-catchment have been selected from recommended design values for various categories of land use types based upon the provisions of the Queensland Urban Drainage Manual (QUDM, 2007).

The pervious and impervious area of each sub-catchment for the Ultimate Case was obtained from zoning_version_4 GIS layer provided by Redland City Council. The proposed future (ultimate) land use consists of a mixture of Urban and Medium Density Residential, Open Space, Community Purpose, Commercial Industry, Major Centre and Conservation Area. The percentage impervious values have been determined for

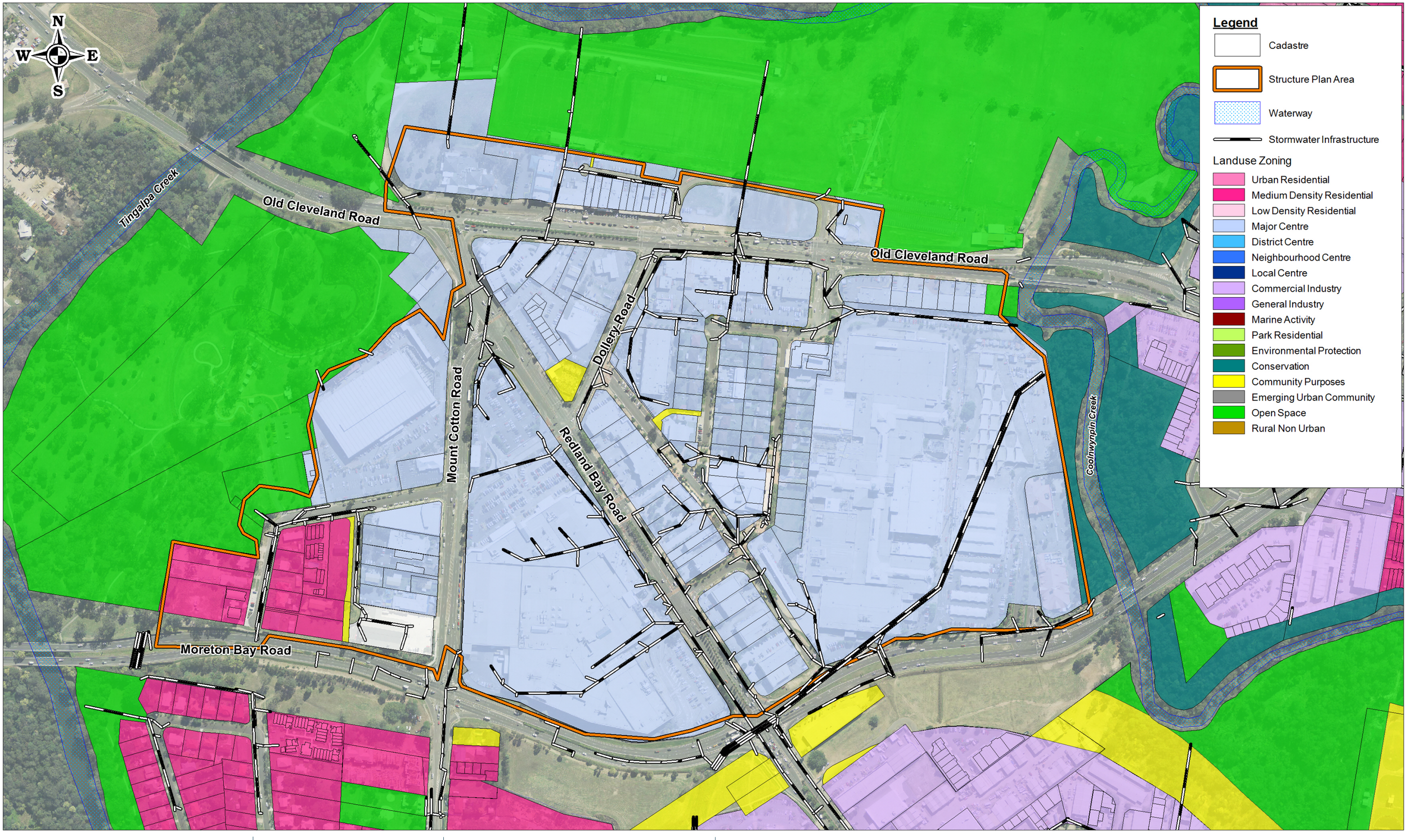
each land use in accordance with Redland City Council Planning Scheme - Policy 9 - Stormwater Management.

The ultimate land use for the Tingalpa Creek development area is illustrated in Figure 4.1. Table 4.1 below outlines the adopted impervious values for the ultimate development land use scenario.

Table 4.1 Land Use Impervious Percentage

Land Use	Impervious Percentage (%)
Conservation	0
Open Space	0
Urban Residential	70
Medium Density Residential	80
Community Purposes	60
Major Center	90
Commercial Industry	90
Road	90

The ultimate catchment plan and XP-RAFTS model layout is presented in Figure 4.2.



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Ultimate Land Use Plan

Figure 4.1

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4.2.3 Rainfall Losses and Intensities

It was assumed that rainfall losses could be represented by an initial loss - continuing loss model. These losses are applied via the associated materials delineation of the study area and are factored according to the percentage imperviousness of the associated land use.

Table 4.2 Rainfall Loss Parameters

Surface Condition	Rainfall Losses
Impervious surfaces	Initial Loss 1 mm
	Continuing Loss 0 mm/hr
Pervious Surfaces	Initial loss 15 mm
	Continuing Loss 2.5 mm/hr

The design rainfall Intensity-Frequency Duration (IFD) data for various storm events within the development area were derived based upon the procedures outlined in Book 2 of Australian Rainfall and Runoff (AR&R 2001 edition).

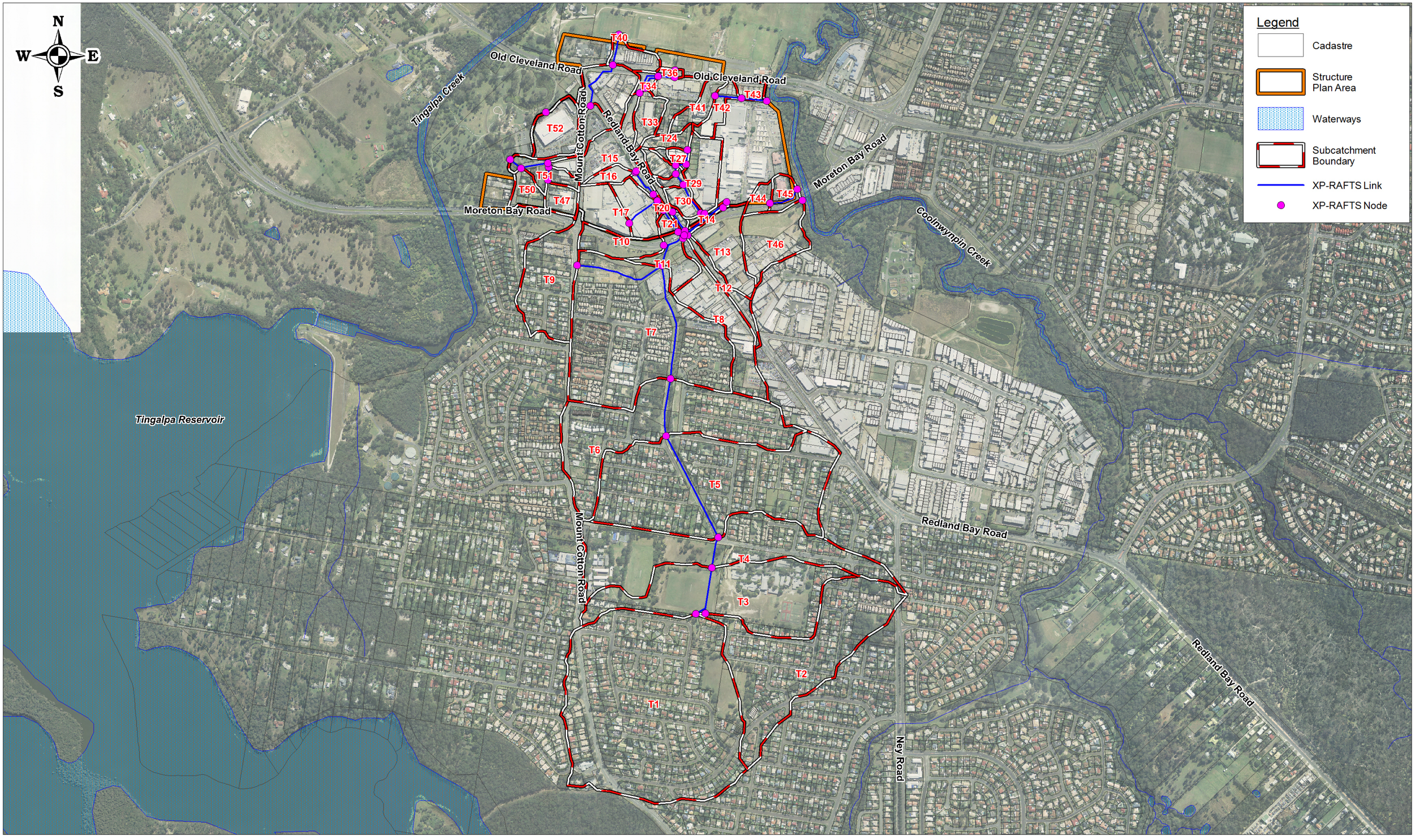
4.2.4 Hydrologic Model Validation

Sub-catchment flows throughout the development area have been independently verified through the use of the Rational Method. A comparison of two (2) sub-catchments was undertaken to compare the RAFTS 100 year ARI peak flows representing the Ultimate Case and the Rational Method flows. The results are summarized in Table 4.3.

Table 4.3 XP-RAFTS and Rational Method 100 Year ARI Comparison

Rational Method Locations	XP-RAFTS Peak Flow (m^3/sec)	Rational Method Flow (m^3/sec)	Difference
T3	8.14	6.49	25
T30	0.671	0.703	5%

Table 4.3 shows there is good correlation between the peak flow results calculated using the Rational Method and those estimated from the hydrologic model. The comparative flows are generally within 25% and as such, it is considered the hydrologic model parameters are suitable for predicting design flood events within the study area.



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Hydrology Model Layout

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4.3 Hydraulic Analysis

Hydraulic analysis of the Capalaba Master Plan Area has been undertaken using the TUFLOW modelling package to assess the performance of the existing stormwater infrastructure for the ultimate land use scenario.

The following sections detail the parameters and data used in the creation of the TUFLOW model.

4.3.1 Model Parameters

The TUFLOW hydraulic model parameters adopted for the modelling scenario investigated in this study are summarised briefly below.

4.3.2 Roughness

Hydraulic roughness for the model has been adopted based on a Manning's "n" roughness coefficient which was determined from the 2008 aerial photographs in combination with a site inspection. Typical roughness "n" values ranged from 0.014 for concrete pipes through to 0.200 which was used to represent buildings (no flow areas) whilst maintaining flood storage representation.

4.3.3 Stormwater Pipe System

Existing stormwater pipe data was supplied by Council in a MapInfo spatial GIS format. Any missing data was obtained during site visit, which was also used to confirm supplied data from Council.

Typically, the pipe information included pipe sizes, invert levels and spatial locations which assisted in locating stormwater assets throughout the system as well as defining pipe lengths. Where culvert invert level information was not available, analysis of the Digital Elevation Model (DEM) and site photographic record were used to estimate invert levels. This method provided a level of detail which is sufficient for the purposes of this study. Existing stormwater infrastructure locations within the Capalaba Master Plan Area are presented in Table 4.5 and Figure 4.3.

4.3.4 Model Topography

Redland City Council has provided 0.25 m contour data from which a Digital Elevation Model (DEM) was created for a 1 m grid size.

All modelling works undertaken for this study have been prepared based on the aforementioned DEM. A grid size within the TUFLOW model of 4 m has been adopted, and ground surface elevations for each cell are based on the topographic detail provided by the created DEM.

Discrete drainage features can sometimes be poorly represented in the topographic data (and DEM), and modifications to model topography based on site inspection and photographic record may have been undertaken to more accurately represent flow behaviour.

4.3.5 Hydraulic Modelling Scenario

The existing case hydraulic assessment represents the ultimate catchment flows and existing trunk infrastructure throughout the study area. The study area is generally drained via a number of stormwater pipes which discharge into Tingalpa Creek to the west and north or Coolnwynpin Creek to the east of the study area. Flows from an external catchment to the south are conveyed through the study area via large box culverts which discharge into Coolnwynpin Creek.

This hydraulic investigation has assessed the hydraulic capacity of the existing drainage system and the ability of the system to accommodate flows for the ultimate land use scenario. It is noted that the change in land use from existing to ultimate development is minor and therefore the change in impervious area and catchment flows are also relatively minor. TUFLOW hydraulic modelling was undertaken for the 2, 10, 50 and 100 year ARI flood events.

The hydraulic modelling results are presented and discussed in Section 4.3.6. The results were presented and discussed with Council who were satisfied that the existing drainage system could service the ultimate land use without the requirement for mitigation works. Based on this advice, no stormwater mitigation measures have been assessed and therefore no stormwater quantity infrastructure is required to service the Capalaba Master Plan Area.

4.3.6 Hydraulic Modelling Results

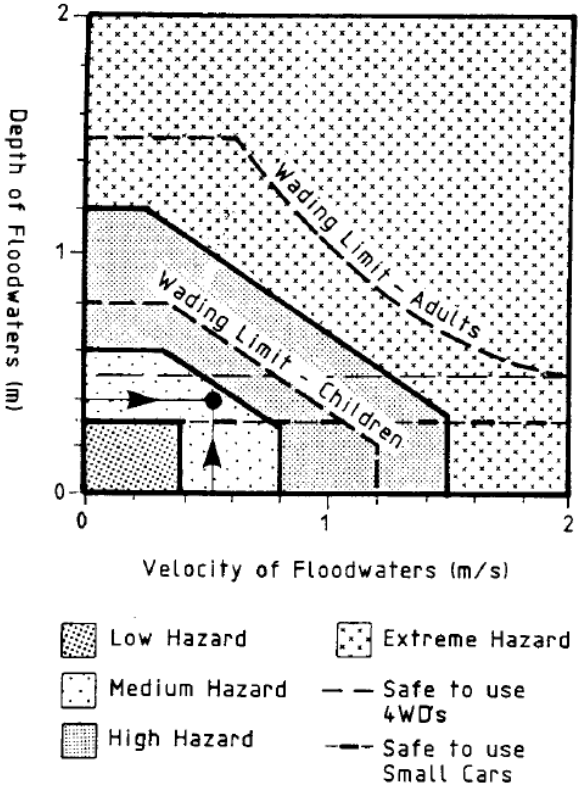
The existing case hydraulic assessment has provided results which demonstrate the capacity of the existing drainage system and flood impacts where flows are not contained within the overland or subsurface drainage system.

The majority of the western portion of the study area drains to Tingalpa Creek whilst the eastern portion of the study area drains to Coolnwynpin Creek via overland and sub-surface drainage systems. The hydraulic modelling results show that the majority

of flows are either conveyed via the subsurface drainage system or contained within the road reserve and overland flow paths. The results for the 100 year ARI event shows that majority of overland flow for the south eastern portion of the catchment is conveyed via Moreton Bay Road to Coolnwynpin Creek. Large box culverts (2 No. 2.4 m x 3.6 m RCBC) are also used to convey flows from the south eastern catchment to Coolnwynpin Creek. These culverts are located under Moreton Bay Road and Capalaba Central.

As shown in Figure 4.7 (100yr ARI Flood Depth), minor inundation is predicted over some properties located along Rickey Street, Old Cleveland Road and Pittwin Road North, however flood depths for the 100 year ARI event are shown to be generally less than 200 mm and are therefore not of major concern. It is estimated that the existing sub-surface drainage system has been designed to convey the 10 year ARI design flows. Greater flood depths are observed within the local Capalaba Central road at the intersection with Moreton Bay Road where water is shown to pond to depths of up to 1 m in the 100 year ARI. Flood inundation is also shown to occur within the Capalaba Central shopping complex however upon review; it would appear that the topographic data used in the hydraulic model does not provide a true representation of the shopping centre floor (slab) level and results over commercial and industrial buildings should be neglected for the purpose of this study. This is due to limitations in the topographic data provided by Council.

Flood risk mapping throughout the study area was undertaken based on low, medium, high and extreme categories in accordance with SCARM Report 73 (CSIRO, 2000) as illustrated in the diagram below.



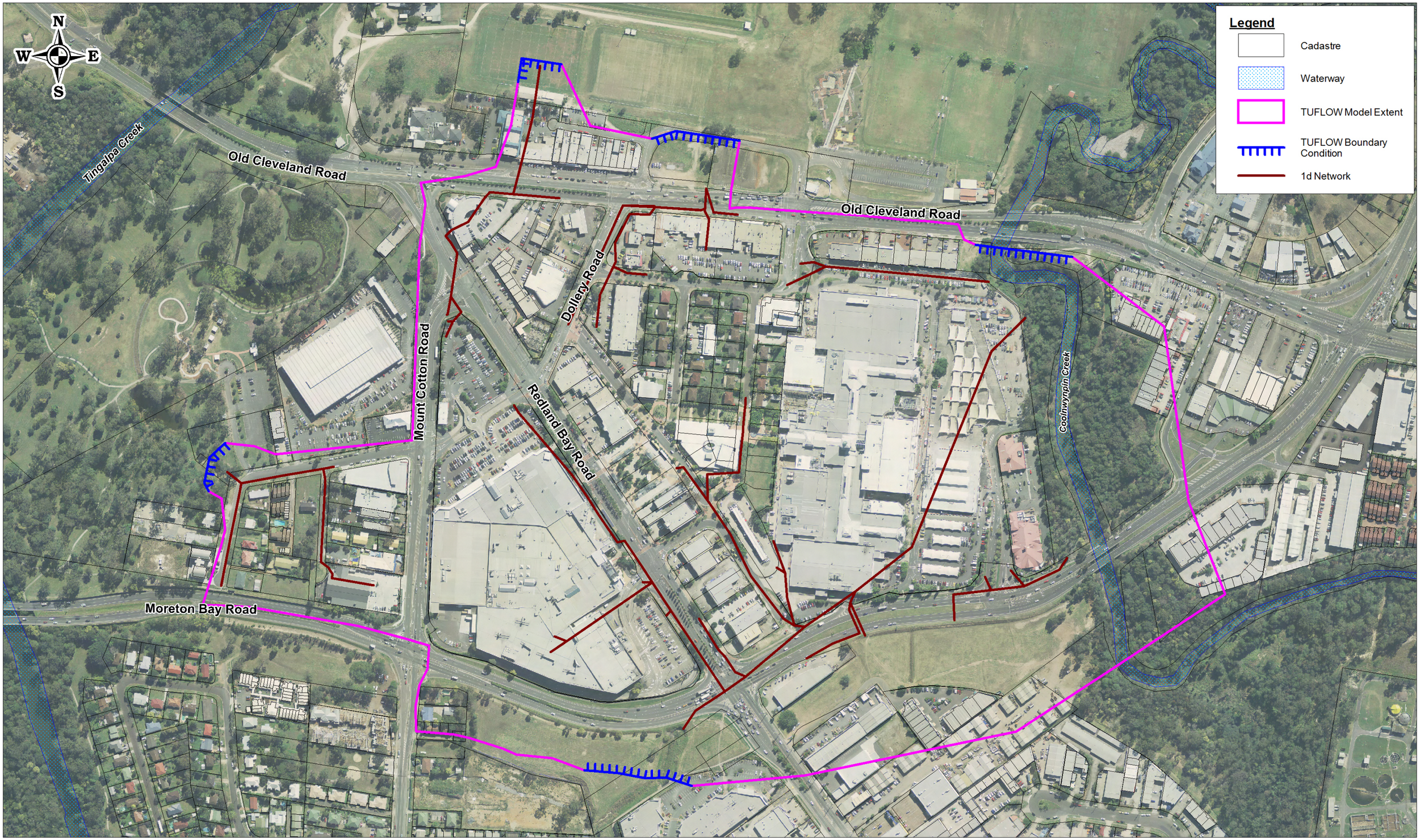
Source: Floodplain Management in Australia: Best Practice Principles and Guidelines (CSIRO, 2000)

The flood hazard mapping was produced in TUFLOW based on the following logic:

- D ≤ 0.3 AND V ≤ 0.38: Category 1 (Low Hazard);
- D ≤ 0.6 AND V ≤ 0.8 AND D + 0.64*V ≤ 0.82: Category 2 (Intermediate Hazard);
- D ≤ 1.2 AND V ≤ 1.5 AND D + 0.69*V ≤ 1.38: Category 3 (High Hazard);
- Otherwise Category 4 (Extreme Hazard).

The 100 year ARI flood hazard map as presented in Figure 4.8 indicates that the majority of the study area has a low hazard; however Moreton Bay Road is shown to have a high to extreme flood hazard due to the depth and velocity within the road. This is a state controlled road (i.e. DTMR) and Old Cleveland Road could be used as an alternative route during flood events.

Following the presentation and discussion of the existing case hydraulic modelling results with Council, it was determined by Council that stormwater drainage augmentation or mitigation works were not required given that the impervious area for the Capalaba Activity Centre was unlikely to increase and that the stormwater drainage system was originally designed for ultimate catchment conditions. From discussions with Council, it is understood that Council are not aware of any major flooding issues within the study area. Based on this direction from Council, the existing stormwater quantity infrastructure is considered to be adequate to service the future Capalaba Activity Centre and therefore the no stormwater quantity infrastructure plan has been developed for this study.



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Hydraulic Model Layout

Figure 4.3

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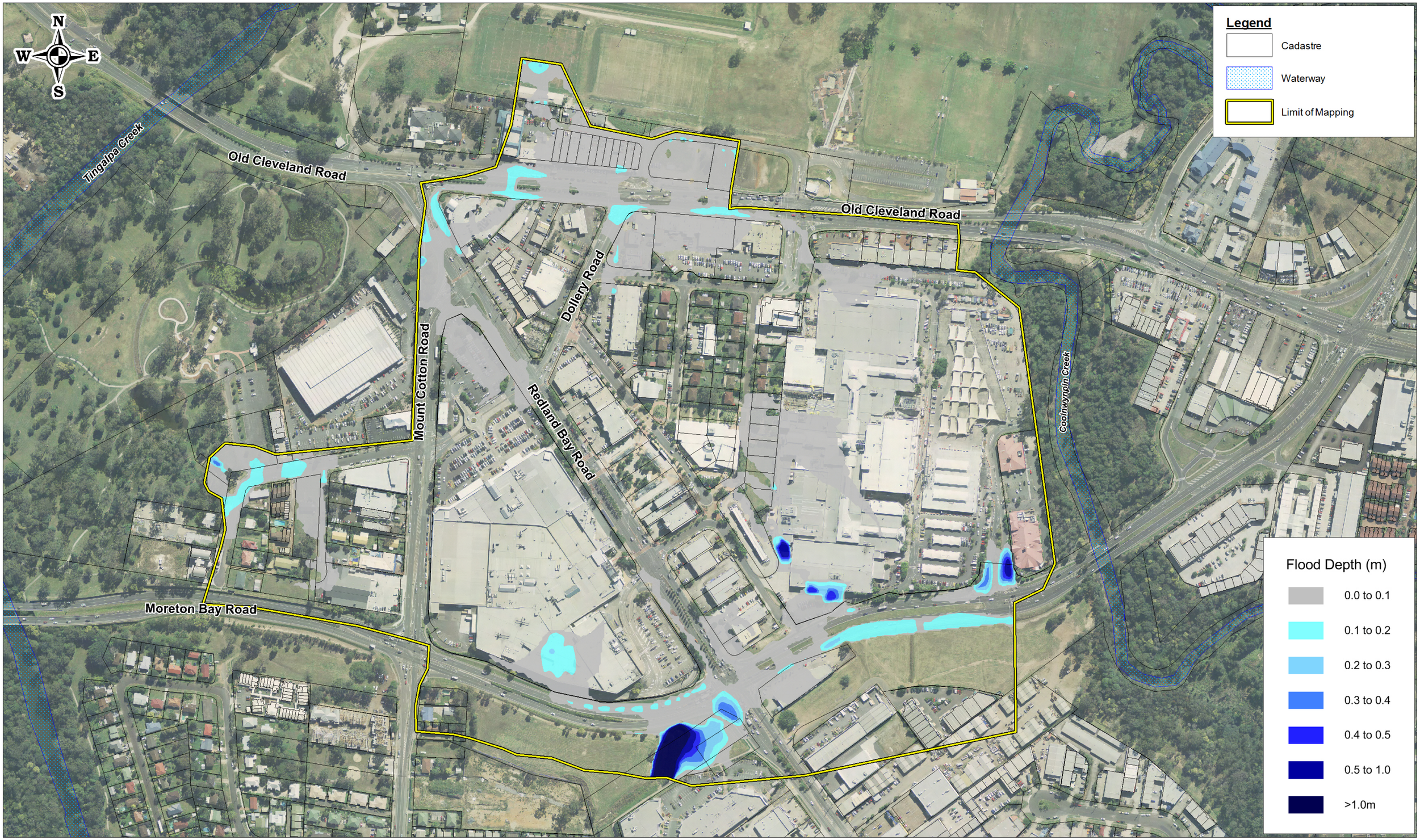
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2 Year ARI Peak Flood Depth

Figure 4.4

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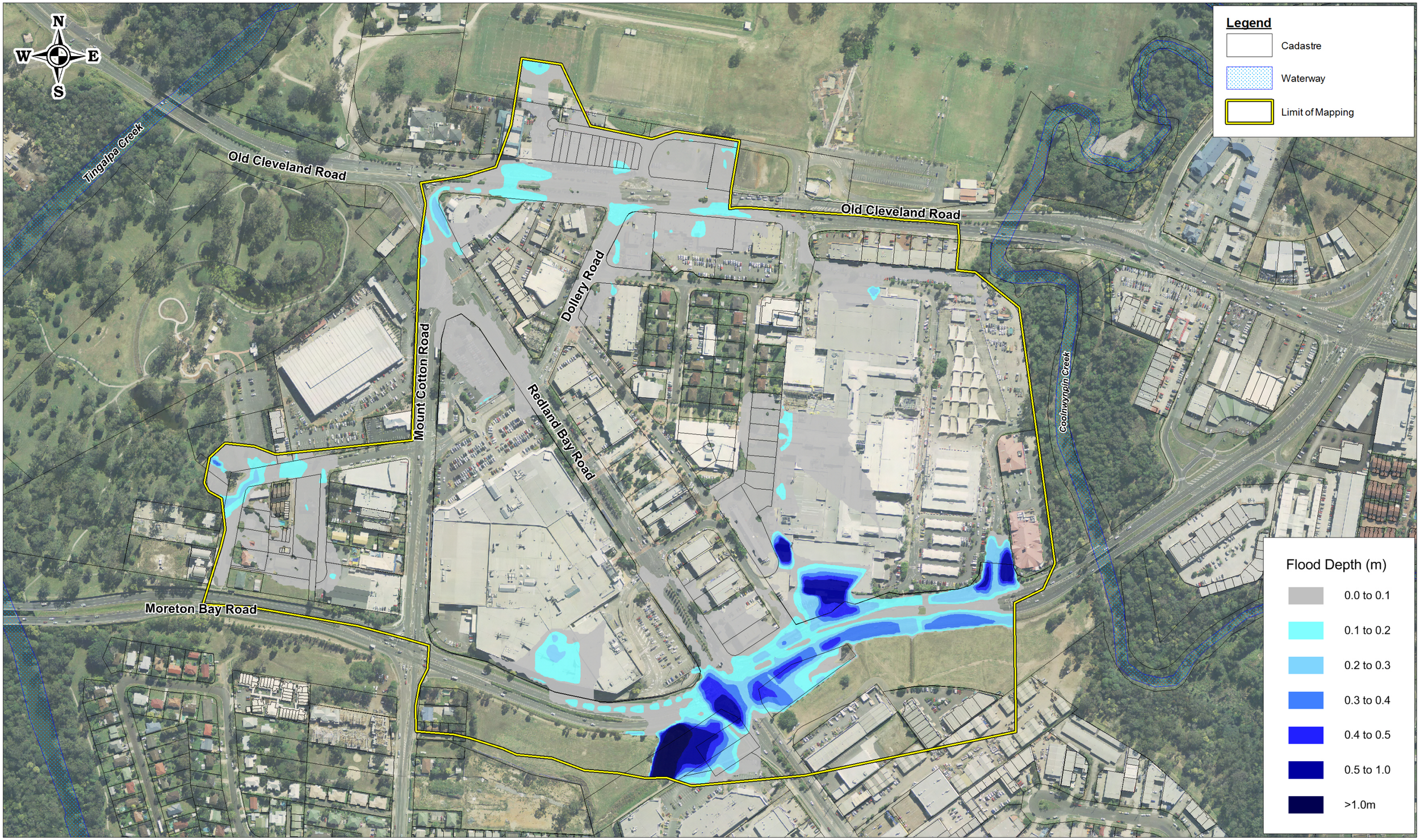
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10 Year ARI Peak Flood Depth

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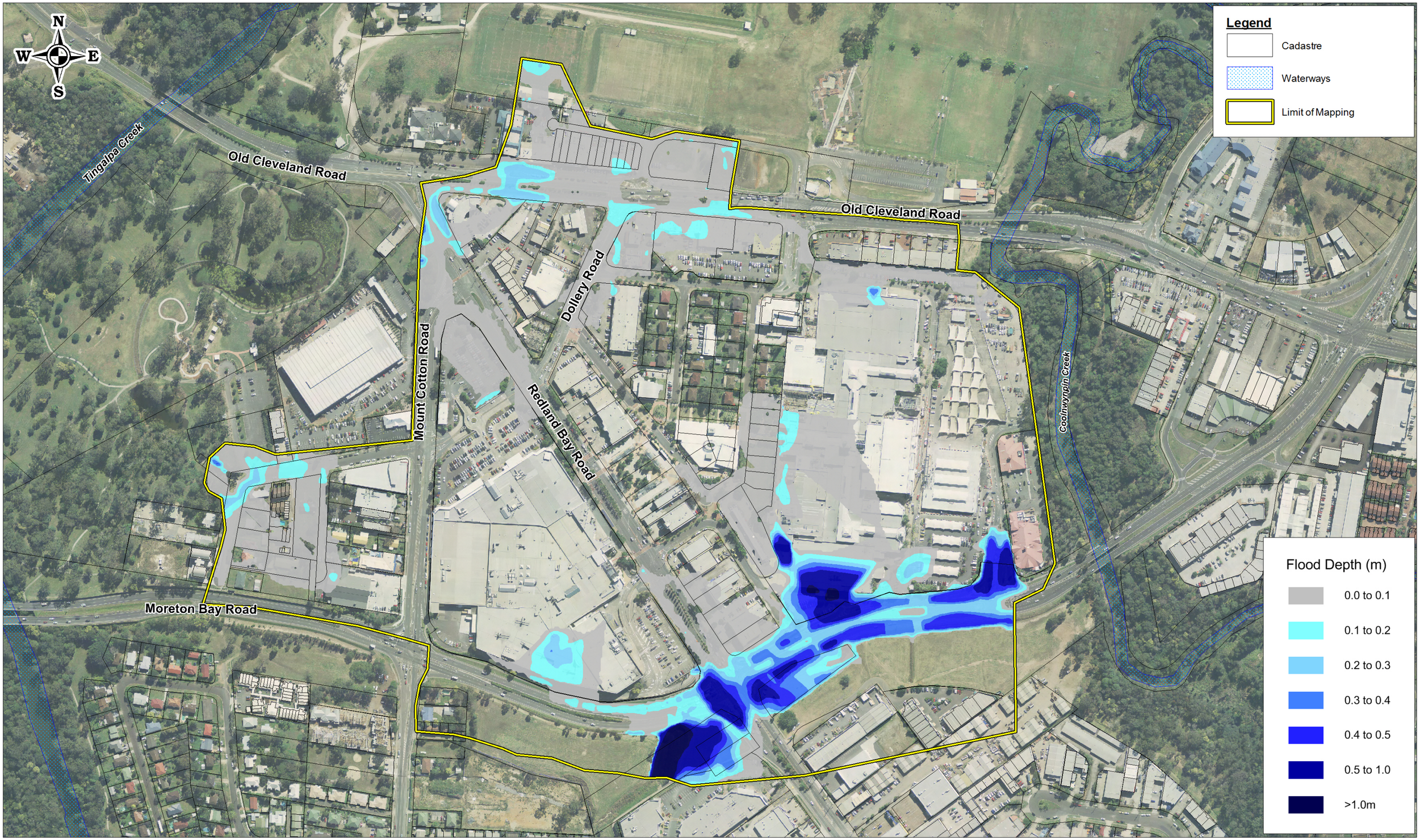
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50 Year ARI Peak Flood Depth

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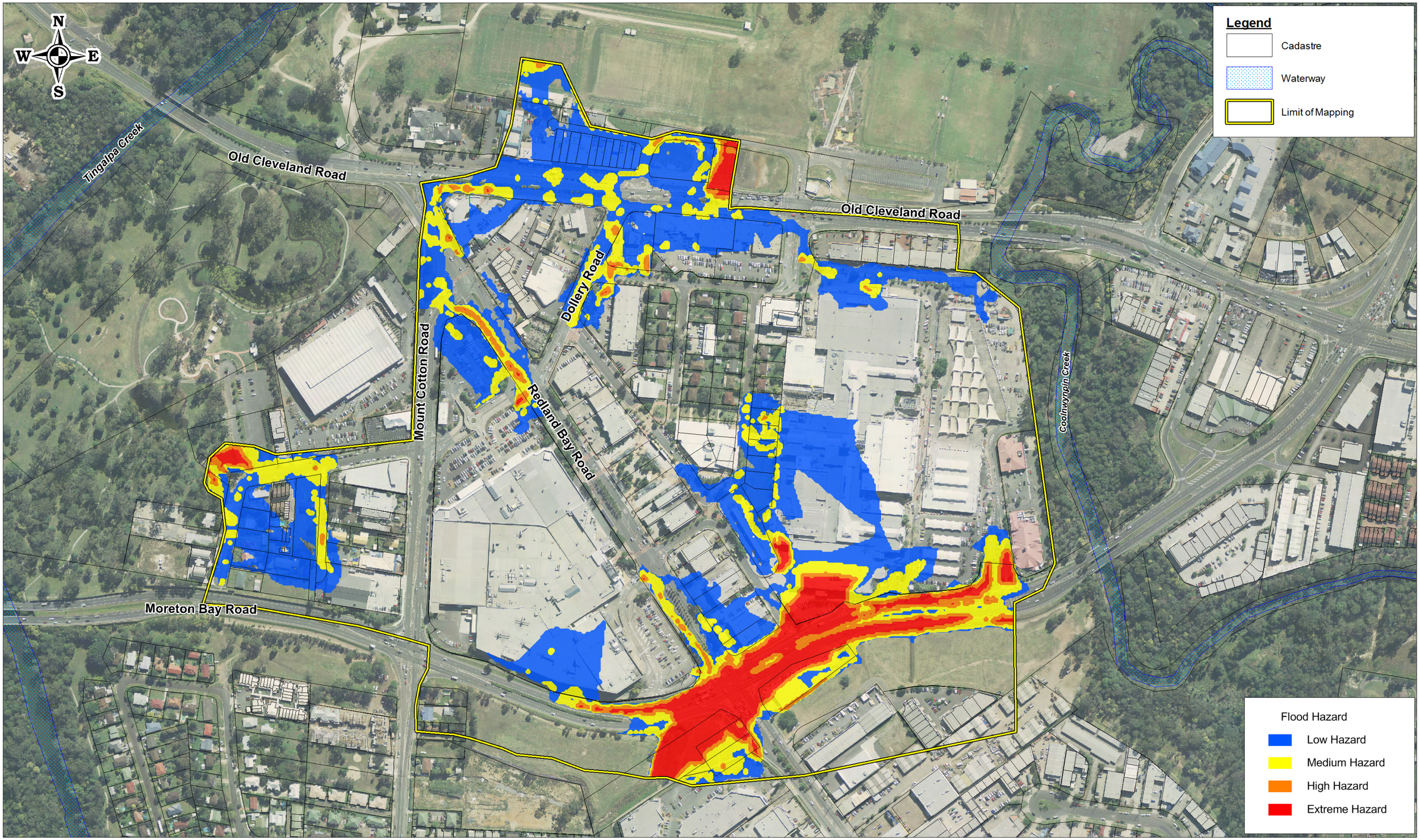
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100 Year ARI Peak Flood Depth

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100 Year ARI Peak Flood Hazard

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5. STORMWATER QUALITY ANALYSIS

5.1 MUSIC Modelling

A quantitative assessment of stormwater runoff quality has been undertaken for the ultimate land use scenario for the Tingalpa Creek Structure Plan Area. This assessment was undertaken in order to develop a required footprint for water quality treatment devices within the Tingalpa Creek Structure Plan Area.

State Planning Policy (SPP) 4/10 and Urban Stormwater Quality Planning Guidelines 2010 (DERM 2010) provide the development criteria intended to ensure development is carried out in a way that will achieve the relevant water quality objectives of the EP water policy 2009. This policy outlines best practice stormwater quality management to protect the environmental values of receiving waters.

The SPP 4/10 guidelines references the Urban Stormwater Quality Planning Guidelines 2010 (DERM, 2010) to provide details of the required management of the site. These guidelines identify pollutant load reductions for urban stormwater. Load based objectives compare loads produced by an unmitigated developed catchment to the loads coming from the developed catchment where Water Sensitive Urban Design has been implemented. It is recommended that these objectives for urbanised areas within the Lower Tingalpa Creek catchment are adopted to ensure “Best Practice” Stormwater Management Standards are achieved. The percentage removal efficiency or the “treatment train effectiveness” required to be achieved are outlined in Table 5.1.

Table 5.1 RCC Water Quality Objectives

Pollutant Type	Objective	Urban Stormwater Quality Planning Guidelines 2010
Total Suspended Solid	Reduction in average annual load of pollutants leaving the developed unmitigated scenario compared to the developed mitigated scenario	80 %
Total Phosphorous	Reduction in average annual load of pollutants leaving the developed unmitigated scenario compared to the developed mitigated scenario	60%
Total Nitrogen	Reduction in average annual load of pollutants leaving the developed unmitigated scenario compared to the developed mitigated scenario	45%
Gross Pollutant	Reduction in average annual load of pollutants leaving the developed unmitigated scenario compared to the developed mitigated scenario	90%

The MUSIC model was established for the ultimate catchment scenario. Climate data for the catchment was sourced from the Bureau of Meteorology (BOM). Rainfall data is from the Redlands BOM station (40265), and uses the 1996-2006 rainfall events with 6 minute rainfall intervals. The water quality catchment layout and land use plan is presented in Figure 5.1.

A quantitative assessment of stormwater runoff quality has been considered for the ultimate land use scenario of the Lower Tingalpa Creek catchment. The pollutant export loads from the catchment were assessed using the Cooperative Research Centre for Catchment Hydrology's (CRCCH) Model for Urban Stormwater Improvement Conceptualisation (MUSIC). MUSIC is a decision support tool, used to plan and design appropriate urban stormwater management systems at the conceptual level. MUSIC Version 5.0, released in August 2011, was used in this assessment.

In accordance with State Planning Policy 4/10 MUSIC modelling has been undertaken in accordance with the Water by Design (2009) "DRAFT MUSIC modelling Guidelines for South East Queensland", in conjunction with the Healthy Waterways "Water Sensitive Urban Design Technical Design Guidelines for South East Queensland".

The stormwater quality treatment devices incorporated into the catchment model have been setup based on the design parameters recommended by the Water by Design (2009) "DRAFT MUSIC modelling Guidelines for South East Queensland".

The MUSIC model was established for the ultimate unmitigated and ultimate mitigated scenarios. This involved the following steps:

1. Climate data for the catchment was sourced from the Bureau of Meteorology (BOM). Rainfall data is from the Redlands BOM station (40265), and uses the 1996-2006 rainfall events with six (6) minute rainfall duration.
2. Land uses for the ultimate catchment were derived from GIS information supplied by Redland City Council. Commercial was the adopted land use for the MUSIC model with an impervious percentage of 90%.
3. A treatment train was developed based on available space, existing drainage infrastructure and target pollutants reductions.

It should be noted that;

- In accordance with the water by design MUSIC modelling guidelines the natural assimilative capacity of any waterway was not represented within the MUSIC model;
- Rainwater tanks have not been included within the MUSIC model. The requirements for rainwater tanks are managed under the Queensland Development Code which is currently undergoing legislative changes.

5.2 Typical Treatment Train

Best management practices in Water Sensitive Urban Design (WSUD) techniques are proposed to be implemented throughout the Lower Tingalpa Creek Structure Plan Area. Stormwater runoff will be treated by a range of treatment devices prior to discharge to the receiving waterways. Certain techniques of WSUD target varying aspects with regard to pollutant reduction and water re-use. Examples of typical WSUD treatment measures include:

5.2.1 Gross Pollutant Traps (GPT's)

GPT's trap coarse sediment, trash and debris carried in stormwater flows. Most GPT's act by passing a design storm flow collected from the pipe networks through a screen. This screen captures gross pollutants down to a certain diameter. The GPT's are generally designed so that flows above the design event by-pass the trash screens so that re-suspension of captured material does not occur. Regardless of the type of gross pollutant trap incorporated into the treatment train. During a site visit it was noted that the majority of gully traps within the Capalaba Central shopping centre had Ecosol litter baskets or similar installed within the gully pits. GPT's have not been included in the MUSIC modelling for the catchment as it is envisaged that pre-treatment will occur via the use of trash racks or sediment forebays located immediately upstream of the treatment systems where deemed appropriate. It may be feasible to install such devices in specific areas of high litter generation (i.e. shopping centres) where alternative treatment measures are unsuitable however these areas are often isolated pockets that require specific investigation and are therefore outside the scope of this infrastructure plan.

5.2.2 Bioretention Basins

Bioretention systems act to treat stormwater by accepting stormwater flows into a shallow planted depression where water ponds above a sandy-loam filter planted filter media. This maximises the volume of runoff that passes through the filtration media. Water then percolates through the filter media at an infiltration rate of approximately 200mm an hour and out through an underdrainage system where it exits into the receiving drainage system or waterway.

The treatment system operates by firstly filtering surface flows through surface vegetation and then percolating runoff through the prescribed filtration media that provides treatment through fine filtration, extended detention and some biological uptake. They also provide flow retardation for smaller events and are particularly efficient in removing nutrients. Due to the constraints associated with the study area, street scale bioretention basins are recommended to be utilised and considered as part of streetscape planning. An example of a street scale system is provided in Plate 5.1.



Plate 5.1 Example of Street Scale Bioretention

5.2.3 Wetlands

Constructed Wetlands are designed to primarily remove stormwater pollutants, associated with fine to colloidal particles and dissolved contaminants. Because of these properties wetlands are effective in reducing loads associated with TN and TP as well as TSS. The wetland is setup with an inlet zone, which acts as a sedimentation basin to protect the macrophyte zone. The macrophyte zone is largely vegetated using wetland species and is the main process for nutrient removal. Fluctuating water levels within the wetland to mimic wetting and drying cycle is a key in their long-term health. A riser outlet is ideally designed to facilitate this characteristic. A typical layout and cross section for a constructed wetland is included in Plate 5.2.

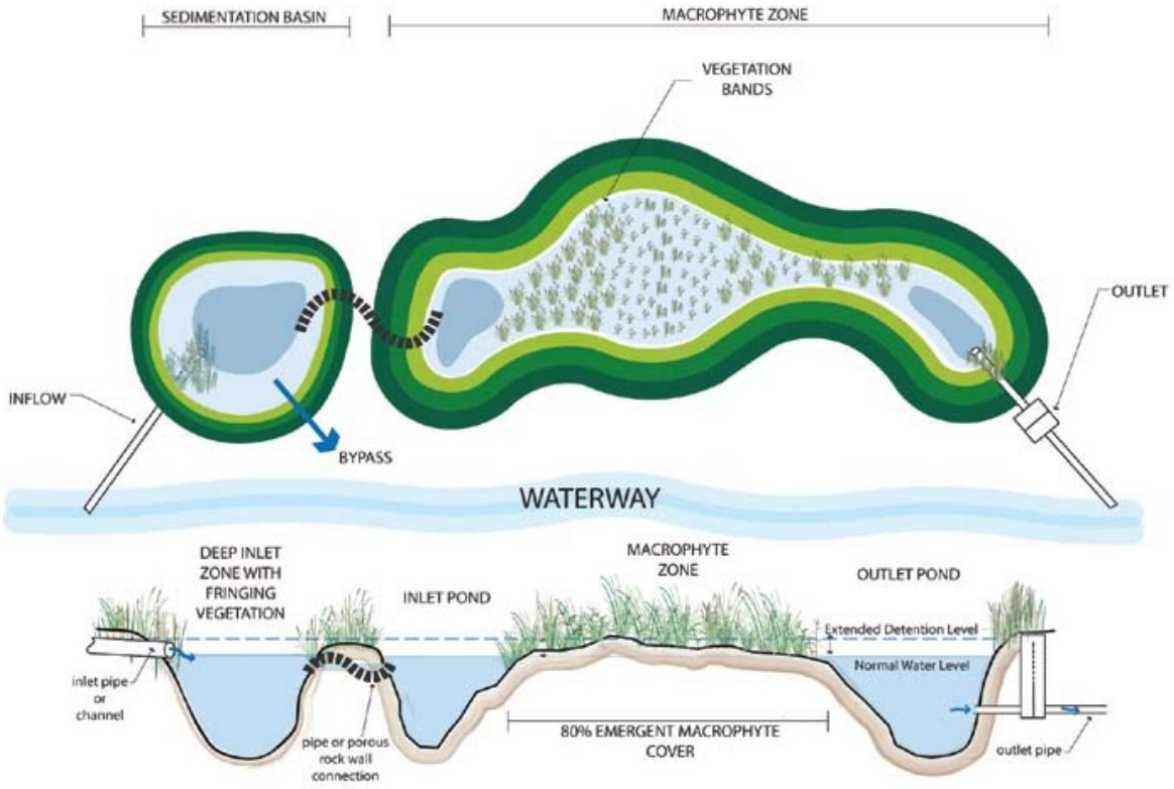


Plate 5.2 Example of a Constructed Wetland

5.2.4 Sediment Basins

Sediment basins as the name suggests are primarily aimed at the removal of sediment medium to course sediments. Sediment basins can to some degree help to reduce loads associated with TP which can be bound to particulates that settle out in the sediment basin and TN which is removed via the nitrogen cycle. Sediment basins are set up with an inlet zone, sediment collection zone, settling zone and outlet structure. Water enters the system where it is detained over a suitable period to allow target sediments to drop out into the sediment collection zone before clean water is discharged via the outlet structure. Sediment basins require desilting to maintain an effective depth for collection of sediments and to avoid suspension during large events.

5.2.5 Stormwater Quality Management Strategy

The stormwater quality management strategy considered the site specific constraints to integrate a range of water sensitive urban design features that will work in conjunction with the conventional drainage network to improve stormwater quality discharged to receiving waters. Due to a number of constraints including the flat nature of the site, storm surge and creek flooding levels, low invert levels of the trunk infrastructure in relation to creek levels and the presence of a capped landfill within the sports fields to the north incorporation of end of pipe solutions was out of the question for the majority of the site.

The parkland to the west (Capalaba Regional Park) currently incorporates a sediment basin and sparsely planted wet basin area. The area has been designed as an open water body area to improve the visual amenity of the park. Currently approximately 20% (Catchments A and B) of the total infrastructure plan catchment area flows into the open water body with over half also passing through the sediment basin upstream. It is proposed to utilise the existing area to improve water quality by desiliting the sediment basin to improve its efficiency and planting out the exiting open water body. The open water body will require some modification to its bathymetry as part of the works and it is proposed that water quality standards can be met by only planting 50% of the available space.

Catchments to the northern end of the site (Catchments C, D, J) discharge into Tingalpa Creek via two main trunk lines that pass through the former landfill which lies under John Fredrick's Park. Incorporation of water quality improvement devices within this area is made difficult for a number of reasons. The invert level of the pipes is very low which would require reduce the height of the wetland to a level that would frequently subject it to tidal flows from the creek and high velocities during flood events. This option would be further complicated by the landfill that exists at the site and space constraints along the upper bank of the waterway. Incorporation of a wetland into this area would be possible however would likely be very expensive and possibly cause maintenance issues into the future.

The remainder of the catchments are also limited by available space to incorporate end of pipe solutions. For this reason it has been decided that the best option for treatment of water from the remainder of the site is the incorporation of streetscape bioretention systems. These systems would treat stormwater off the majority of road surfaces and car parks with roof water also entering the systems where possible. Using this method stormwater would be kept at surface for as long as possible before discharging into the pipe network neglecting any issues associated with trunk pipe invert levels. The systems would be introduced as the Activities Centre is slowly upgraded with the gardens improving visual amenity whilst reducing the effects of the urban heat island. Educational signs could also be incorporated into the basins improving community awareness and acting to connect the community with the waterways.

5.3 Stormwater Quality Results

A MUSIC model was developed for the Lower Tingalpa Creek Structure Plan Area. The water quality sub-catchments have been illustrated in Figure 5.1 whilst the MUSIC model layout for the Lower Tingalpa Creek Plan Area is provided in **Figure 5.2**. Outlined in Table 5.2 is the MUSIC modelling results which demonstrate that the load based objectives for the catchment have been achieved using a number of small streetscape bioretention systems and the modification to the water body located in Capalaba Regional Park into a water treatment wetland. The details of the proposed treatment measures are outlined in Section 7.2.

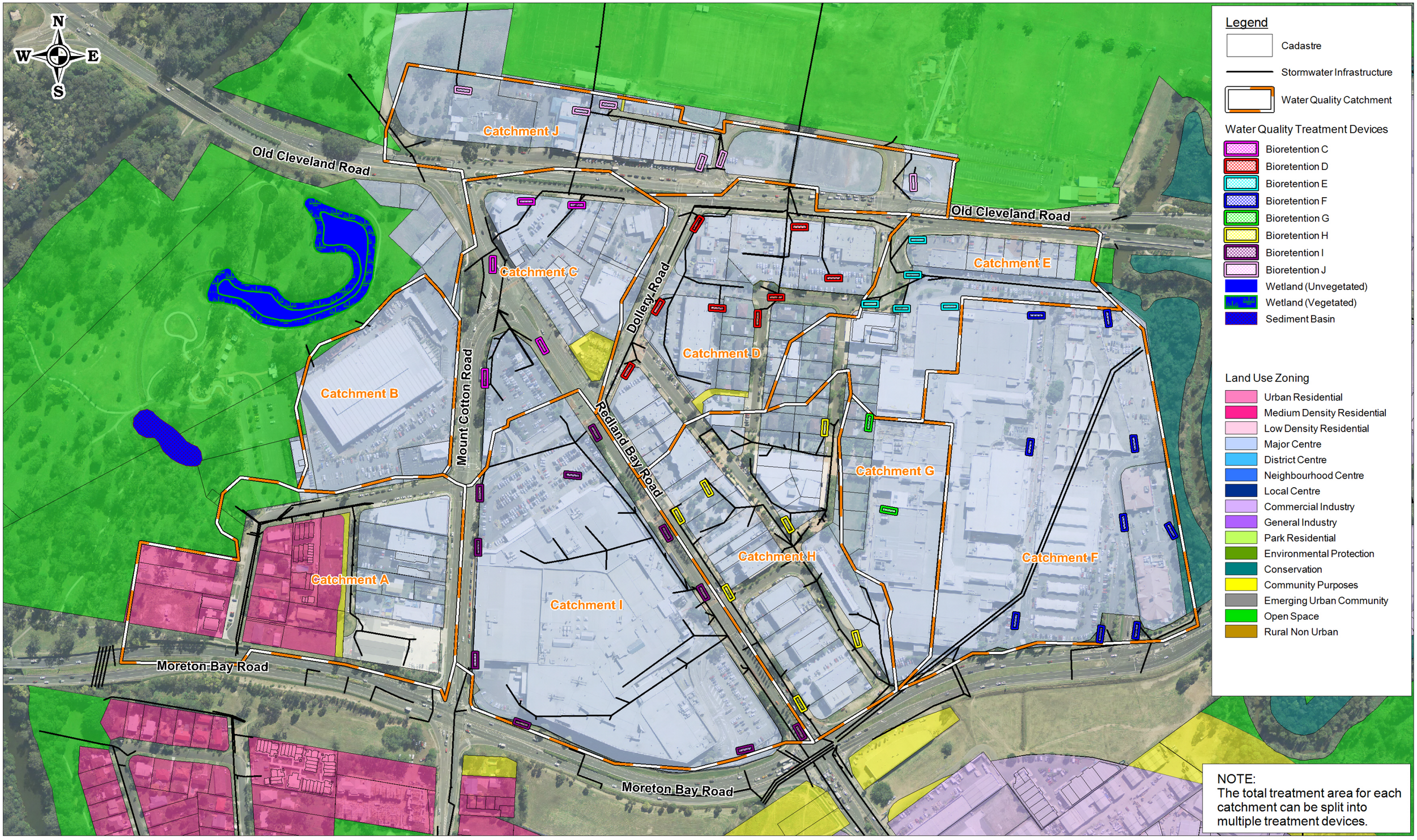
Table 5.2 MUSIC Modelling Results

Location	Pollutants	Unmitigated	Mitigated	Reduction (%)	Target	Target Achieved
Receiving Node	TSS (kg/yr)	88300.0	15600.0	82.3	80	✓
	TP (kg/yr)	228	73.7	67.7	60	✓
	TN (kg/yr)	1320	683	48.3	45	✓
	GP (kg/yr)	9810.0	0	100	90	✓
Catchment A and B	TSS (kg/yr)	17400	1880	89	80	✓
	TP (kg/yr)	43.9	8.59	80	60	✓
	TN (kg/yr)	251	135	46	45	✓
	GP (kg/yr)	1870	0	100	90	✓
Catchment C	TSS (kg/yr)	8840.0	1760	80.1	80	✓
	TP (kg/yr)	23.4	8.24	64.7	60	✓
	TN (kg/yr)	134	69.7	47.8	45	✓
	GP (kg/yr)	1000	0	100	90	✓
Catchment D	TSS (kg/yr)	10300.0	1600	84.5	80	✓
	TP (kg/yr)	26.9	8.75	67.5	60	✓
	TN (kg/yr)	151	71.9	52.4	45	✓
	GP (kg/yr)	1150	0	100	90	✓
Catchment E	TSS (kg/yr)	9870	1910	80.6	80	✓
	TP (kg/yr)	25.4	8.8	65.3	60	✓
	TN (kg/yr)	146	76.2	47.8	45	✓
	GP (kg/yr)	1090	0	100	90	✓
Catchment F	TSS (kg/yr)	15700	3160	80	80	✓
	TP (kg/yr)	42.2	1550	63.3	60	✓
	TN (kg/yr)	244	131	46.2	45	✓
	GP (kg/yr)	1820	0	100	90	✓
Catchment G	TSS (kg/yr)	4270	752	82	80	✓

Location	Pollutants	Unmitigated	Mitigated	Reduction (%)	Target	Target Achieved
	TP (kg/yr)	11.3	386	66	60	✓
	TN (kg/yr)	65	32.8	49	45	✓
	GP (kg/yr)	485	0	100	90	✓
Catchment H	TSS (kg/yr)	10400	2030	80.4	80	✓
	TP (kg/yr)	27.3	9.6	64.8	60	✓
	TN (kg/yr)	155	80.1	48.2	45	✓
	GP (kg/yr)	1160	0	100	90	✓
Catchment I	TSS (kg/yr)	17300	3380	80.4	80	✓
	TP (kg/yr)	43.1	15.2	64.7	60	✓
	TN (kg/yr)	254	132	47.8	45	✓
	GP (kg/yr)	1890	0	100	90	✓
Catchment J	TSS (kg/yr)	8890	1740	80	80	✓
	TP (kg/yr)	23	8	65	60	✓
	TN (kg/yr)	139	72.2	48	45	✓
	GP (kg/yr)	1010	0	100	90	✓

In recommending appropriate treatment devices for this catchment, an assessment was undertaken considering the individual site constraints for each sub-catchment. Wetlands require a larger area per hectare of developable land and are therefore generally placed where the topography is flatter and there are limitations in grade for bioretention systems. In this particular case the existing topography tended towards incorporation of a wetland into the open water body located in Capalaba Regional Park. This was the most cost effective method that provided multiple benefits including increased visual amenity, improvement in habitat value and Educational purposes.

Bioretention basins are generally located where the land is more constrained or where achieving an effective outlet is possible due to an increasing grade over the treatment area. Due to constraints associated with flood levels, pipe inverts and the landfill to the north available area for an end of pipe solution was limited. For this reason the remainder of the catchment incorporates a number of streetscape bioretention systems. Using this option does increases the number of treatment systems however it is considered to be more cost effective when compared with the alternative option of installing a wetland system along the banks of Tingalpa Creek. A stormwater quality infrastructure conceptual plan for the Tingalpa Creek Structure Plan Area has been shown in Figure 5.1. It is noted that the total bioretention treatment area for each sub-catchment has be divided into a number of minor treatment areas to allow for integration into the streetscape and achieve treatment prior to flows entering the drainage system.



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ENGENY WATER MANAGEMENT

Redland CITY COUNCIL

0 70 150

Scale in Meters (1:3,500 @ A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

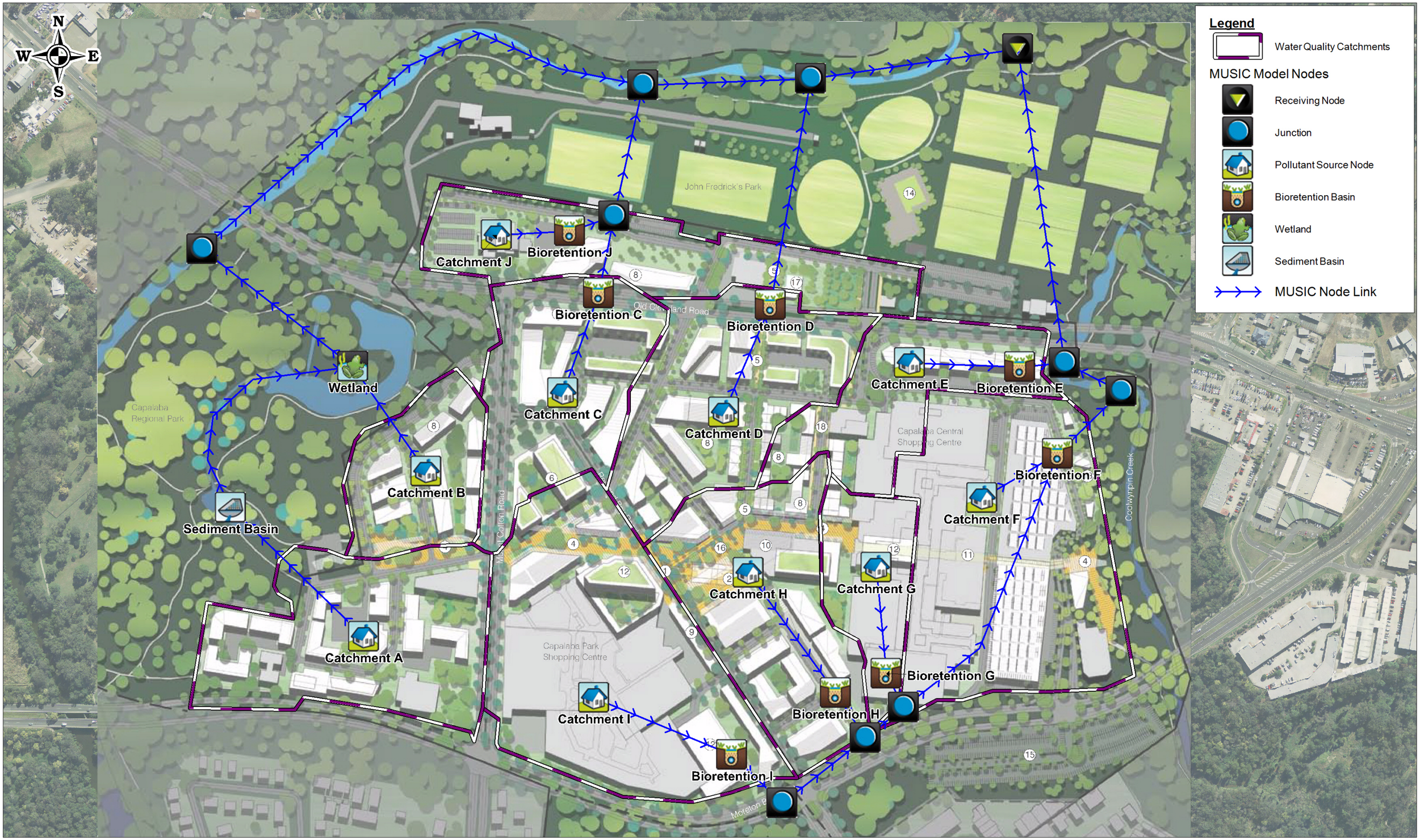
Lower Tingalpa Creek Stormwater Infrastructure Plan

Figure 5.1

Stormwater Quality Infrastructure Conceptual Plan for Ultimate Land Use

Job Number: M8000_015
Revision: A
Drawn: JNA
Date: 17 Apr 2013

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Scale in Meters (1:4,000 @ A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Lower Tingalpa Creek Stormwater Infrastructure Plan

MUSIC Model Layout

Figure 5.2

Job Number: M8000_015
Revision: A
Drawn: JNA
Date: 17 Apr 2013

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6. PROPOSED TRUNK STORMWATER INFRASTRUCTURE

6.1 Stormwater Quantity Infrastructure Requirements

Following the presentation and discussion of the existing case hydraulic modelling results with Council, it was advised by Council that stormwater drainage augmentation or mitigation works were not required for the Capalaba Activity Centre given that the impervious area was unlikely to increase and that the stormwater drainage system was originally designed for ultimate catchment conditions. In addition, it is understood that Council are not aware of any major flooding issues within the study area. Based on this direction from Council, the existing stormwater quantity infrastructure is considered to be adequate to service the future Capalaba Activity Centre and therefore the no stormwater quantity infrastructure plan has been developed for this study.

6.2 Stormwater Quality Trunk Infrastructure Requirements

As seen in Figure 5.1, the stormwater quality treatment train includes eight (8) Biorentention Basins, one (1) Wetland and one (1) Sediment Basin. Table 6.1 outlines the details of the stormwater quality treatment infrastructure.

Table 6.1 Details of Stormwater Quality Treatment Infrastructure

Catchment	Treatment Device	Filter Area(m^2)	Surface Area(m^2)	Filter Depth(m)	Extended Depth(m)
Catchment A	Wetland A	NA	2500	NA	0.5
Catchment A	Sediment Basin	NA	1200	NA	0.5
Catchment B	Wetland A	NA	2500	NA	0.5
Catchment C	Bioretention	420	560	0.5	0.3
Catchment D	Bioretention	595	790	0.5	0.3
Catchment E	Bioretention	460	610	0.5	0.3
Catchment F	Bioretention	620	950	0.5	0.3
Catchment G	Bioretention	225	300	0.5	0.3
Catchment H	Bioretention	490	650	0.5	0.3
Catchment I	Bioretention	800	1060	0.5	0.3
Catchment J	Bioretention	440	570	0.5	0.3

The various treatment measures and locations that have been considered are discussed below.

6.2.1 Consideration of Treatment Options and Locations

The selection of treatment devices and locations was undertaken based on the Redland City Planning Scheme and Capalaba Activities Centre Master plan as well as

the requirements of various Council stakeholders including Infrastructure Planning, Environmental Management, Development & Community Standards, etc. In all cases, it has been considered to minimize disturbance to the natural environment, minimise both construction and maintenance costs and add to the feel of the areas they could be incorporated into. It is also intended to maximize the amount of available land for community uses and as such all bioretention basins have been positioned within areas that will likely be designated for green open space. All the treatment devices have been placed with consideration of site access for construction and maintenance.

7. CONSTRUCTION COST ESTIMATES

7.1 Stormwater Quality

Construction cost estimation for the bioretention basins, wetland and sediment basin was obtained from the life cycle costing module of the MUSIC model. It should be noted that the connection from the outlet of each catchment to the bioretention basins has not been included in the cost estimation as this should be undertaken at the detailed design stage. It should also be noted that cost estimation is based on upper acquisition cost as calculated in MUSIC Version 5. The total acquisition cost does not include land acquisition, annual maintenance, annual renewal, annual establishment or decommissioning costs.

The summary of the stormwater quality infrastructure acquisition costs (excluding land acquisition) is outlined in Table 7.1 and illustrated in Appendix A.

Table 7.1 Stormwater Quality Infrastructure Cost Estimate

Treatment Device	Total Acquisition Cost ($)
Bioretention C	$117,578
Bioretention D	$149,489
Bioretention E	$125,010
Bioretention F	$166,328
Bioretention G	$79,116
Bioretention H	$130,522
Bioretention I	$185,565
Bioretention J	$121,307
Wetland	$545,798
Sediment Basin	$176,273
Total Cost	$ 1 796 986

8. CONCLUSIONS/RECOMMENDATIONS

This study has been prepared for the purposes of quantifying stormwater quantity and quality infrastructure requirements for the development of the Capalaba Activity Centre. The study has included a comprehensive assessment of both stormwater flooding and water quality under a range of scenarios to assist in determining infrastructure requirements to appropriately manage and address any impacts resulting from the planned development works.

The study has quantified stormwater infrastructure requirements relating to water quality measures for the catchment and has satisfied Redland City Council that the existing stormwater drainage infrastructure is adequate for servicing the ultimate land use and therefore the no stormwater quantity infrastructure plan has been developed for this study.

The stormwater quality measures have been defined in order to ensure that the proposed development can be undertaken without resulting in adverse stormwater management outcomes and to address Council's Codes and Policies relating to stormwater quality for the development.

The hydraulic assessment has shown that the majority of stormwater flows are either conveyed via the subsurface drainage system or contained within the road reserve and overland flow paths. The results for the 100 year ARI event shows that majority of overland flow for the south eastern portion of the catchment is conveyed via Moreton Bay Road to Coolnwynpin Creek. Minor inundation is predicted to occur over some properties located along Rickey Street, Old Cleveland Road and Pittwin Road North, however flood depths for the 100 year ARI event are shown to be generally less than 200 mm and are therefore not of major concern. Greater flood depths are observed within the local Capalaba Central road at the intersection with Moreton Bay Road where water is shown to pond to depths of up to 1 m in the 100 year ARI.

The 100 year ARI flood hazard map as presented in Figure 4.8 indicates that the majority of the study area has a low flood hazard; however Moreton Bay Road is shown to have a high to extreme flood hazard due to the depth and velocity within the road. It is therefore recommended that these risks be considered and managed by Council.

The proposed stormwater quality infrastructure requirements including cost estimates are presented in this report. The construction cost estimates represent budget cost allocations based upon conceptual infrastructure sizing and should be updated as part of the future detailed design of the infrastructure works.

It should be noted that the total acquisition costs have been determined within the MUSIC model and does not include land acquisition, annual maintenance, annual renewal, annual establishment or decommissioning costs. The estimated stormwater quality infrastructure costs are presented in the table overleaf.

Table 8.1 Stormwater Quality Infrastructure Costs

Treatment Device	Total Acquisition Cost ($)
Bioretention C	$117,578
Bioretention D	$149,489
Bioretention E	$125,010
Bioretention F	$166,328
Bioretention G	$79,116
Bioretention H	$130,522
Bioretention I	$185,565
Bioretention J	$121,307
Wetland	$545,798
Sediment Basin	$176,273
Total Cost	$ 1 796 986

The selection and location of treatment options was undertaken with the intention to minimize disturbance to the natural environment, minimise both construction and maintenance costs and add to the feel of the areas they could be incorporated into. It is also intended to maximize the amount of available land for community uses and as such all bioretention basins have been positioned within areas that will likely be designated for green open space. All the treatment devices have been placed with consideration of site access for construction and maintenance.

It is recommended that the locations and types of treatment devices are reviewed when additional planning is undertaken for the proposed Capalaba Activity Centre. It is also recommended that further investigations be conducted into the potential flood risks to Moreton Bay Road and associated mitigation measures given that this is a major and highly used road.

9. QUALIFICATIONS

a. In preparing this document, including all relevant calculation and modelling, Engeny Management Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b. Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

c. Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

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   (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

d. Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents and representatives of Engeny to the same extent that they apply for the benefit of Engeny.

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APPENDIX A

MUSIC Model Cost Estimation Screenshots

Bioretention C - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$53,453	Real Discount Rate (%)	5.50
Acquisition Cost	$117,578	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$12,062	Decommissioning Cost	$54,844	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Bioretention C ($2013)	$364,423
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$7,288
Equivalent Annual Payment per m3/s maximum flow reduction	invalid
Equivalent Annual Payment/ML flow reduction/annum	$7,495.92
Equivalent Annual Payment/kg Total Suspended Solids/annum	$1.04
Equivalent Annual Payment/kg Total Phosphorus/annum	$465.69
Equivalent Annual Payment/kg Total Nitrogen/annum	$112.55
Equivalent Annual Payment/kg Gross Pollutant/annum	$7.27

Close

Bioretention F - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$75,615	Real Discount Rate (%)	5.50
Acquisition Cost	$166,328	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$14,427	Decommissioning Cost	$77,583	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Bioretention F ($2013)	$471,071
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$9,421
Equivalent Annual Payment per m3/s maximum flow reduction	$18,138.00
Equivalent Annual Payment/ML flow reduction/annum	$5,885.96
Equivalent Annual Payment/kg Total Suspended Solids/annum	$0.73
Equivalent Annual Payment/kg Total Phosphorus/annum	$345.31
Equivalent Annual Payment/kg Total Nitrogen/annum	$83.82
Equivalent Annual Payment/kg Gross Pollutant/annum	$5.17

Close

Bioretention G - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$35,967	Real Discount Rate (%)	5.50
Acquisition Cost	$79,116	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$9,966	Decommissioning Cost	$36,903	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Bioretention G ($2013)	$276,411
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$5,528
Equivalent Annual Payment per m3/s maximum flow reduction	invalid
Equivalent Annual Payment/ML flow reduction/annum	$10,634.71
Equivalent Annual Payment/kg Total Suspended Solids/annum	$1.56
Equivalent Annual Payment/kg Total Phosphorus/annum	$745.36
Equivalent Annual Payment/kg Total Nitrogen/annum	$172.09
Equivalent Annual Payment/kg Gross Pollutant/annum	$11.40

Close

Bioretention H - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$59,337	Real Discount Rate (%)	5.50
Acquisition Cost	$130,522	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$12,717	Decommissioning Cost	$60,881	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Bioretention H ($2013)	$393,205
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$7,864
Equivalent Annual Payment per m3/s maximum flow reduction	$94,930.02
Equivalent Annual Payment/ML flow reduction/annum	$6,933.73
Equivalent Annual Payment/kg Total Suspended Solids/annum	$0.95
Equivalent Annual Payment/kg Total Phosphorus/annum	$450.50
Equivalent Annual Payment/kg Total Nitrogen/annum	$104.27
Equivalent Annual Payment/kg Gross Pollutant/annum	$6.77

Close

Bioretention I - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$84,360	Real Discount Rate (%)	5.50
Acquisition Cost	$185,565	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$15,291	Decommissioning Cost	$86,556	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Bioretention I ($2013)	$511,996
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$10,240
Equivalent Annual Payment per m3/s maximum flow reduction	$13,646.72
Equivalent Annual Payment/ML flow reduction/annum	$5,530.56
Equivalent Annual Payment/kg Total Suspended Solids/annum	$0.74
Equivalent Annual Payment/kg Total Phosphorus/annum	$366.15
Equivalent Annual Payment/kg Total Nitrogen/annum	$84.86
Equivalent Annual Payment/kg Gross Pollutant/annum	$5.43

Close

Sedimentation Basin - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$108,291	Real Discount Rate (%)	5.50
Acquisition Cost	$176,273	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$10,625	Decommissioning Cost	$81,231	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Sedimentation Basin ($2013)	$441,307
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$8,826
Equivalent Annual Payment per m3/s maximum flow reduction	$5,844.59
Equivalent Annual Payment/ML flow reduction/annum	$6,580.41
Equivalent Annual Payment/kg Total Suspended Solids/annum	$1.06
Equivalent Annual Payment/kg Total Phosphorus/annum	$499.83
Equivalent Annual Payment/kg Total Nitrogen/annum	$257.38
Equivalent Annual Payment/kg Gross Pollutant/annum	$6.95

Close

Wetland - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	80	Renewal/Adaptation Cost	$293,525	Real Discount Rate (%)	5.50
Acquisition Cost	$545,798	Renewal Period (yrs)	20	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$23,285	Decommissioning Cost	$422,220	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Wetland ($2013)	$1,116,031
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$13,950
Equivalent Annual Payment per m3/s maximum flow reduction	$14,748.68
Equivalent Annual Payment/ML flow reduction/annum	$1,607.47
Equivalent Annual Payment/kg Total Suspended Solids/annum	$2.10
Equivalent Annual Payment/kg Total Phosphorus/annum	$783.85
Equivalent Annual Payment/kg Total Nitrogen/annum	$169.44
Equivalent Annual Payment/kg Gross Pollutant/annum	$23.15

Close

Bioretention D - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$67,960	Real Discount Rate (%)	5.50
Acquisition Cost	$149,489	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$13,640	Decommissioning Cost	$69,728	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Bioretention D ($2013)	$434,749
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$8,695
Equivalent Annual Payment per m3/s maximum flow reduction	$26,026.34
Equivalent Annual Payment/ML flow reduction/annum	$6,340.13
Equivalent Annual Payment/kg Total Suspended Solids/annum	$1.00
Equivalent Annual Payment/kg Total Phosphorus/annum	$477.44
Equivalent Annual Payment/kg Total Nitrogen/annum	$105.90
Equivalent Annual Payment/kg Gross Pollutant/annum	$7.59

Close

Bioretention E - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$56,831	Real Discount Rate (%)	5.50
Acquisition Cost	$125,010	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$12,441	Decommissioning Cost	$58,310	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Bioretention E ($2013)	$380,994
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$7,620
Equivalent Annual Payment per m3/s maximum flow reduction	$201,181.64
Equivalent Annual Payment/ML flow reduction/annum	$7,157.21
Equivalent Annual Payment/kg Total Suspended Solids/annum	$0.96
Equivalent Annual Payment/kg Total Phosphorus/annum	$459.73
Equivalent Annual Payment/kg Total Nitrogen/annum	$109.55
Equivalent Annual Payment/kg Gross Pollutant/annum	$7.02

Close