PLANS AND DOCUMENTS referred to in the ULDA APPROVAL dated 16/10/2012

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STORMWATER MANAGEMENT PLAN ANDERGROVE, MACKAY

Urban Land Development Authority
04 August 2010

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For and on behalf of
WRM Water & Environment Pty Ltd

David Newton
Director

0678-01-C
4 August 2010

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1 INTRODUCTION

WRM Water & Environment has been commissioned by the Urban Land Development Authority (ULDA) to prepare a Stormwater Management Plan (SMP) for a proposed residential development on Bedford Road, Andergrove (the subject site). The development is proposed to be developed in seven stages.

This report provides methodology and results of investigations undertaken to develop concept designs of the proposed stormwater quantity and quality management measures for the ultimate developed masterplan.

The objective of this SMP is to ensure that the quality of stormwater runoff from the developed site meets Council's water quality objectives. In addition, there will be no increase in peak discharge flow rates from the development site to ensure that flooding of downstream property is not adversely impacted.

2 SITE CHARACTERISTICS

2.1 LOCATION

The subject site is located in Andergrove, which is in Mackay Regional Council's Local Government Area, 6km north of Mackay's CBD.

The subject site is bounded by Bedford Road to the east, Newton Street to the south, Emperor Drive to the north and Broomdykes Drive to the west. Access from the site is from Bedford Road.

A map extract has been included as Figure 2.1 to identify the location of the subject site.

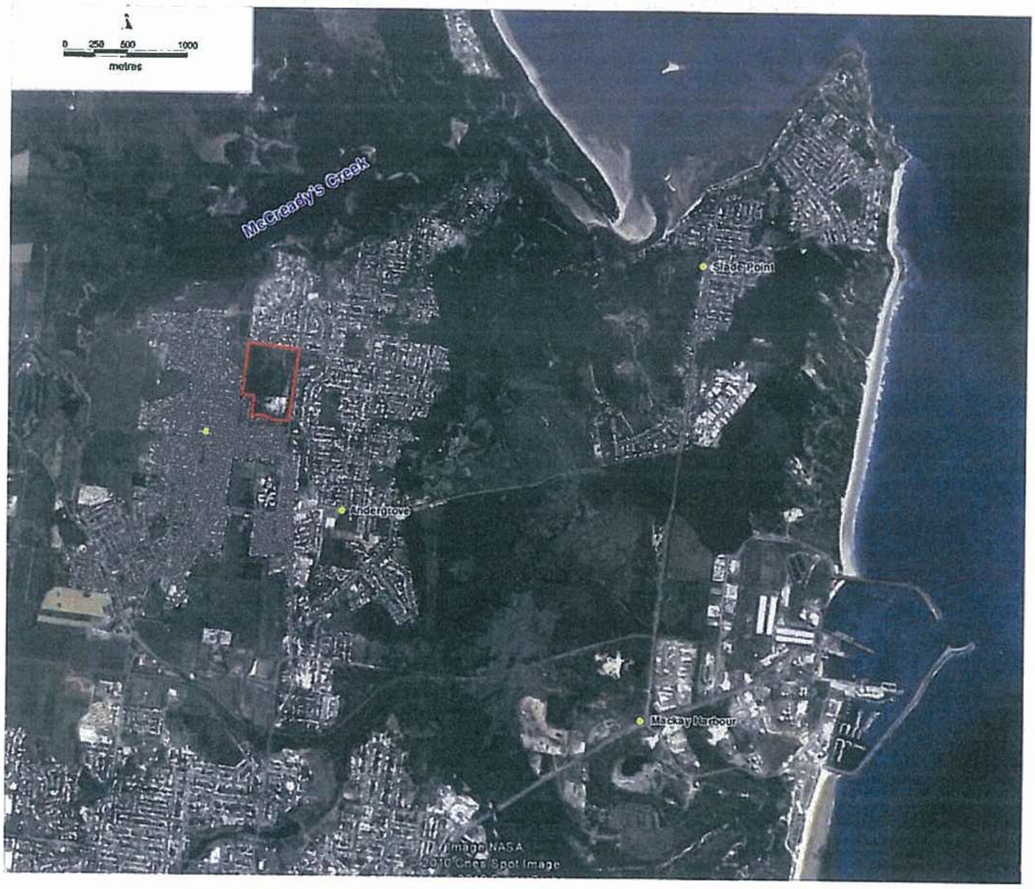

Figure 2.1 Locality Plan (Source: Google Earth)

2.2 EXISTING CATCHMENT CONDITIONS

Figure 2.2 shows the existing drainage features of the subject site. The majority of the development site consists of open space. The site also includes the Council's depot facilities. Runoff currently drains to two points of discharge;

- Site Discharge Point 1 (SDP1) – Bedford Road (900X600mm box culvert)
- Site Discharge Point 2 (SDP2) – Western boundary (600x300mm box culvert)

A description of each sub catchment is given below and the catchment areas are shown in Table 2.1:

- Subcatchment A is located in the south-eastern corner of the development site and comprises buildings and hard stand areas of the Council depot. This catchment currently drains into sub catchment B.
- Subcatchment B is located along the north-eastern boundary and comprises car parks, hard stand areas of the depot site and grassed farm land. There is a drainage channel through the farm land which drains overland flow to a box culvert (900X600mm) under Bedford Road (SDP1).
- Subcatchment C is in the south-western corner, which comprises dense significant vegetation and a portion of the Council's depot hard standing area. A drainage channel conveys flow from residential lots south of Newton Street through to Sub catchment D.
- Subcatchment D covers the north-western corner of the site and comprises dense significant vegetation and cleared farmland. There is a natural depression in the north-western corner, which ponds water before draining via a small box culvert (600 x300mm) located under a pathway along the western boundary (SDP2) to an existing lake near Caledonian Drive.
- External catchment 1 comprises of urban residential to the south of Newton Street. Runoff from this area drains into the site via a 900mm pipe culvert without treatment.

Table 2.1 Catchment Areas

Sub catchment	Existing (ha)	Proposed (ha)
A	2.24	3.5
B	5.39	4.01
C	3.18	2.17
D1	11.27	7.8
D2	-	2.64
D3	-	1.96
Ext 1	9.97	9.97
Total	32.05	32.05
Contributing area to:		
SDP1	7.63	4.01
SDP2	24.42	28.04

2.3 PROPOSED CATCHMENT CONDITIONS

Figure 2.3 shows the proposed development site configuration and the proposed stormwater management measures. The catchments have been delineated based on the development layout. A description of the proposed development site and drainage characteristics of the various sub catchments is given below and the catchment areas are shown in Table 2.1:

- Subcatchment A will be developed into urban residential and all runoff will be redirected into a wetland in subcatchment C.
- Subcatchment B has been reduced by earthworks to modify the catchment boundaries which will minimise the runoff draining to Bedford Road (SDP1). Runoff from the allotments will drain to bio-filtration pods that will be built into the landscape before exiting the site under Bedford Road.
- Subcatchment C will be partially developed into urban residential, however most of the area will be occupied by the proposed wetland. The residential area and wetland will be designed not to disturb the existing significant vegetation.
- The External catchment 1 will remain urban residential. The runoff currently discharges into the dense significant vegetation on site without treatment. The proposed wetland will provide stormwater quality treatment to this runoff from the external catchment.
- Subcatchment D has been split into three catchments;
    - Subcatchment D1 will remain as dense significant vegetation;
    - Subcatchment D2 will be developed into urban residential and all runoff will drain to a bio-filtration basin and ultimately to SDP2. This catchment includes additional catchment area from existing Subcatchment B.
    - Subcatchment D3 will be developed into urban residential and all runoff will drain to a wetland and ultimately to SDP2. This catchment includes additional catchment area from existing Subcatchment B.

2.4 MASTERPLAN OF DEVELOPMENT

Mackay Regional Council have proposed a regional wetland system south of Caledonian Drive. The western subcatchments of the development will drain to this wetland before entering McCreadys Creek. Council have agreed that this wetland system can be incorporated into the treatment train for runoff discharging to the west. However they cannot confirm the construction date of this system, so to avoid delay to this development, onsite treatment has been proposed. The following stormwater management measures will be included into the overall masterplan;

Stormwater Quality Measures

- All developed runoff discharging east to Bedford Road will be treated via a series of bio-filtration pods (B1). This bio-filtration system will be constructed in Stage 1.
- All developed runoff from Stage 1 and 2 flowing west will be directed to a bio filtration basin (B2) located on the western boundary of Stage 1. This basin has been sized to account for future development west of Stage 2.
- A vegetated buffer will constructed along the road running north-south along the western boundary of Stage 1 and 2, to deliver part of the road runoff to Basin B2. This bio-filtration system will be constructed in Stage 1.
- A wetland (W1) is proposed in the south end of the development, to treat all runoff from Stages 3, 4 5, 6 and 7.
- Currently runoff from the existing residential area along Newton Street (External catchment 1) flows into the significant vegetation area on site without treatment.
- The wetland is proposed to also treat the runoff from this external residential area, in order provide greater protection to the significant vegetation on site. This goes above and beyond the standard requirements for the proposed development.
- A vegetated buffer will be constructed along the road fronting the significant vegetation area, running north-south along the western boundary of Stages 3, 4 and 5 allow part of the road runoff to drain to a vegetated buffer and deliver them to the wetland (W1). The remaining runoff will be directed to the wetland via pipes and surcharge flow paths.

Stormwater Quantity Measures

- Onsite detention is not required at SDP1, as the proposed catchment areas have decreased, therefore conveying less flow to the east and maintaining the existing flow rates.
- The wetland in the south will sit within the base of a detention basin to provide the onsite detention requirements for all runoff discharging west (SDP2).
- This wetland/detention basin is proposed to be constructed in Stage 3.

Stage 1 will be cut and filled to form up to 35 allotments ranging in size from 245m^2 to 495 m^2. The following proposed stormwater management measures will be included in Stage 1 only;

- A number of bio-filtration pods (B1) will be designed into the landscape along the entry road of Stage 1 and the upgraded road reserve of Bedford Road.
- The proposed earthworks for Stage 1 has decreased the runoff draining to the east, so that on-site detention is not required to ensure that the existing flow rates are maintained at Bedford Road.

Figure 2.2 Existing Catchment Characteristics

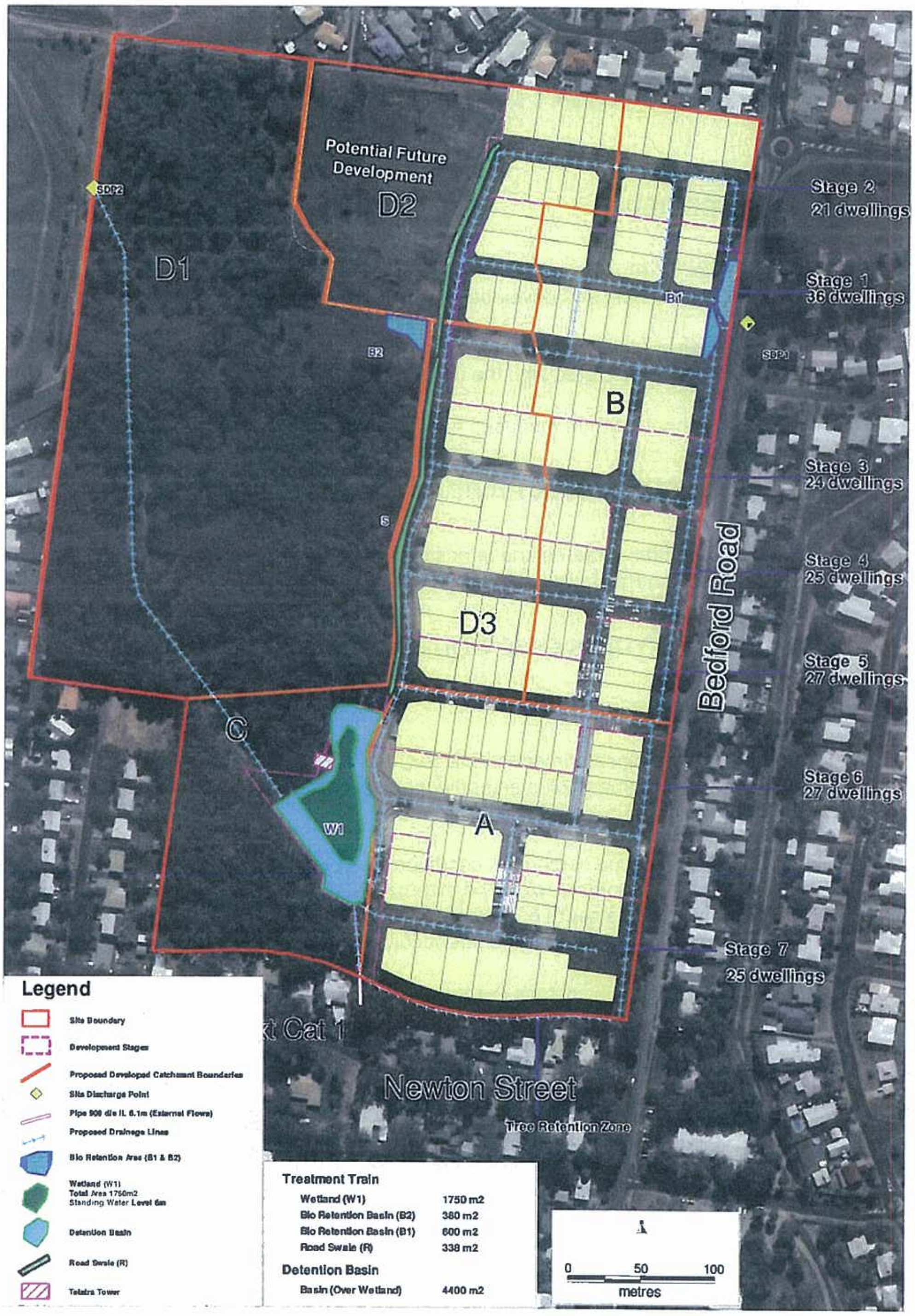

Figure 2.3 Proposed Developed Conditions and Stormwater Management Measures

3 ESTIMATION OF DISCHARGES

3.1 OVERVIEW

The 'RAFTS' runoff-routing model (XP Software, 2001) was used to estimate design discharges from the existing and developed site and to design the proposed detention basin on site.

Separate models were developed for existing and developed conditions to reflect the changes in catchment associated with the development.

The Rational Method was used to calibrate discharges estimated by the RAFTS model.

3.2 ADOPTED DESIGN RAINFALLS

Design rainfall patterns and intensities for the area were determined using standard procedures in Australian Rainfall and Runoff (IEAust, 1998).

3.3 RAFTS HYDROLOGIC MODEL

3.3.1 Configuration

For the existing catchment conditions, four subcatchments have been used to represent runoff from the catchment, plus an additional sub catchment to represent runoff from the external catchment to the south of Newton Street.

For the developed catchment conditions, six subcatchments have been used to represent runoff from the development, plus one external catchment to represent runoff from the external catchment to the south of Newton Street. Figure 3.1 shows the configuration of the RAFTS model for the developed catchment conditions.

3.3.2 Existing Conditions Parameters

Table 3.1 shows the RAFTS parameters adopted for the pre-developed catchment.

Table 3.1 RAFTS Model Parameters, Existing Conditions

Sub catchment	Catchment Area (ha)	Catchment Slope (%)	Percentage Impervious (%)	Mannings 'n'
A	2.24	0.5	80	0.04
B	5.39	0.5	12	0.04
C	3.18	1.1	22	0.04
D	11.27	0.5	0	0.06
Ext A	9.97	1.3	70	0.045

3.3.3 Development Conditions Parameters

For the developed catchment conditions, the RAFTS model was reconfigured to reflect the proposed changes to catchment areas.

Table 3.2 shows the revised catchment areas and RAFTS parameters adopted for the proposed Ultimate Development Catchment conditions:

Table 3.2 RAFTS Model Parameters, Developed Conditions

Sub Catchment	Catchment Area (ha)	Catchment Slope (%)	Percentage Impervious (%)	Mannings 'n'
A	3.5	1	70	0.04
B	4.01	1	70	0.04
C	2.17	1	0	0.06
D1	7.8	1	0	0.06
D2	2.64	1	70	0.04
D3	1.96	1.3	70	0.04
Ext A	9.97	1.3	70	0.045

3.4 MODEL CALIBRATION

The Rational Method was used to estimate design flood discharges for existing and developed conditions at each site discharge point. A C10 value of 0.7 was adopted for undeveloped conditions assuming medium density bush and medium soil permeability (QUDM, 2007), and 0.86 was used for the existing industrial areas on the site. A C10 value of 0.84 was adopted for urban residential development. These runoff coefficients were based on the expected percent impervious areas in accordance with QUDM (2007). The Rational Method Calculations are shown in Appendix A.

Table 3.3 shows a comparison of existing and developed Rational Method and RAFTS model discharges at each site discharge point.

The RAFTS discharges generally correspond well to the Rational Method discharges and have been adopted for this study. RAFTS model calibration was achieved using:

- Initial and continuing rainfall losses of 15 mm and 2.5mm/hr for all agricultural land for all storms;
- Initial and continuing rainfall losses of 0 mm and 1 mm/hr for all industrial land for all storms; and,
- A BX factor of 1 has been adopted

For existing and developed conditions, the critical storm duration is 60 minutes for all ARI design discharges.

Table 3.3 Rational Method and RAFTS Model Discharges at Bedford Road (SDP1)

Event ARI (Years)	Existing Discharge (m^3/s)		Developed Discharge (m^3/s)	
	Rational Method	RAFTS	Rational Method	RAFTS
1	1.03	0.95	0.72	1.00
2	1.43	1.35	0.99	1.40
5	2.08	1.94	1.44	1.92
20	3.06	2.83	2.09	2.54
50	4.00	3.36	2.72	2.86
100	4.71	3.99	3.20	3.23

Table 3.4 Rational Method and RAFTS Model Discharges on western boundary (SDP2)

Event ARI (Years)	Existing Discharge (m^3/s)		Developed Discharge (m^3/s)	
	Rational Method	RAFTS	Rational Method	RAFTS
1	2.52	2.99	2.98	3.75
2	3.53	4.17	4.17	4.94
5	5.18	5.71	6.14	6.85
20	7.69	7.70	9.15	9.38
50	10.12	9.06	12.07	10.85
100	11.91	10.38	14.22	12.43

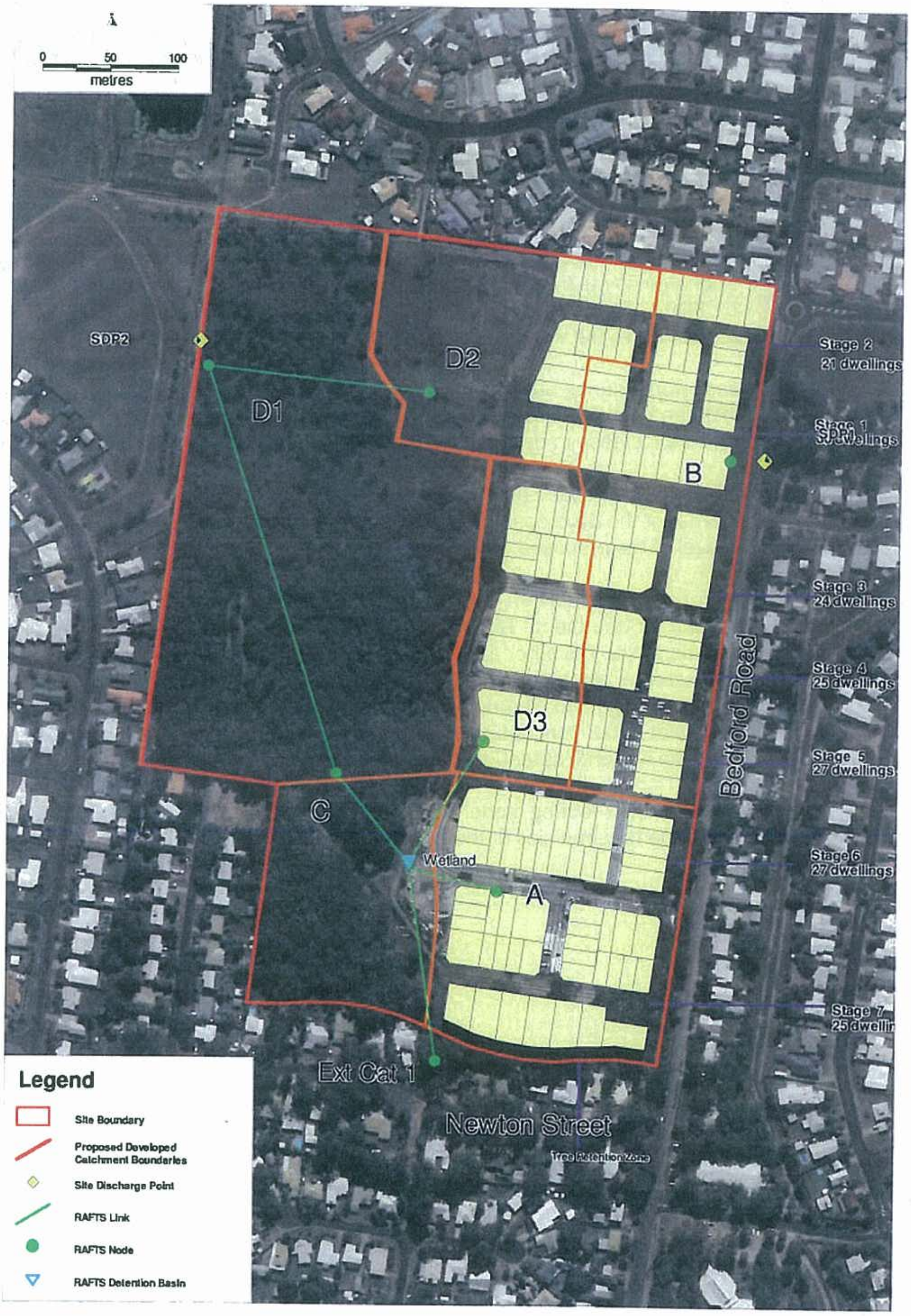

Figure 3.1 Proposed RAFTS Model Configuration

4 WATER QUANTITY MANAGEMENT

4.1 GENERAL

The objective of the stormwater quantity management measures proposed for the site is to ensure that the proposed development does not increase downstream discharges. There are two discharge points from the site.

1. SDP1 - To the east, via culverts under Bedford Road; and,
2. SDP2 - To the west via culverts along the western boundary.

The earthworks during Stage 1 will direct more flow to the west. Therefore the existing flow rate at SDP1 can be maintained without any detention measures for all storm events greater than a 5yr ARI. The increase in developed flow rates for 1yr and 2yr ARI storm event is negligible.

To mitigate the increased runoff to the west (SDP2), a detention basin is proposed in the south-west corner of the developed area. The detention area will utilise storage above the standing water level of the proposed wetland.

The wetland will be adjacent to the existing drainage channel. Lows flows will be diverted into the wetland for treatment. The proposed wetland will have two inlet ponds, one at the northern of the wetland and the other at the southern end just downstream of the existing discharge pint from the external catchment. All runoff from Stage3, 4 and 5 will enter the wetland from the northern inlet pond and all runoff from Stage 6 and 7 and southern external catchment via the southern inlet pond. Conceptual details of the wetland are provided in Section 6. The detail design of the wetland/detention basin will be undertaken at Operational Works Stage.

The 'RAFTS' runoff routing model (XP Software, 2001) described in Section 3 was used to determine the required size of the detention basin.

4.2 DETENTION BASIN

The proposed detention basin will mitigate the potential increased discharges due to the proposed development at the western site discharge point (SPD2).

Figure 4.2 shows the approximate location and configuration of the detention basin. Concept design details are given in Table 4.1. The basin flows will be discharged either by the spillway or by the proposed pipe outlet to the existing downstream channel. The base level of the basin has been assumed to be the standing water level in the wetland.

Figure 4.1 shows simulated water levels hydrographs in the basin for various ARI storm events. That the maximum water in the basin reaches 8.0m and the basin has returned to the standing water in the wetland (6m) within approximately six hours. This short ponding time should not impact of the vegetation of the wetland.

Table 4.1 Detention Basin Parameters

Base Level	6.0m AHD
Base Surface Area	1750m²
Q100 Peak Water Level	8m AHD
Detention Volume	6000m³ (at 8.0m AHD)
Total Basin Area	4400m²
Basin Depth*	2.0 m
Outlet Configuration	3 x 750mm pipe, 0.2%
Spillway*	10m wide (at 7.7m AHD)
Internal Batters	1V:6H on three sides,

** From standing water level in the wetland*

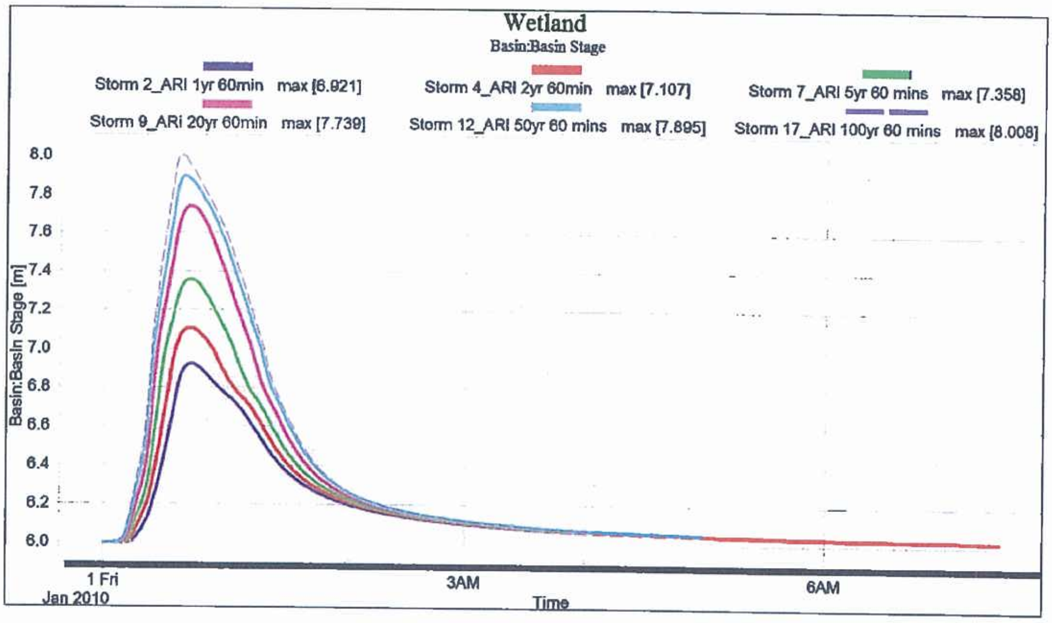

Figure 4.1 Stage Hydrograph in the proposed wetland

4.2.1 Proposed Detention Stage Storage Curves

Table 4.2 shows the adopted stage storage relationship for the proposed detention basin.

Table 4.2 Adopted Stage Surface Area- Storage Relationship

Stage (m AHD)	Detention Basin Surface Area (m^2)	Storage (m^3)
6	1750	0
6.1	1750	175
7	2700	2177.5
8	4440	5747.5

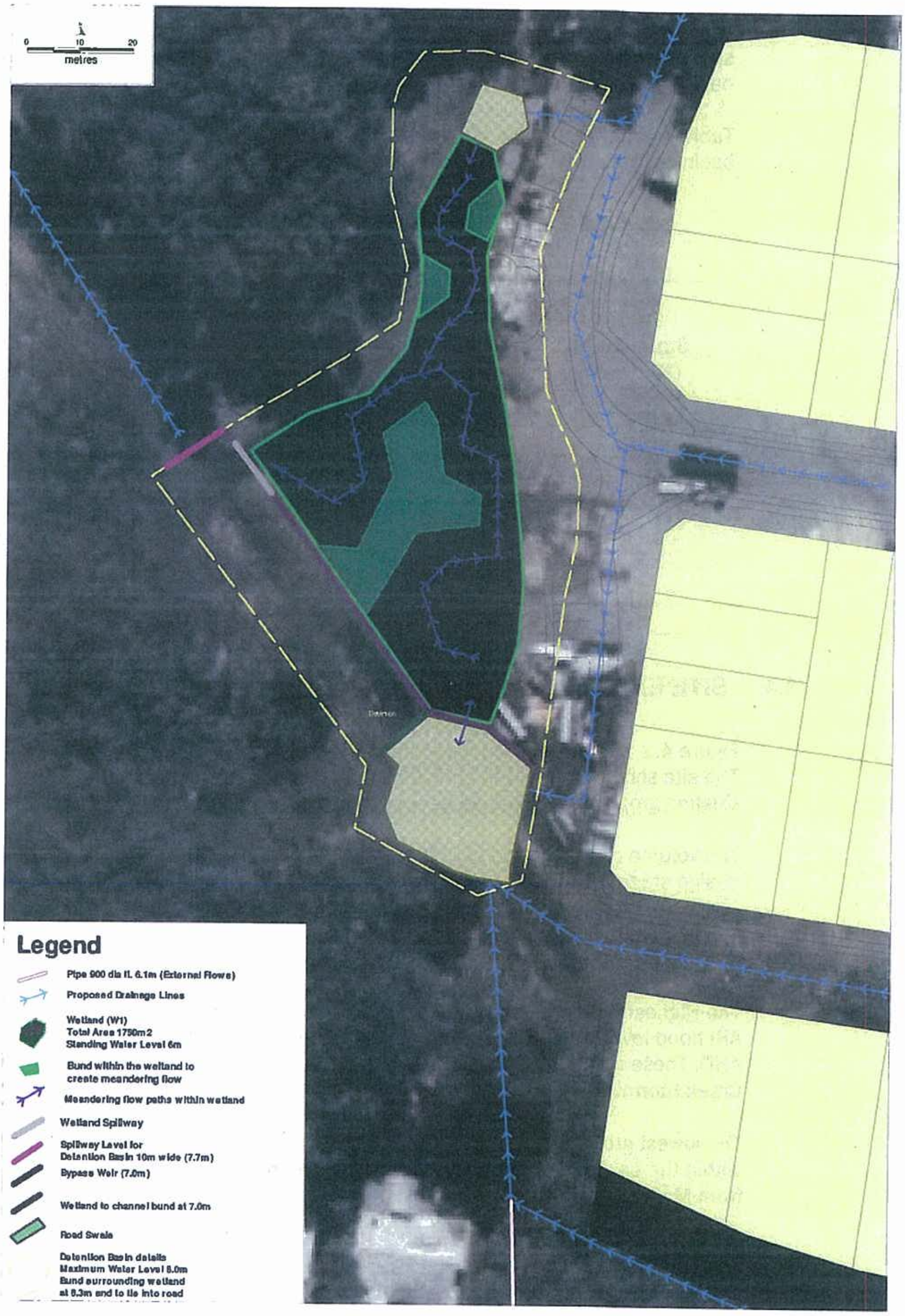

Figure 4.2 **Wetland/Detention Basin Details**

4.3 IMPACT OF DETENTION BASIN ON DESIGN DISCHARGES

Table 4.3 shows the calculated 1, 2, 5, 10, 20, 50 and 100 year ARI design discharges for the site under existing and developed site conditions (with and without the proposed detention basin) as determined by the RAFTS model.

Table 4.3 shows that the developed site conditions discharges with the proposed detention basin are less than or equal to existing site conditions discharges at SDP2.

Table 4.3 Design Discharges at SDP2 with and without Detention Basin

Design Storm Event (ARI years)	SDP 2 Discharge (m^3/s)			Peak Water Level in Basin (m)
	Existing Site Conditions	Developed Site Conditions		
		Without basin	With Basin	
1	2.99	3.75	2.37	6.92
2	4.17	4.94	3.29	7.11
5	5.71	6.85	4.35	7.35
20	7.70	9.38	5.86	7.74
50	9.06	10.85	7.84	7.89
100	10.38	12.43	9.85	8.00

4.4 SITE EXCAVATION FOR DRAINAGE

Figure 4.2 shows the expected extent of disturbance for the proposed wetland/detention basin. The site should be cut with sufficient grade such that the runoff drains overland to the wetland. Existing ground levels should be maintained downstream of the detention basin.

The volume of earthworks and its suitability for use as fill on site will be assessed at detail design stage.

4.5 REGIONAL FLOOD IMPACTS

The Highest Astronomical Tide (HAT) level in McCreadys Creek is 3.47m AHD, and the 100 year ARI flood level in downstream of the site to the west is 4.29 m AHD and to the east is 7.24 m AHD. These flood levels have been sourced from the HEC RAS model created for the 'McCreadys Creek Stormwater Drainage Study' (KBR, 2006).

The lowest ground level on the subject site within the western catchment is 4.4m AHD and within the eastern catchment is 7.4m AHD. Therefore backwater flooding onto the subject site from McCreadys Creek will not occur.

5 WATER QUALITY OBJECTIVES

5.1 OVERVIEW

The stormwater quality management plan (SQMP) includes the following:

- An outline of the design objectives that must be met by the proposed stormwater treatment system;
- Descriptions and preliminary sizing of Stormwater Treatment Measures (STMs) proposed for the operational phase of the development; and
- Quantitative modelling to demonstrate that the treatment system will meet relevant performance criteria.

The proposed development can be classified as urban residential. The 'MUSIC' model for urban stormwater improvement conceptualisation (CRCCH, 2005) was used to assess the mitigated developed site runoff quality, and determine the performance of the proposed stormwater treatment system.

The design objectives set out in the 'Stormwater Quality Performance Curves and Stormwater Quality Objectives for Mackay' have been adopted as the water quality objectives (WQO's) for the proposed development.

5.2 WATER QUALITY OBJECTIVES

Table 5.1 gives the best practice load-based design objectives set out in 'Stormwater Quality Performance Curves and Stormwater Quality Objectives for Mackay' (MRC 2009) for site runoff in the operational phase of a development. The design objectives have been adopted as the WQO's for the proposed development.

Table 5.1 Operational Phase Water Quality Objectives

Parameter	Percent Reduction (%)
Suspended Solids	75
Total Nitrogen	40
Total Phosphorous	60
Gross Pollutants	90

The percent reductions given in Table 5.1 are target reductions for comparing mitigated site annual pollutant loads with unmitigated site annual pollutant loads. The treatment train selected for the proposed development will ensure design objectives are met for all pollutants.

The Mackay Stormwater Quality Management Plan (2006) lists pollutants that are generally of concern during the operational phase of a residential development. These include:

- Litter
- Sediment
- Nutrients (Total Nitrogen & Total Phosphorus)
- Hydrocarbons
- Heavy Metals

Current WQOs for all pollutants other than litter, total N, total P and suspended solids are either not available or not comparable with the output of water quality models. Therefore, until more appropriate WQOs are available for these pollutants, the maximum possible reduction must be achieved, given the site topography and other constraints.

6 STORMWATER QUALITY MANAGEMENT MEASURES

6.1 ASSUMPTIONS

The objective of the water quality management measures proposed for the site is to ensure the runoff from the development site meets Mackay Quality Objectives at the two site discharge points.

1. SDP 1 - To the east, via culverts under Bedford Road; and,
2. SDP 2 - To the west via culverts along the western boundary.

A bio-filtration basin is proposed to be built into the landscape of the entry road of Stage 1. This bio-filtration will be designed to treat all runoff discharging east to the Bedford Road culverts (SDP1). A bio-filtration basin to the north and a wetland to the south are proposed to treat all runoff discharging to the west (SDP2).

If the Caledonian Drive regional wetland downstream of the site is constructed prior to this development, then the treatment train for all runoff discharging to the west may not be required. In the absence of a known completion date of the regional wetland, the following sections detail the treatment measures required to meet water quality objectives for both site discharge points.

6.2 ADOPTED MEASURES

The proposed stormwater quality management measures for the site, includes the following:

- All dwellings will install a minimum 5kL rainwater tank to collect roof water from a minimum of 50% of the total dwelling roof area. The collected water will be used for gardening purposes, the cold water washing machine tap and toilet flushing.
- Overflow from the rainwater tanks will be directed to the biofiltration areas for treatment prior to discharge from the development site.
- Stormwater from lots, roads and overflows from rainwater tanks will be directed to the kerb and channel within the roadways.
- Two bio-filtration basins and one wetland will be constructed on site. See Figure 2.1 for their location.
- Bio-filtration Basin B1 is to be built into the landscape of the entry road of Stage1 and designed treat all runoff discharging to the east for all stages.
- Bio filtration Basin B2 is to the west of Stage 1. This basin will treat the runoff flowing to the west in Stage 1 and 2.
- Wetland (W1) will treat runoff flowing to the west for Stages 3,4,5,6 and7.
- A vegetated swale is proposed along the road fronting the significant vegetation area in Stages 3 to 6, to assist in directing part of the runoff to the wetland. All other runoff from these stages will be directed to W1 by underground drainage and surcharge flow paths.

6.2.1 Bio-filtration Details

- The bio-filtration system will include appropriate pre-treatment measures, such as a GPT or sediment forebay, to protect the filter media surface from inflows of coarse sediment.
- The bio-filtration basins will be used as the tertiary stormwater treatment measure for stormwater discharging from the site. They will be constructed with a 600mm deep filter media of sandy loam and have a 300 mm extended detention depth above the filter media.
- Runoff entering the basin will percolate through the filter media, with sediment and nutrients being removed in the process. It was assumed that the bed below the bio-filtration area is impermeable when undertaking the water quality modelling. Slotted PVC pipe will be placed in the base to drain the filtered water.
- The bio-filtration system will treat runoff up to the 2yr ARI event.
- The required surface area of the bio-filtration filter media is;
  - Basin B1 - 600 m²
  - Basin B2 - 380 m²

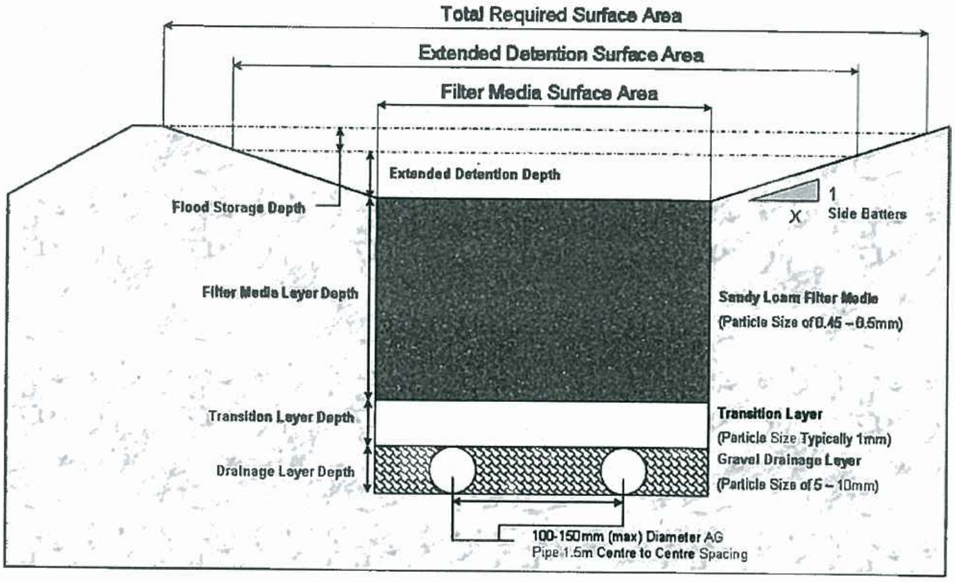

Figure 6.1 Typical Cross Section of a Bio-filtration system

6.2.2 Constructed Wetland Details

The constructed wetland will have the following features:

- A surface area of 1750m².
- Two inlet sediment ponds. The northern inlet pond will receive runoff from Stage 3, 4, 5 and southern inlet pond will receive runoff from Stage 6, 7 and External catchment 1.
- A riser outlet pit will be used to maintain the permanent water level at 6.0m AHD.
- The overflow level for the wetland will be about 6.5m AHD.

- The crest of the bund containing the wetland will be at an elevation of 8.3m AHD, with a spillway at 7.7m AHD and the 100yr ARI water level in the basin is 8m AHD.
- A minimum aspect ratio of 1W:5L within the macrophyte zone.

A diverse range of habitat areas will be constructed within the macrophyte zone, ie, ephemeral marsh, shallow marsh, marsh and deep marsh. These areas will be planted with an appropriate selection of species that are suited to the climate of Mackay. Additional permanent pool zones will be included to provide refuge for mosquito predators during extended dry periods.

The wetland will be designed to take flows up to the 1 year ARI design flood. Higher flows will be diverted to the bypass channel, which will utilise the existing drainage channel along the south side of the wetland. Refer section 4 for details on the detention measures.

Final levels of the various weirs and embankments will be determined as part of detailed design which will ensure that flood levels upstream of the wetland will not be impacted.

7 WATER QUALITY MODELLING

7.1 GENERAL

Assessment of mitigated and unmitigated developed site runoff water quality was undertaken using the 'MUSIC' water quality model (CRCCH, 2005) for proposed ultimate developed site conditions.

Mackay Regional Council's MUSIC Guidelines for Pollutant Export Modelling (2008) were used in the configuration of the MUSIC model. Suspended solids, total nitrogen, total phosphorus and litter concentrations were estimated with the MUSIC model runoff generation parameters.

7.2 AVAILABLE DATA

7.2.1 Rainfall

Six minute rainfall data for Mackay MO (Station 33119) has been adopted. A rainfall period of ten years was used for all MUSIC modelling, recommended by the Mackay Regional Council (2008). The adopted period of analysis was January 1, 1990 to 31 December, 1999.

7.2.2 Evapo-transpiration

Monthly average areal potential evapo-transpiration estimates were obtained from the Climatic Atlas of Australia – Evapo-transpiration (BOM, 2001). Table 7.1 shows the adopted monthly evapo-transpiration rates.

Table 7.1 Adopted Average Monthly Evapo-transpiration Rates

Month	Monthly Evapo-transpiration	
	(mm/day)	(mm/month)
Jan	6.1	190
Feb	5.4	152
Mar	4.8	150
Apr	3.5	105
May	2.4	75
Jun	2.0	60
Jul	2.1	65
Aug	2.6	80
Sep	3.6	107
Oct	4.8	150
Nov	5.8	175
Dec	6.1	190

7.2.3 Source Node Parameters

In order to accurately model developed conditions water quality, the site was split into roof, yard and road areas. Mean stormwater flow pollutant concentrations for roof, road and other impervious/pervious areas within an urban residential area were adopted from the Mackay MUSIC moodelling Guidelines (MRC, 2008). Mean base flow pollutant concentrations and standard deviations given for residential use areas (MRC, 2008) were applied to roof, yard and road areas. Routing was not used in any drainage links.

7.3 MODEL CONFIGURATION

The MUSIC model was configured on the basis of the following assumptions:

- Equivalent of 214 total lots on site (including the 29 future dwellings to the north);
- Each lot has a 5 kL tank that collects roof water. A daily reuse demand of 0.326kL/day/lot was assumed.
- 50% of roof area was connected to rainwater tanks.

Figure 7.1 shows the MUSIC model configuration used to assess the mitigated developed site runoff quality and Table 7.2 shows the adopted source nodes.

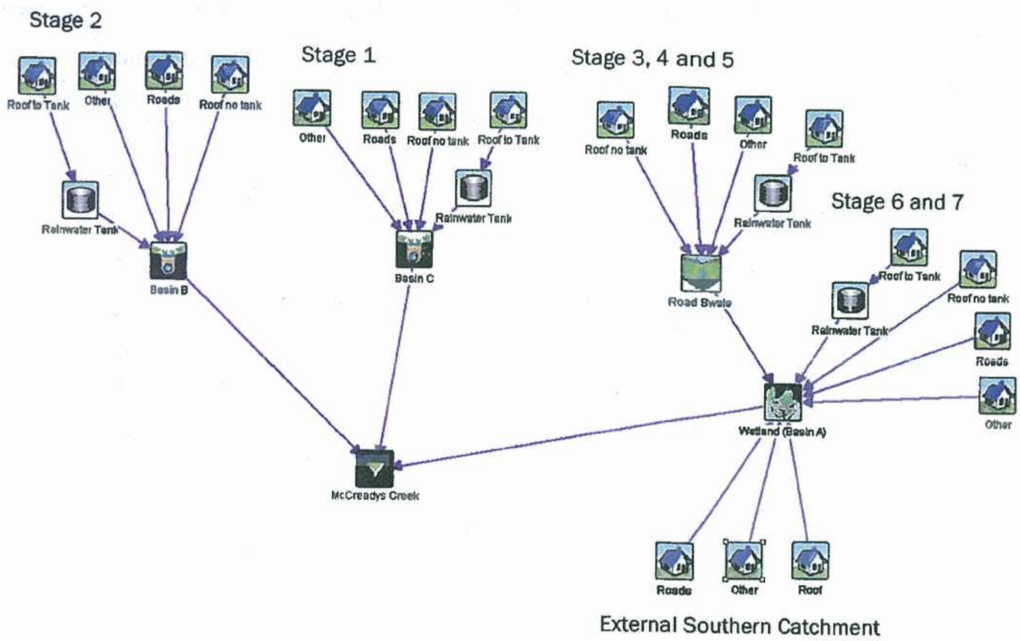

Figure 7.1 MUSIC Model Configuration

Table 7.2 Adopted Source Node Percent Imperviousness and Areas

Source Node ID	Adopted MUSIC Source Node Parameters	Area (Development Site) (ha)	Area (Southern Catchment) (ha)	Percent Impervious (%)
Roof to Tank	*Urban - Roof*	2.539	NA	100
Roof no Tank	*Urban - Roof*	2.539	2.126	100
Road	*Urban - Road*	1.719	0.766	100
Other (Yard, Road Reserves)	*Urban – Other Pervious*	5.264	7.078	10

7.4 WATER QUALITY RESULTS

Table 7.3 shows the mean annual pollutant loads for suspended solids, total nitrogen, total phosphorous and litter for mitigated and unmitigated developed conditions at Bedford Road (SDP1). This shows that the load reduction targets for all pollutants meet the performance criteria set by Mackay Regional Council.

Table 7.3 Mean Annual Pollutant Loads, at SDP 1

Pollutant	Annual Pollutant Load (kg/year)		Percent Reduction (%)	Performance Criteria (%)
	Developed Conditions Unmitigated	Developed Conditions Mitigated		
Suspended Solids	5860	1370	77	75
Total P	12.7	4.31	66	60
Total N	86.5	48	44	40
Litter	722	0	100	90

Table 7.3 shows the results for mitigated and unmitigated developed conditions at the western boundary (SDP2). This shows that the load reduction targets for all pollutants meet the performance criteria set by Mackay Regional Council.

Table 7.4 Mean Annual Pollutant Loads at SDP 2 for Development site only

Pollutant	Annual Pollutant Load (kg/year)		Percent Reduction (%)	Performance Criteria (%)
	Developed Conditions Unmitigated	Developed Conditions Mitigated		
Suspended Solids	11500	2270	80	75
Total P	26	8.81	66	60
Total N	182	110	40	40
Litter	1510	0	100	90

Table 7.5 shows the mean annual pollutant loads and the reductions when the external catchment (Ex 1) is included into the treatment train. The modelling shows that the total combined runoff downstream of the wetland does not meet best practice reduction targets, due to the limited space available for the wetland. However the treatment performance achieved by this wetland is considered to be a substantial improvement in the stormwater quality entering the significant vegetation on site.

Table 7.5 Mean Annual Pollutant Loads at SDP2 for total upstream catchment

Pollutant	Annual Pollutant Load (kg/year)		Percent Reduction (%)	Performance Criteria (%)
	Developed Conditions Unmitigated	Developed Conditions Mitigated		
Suspended Solids	22800	8340	64	75
Total P	52.5	26.6	49	60
Total N	342	249	27	40
Litter	2780	3.28	99.9	90

8 SUMMARY

The Urban Land Development Authority propose to develop Council's Depot land in Andergrove for residential use. WRM Water & Environment have prepared a stormwater management plan for the development site to support the development application.

No increase in peak discharge from the site will be achieved by the following:

- Discharges from the eastern catchment of the development site have been reduced by decreasing the catchment area contributing to discharges at this location; and
- Discharges from the southern catchment will be mitigated by the construction of a detention basin, located in the southern end of the site.

The stormwater quality management achieves the water quality objectives for all runoff produced from the development and significantly improves the water quality from the southern external catchment.

The proposed stormwater management plan for the site includes the following features;

- The construction of two biofiltration areas (totalling approximately 950m^2 in filter area) are proposed on the western and eastern boundaries of Stage 1. These will treat the runoff from Stage 1 and 2;
- A wetland is proposed in southern end of the catchment to treat runoff for the remaining Stages 3,4,5,6 and 7;
- The wetland will also treat the runoff from the external southern catchment;
- A GPT or trash rack/sediment forebay installed on the inlets to each of the bio-filtration basins will treat runoff prior to discharge to each bio-filtration basin; and
- The installation of 5kL rainwater tanks on each new dwelling with collected water used for gardening, cold water washing machine taps and toilet flushing.

Stormwater harvesting options can be assessed in conjunction with the operational works phases of Stages 3 through to 7.

9 REFERENCES

BOM (2001), Climatic Atlas of Australia - Evapotranspiration, Bureau of Meteorology.

CRCCH (2003), MUSIC (Model for Urban Stormwater Improvement Conceptualisation), CRC for Catchment Hydrology, Australia.

HW (2006), Draft Design Objectives for Water Sensitive Urban Design in South East Queensland, Healthy Waterways

IEAust (1998) – 'Australian Rainfall and Runoff: A guide to Flood Estimation', Institute of Engineers, Australia

MRC (2008) Mackay Regional Council MUSIC Guidelines *Version 1.1*, Mackay Regional Council & Designflow, Brisbane

MRC (2009) Mackay Planning Scheme, Planning Scheme Policy 3, Mackay Regional Council.

MRC (2009), Stormwater Quality Performance Curves and Stormwater Quality Objectives for Mackay', Mackay Regional Council.

KBR (2006), McCreadys Creek Stormwater Drainage Study, KBR.

APPENDIX A

RATIONAL METHOD CALCULATIONS

SDP 1 Existing Conditions

Rational Method Parameters	Units	Design Storm Event						
		1 Year ARI	2 Year ARI	5 Year ARI	10 Year ARI	20 Year ARI	50 Year ARI	100 Year ARI
Catchment Area	ha	7.68	7.68	7.68	7.68	7.68	7.68	7.68
Time of Concentration								
Standard Inlet Time	min	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Channel Flow Time		3.2	2.9	2.5	2.4	2.2	2.1	2.0
Length	m	250	250	250	250	250	250	250
Mannings 'n'		0.05	0.05	0.05	0.05	0.05	0.05	0.05
Slope of Channel	m/m	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total Time of Concentration	**min**	**18.2**	**17.9**	**17.5**	**17.4**	**17.2**	**17.1**	**17.0**
Runoff Coefficient (Cy)		0.62	0.66	0.74	0.78	0.82	0.90	0.94
Frequency Factor (Fy)		0.80	0.85	0.95	1.00	1.05	1.15	1.20
Rainfall Intensity (Iy)	mm/hr	77.5	101.2	131.9	150.8	175.4	209.3	235.6
Design Discharge	**m^3/s**	**1.03**	**1.43**	**2.08**	**2.51**	**3.06**	**4.00**	**4.71**

SDP 1 Developed Conditions

Rational Method Parameters	Units	Design Storm Event						
		1 Year ARI	2 Year ARI	5 Year ARI	10 Year ARI	20 Year ARI	50 Year ARI	100 Year ARI
Catchment Area	ha	4.01	4.01	4.01	4.01	4.01	4.01	4.01
Time of Concentration								
Standard Inlet Time	min	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Total Time of Concentration	**min**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**
Runoff Coefficient (Cy)		0.67	0.71	0.80	0.84	0.88	0.97	1.01
Frequency Factor (Fy)		0.80	0.85	0.95	1.00	1.05	1.15	1.20
Rainfall Intensity (Iy)	mm/hr	96.8	125.0	162.0	184.0	213.0	253.0	285.0
Design Discharge	**m^3/s**	**0.72**	**0.99**	**1.44**	**1.72**	**2.09**	**2.72**	**3.20**

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SDP 2 Existing Conditions

Rational Method Parameters	Units	Design Storm Event						
		1 Year ARI	2 Year ARI	5 Year ARI	10 Year ARI	20 Year ARI	50 Year ARI	100 Year ARI
Catchment Area	ha	24.42	24.42	24.42	24.42	24.42	24.42	24.42
Time of Concentration								
Standard Inlet Time	min	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Channel Flow Time		13.4	12.4	11.3	10.8	10.4	9.8	9.4
Length	m	700	700	700	700	700	700	700
Mannings 'n'		0.06	0.06	0.06	0.06	0.06	0.06	0.06
Slope of Channel	m/m	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Total Time of Concentration	**min**	**29.8**	**28.8**	**27.7**	**27.2**	**26.8**	**26.2**	**25.8**
Runoff Coefficient (Cy)		0.61	0.65	0.72	0.76	0.80	0.87	0.91
Frequency Factor (Fy)		0.80	0.85	0.95	1.00	1.05	1.15	1.20
Rainfall Intensity (Iy)	mm/hr	61.0	80.6	105.8	121.6	142.1	170.7	192.4
Design Discharge	m^3/s	**2.52**	**3.53**	**5.18**	**6.27**	**7.69**	**10.12**	**11.91**

SDP 2 Developed Conditions

Rational Method Parameters	Units	Design Storm Event						
		2 Year ARI	2 Year ARI	5 Year ARI	10 Year ARI	20 Year ARI	50 Year ARI	100 Year ARI
Catchment Area	ha	28.04	28.04	28.04	28.04	28.04	28.04	28.04
Time of Concentration								
Standard Inlet Time	min	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Channel Flow Time		60.5	14.1	11.7	141.6	10.5	9.8	9.4
Length	m	700	700	700	700	700	700	700
Mannings 'n'		0.05	0.05	0.05	0.05	0.05	0.05	0.05
Slope of Channel	m/m	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Total Time of Concentration	**min**	**30.5**	**29.3**	**28.1**	**27.5**	**26.9**	**26.2**	**25.8**
Runoff Coefficient (Cy)		0.63	0.67	0.75	0.79	0.83	0.91	0.95
Frequency Factor (Fy)		0.80	0.85	0.95	1.00	1.05	1.15	1.20
Rainfall Intensity (Iy)	mm/hr	60.5	79.7	105.1	121.0	141.6	170.5	192.5
Design Discharge	m^3/s	**2.98**	**4.17**	**6.14**	**7.45**	**9.15**	**12.07**	**14.22**