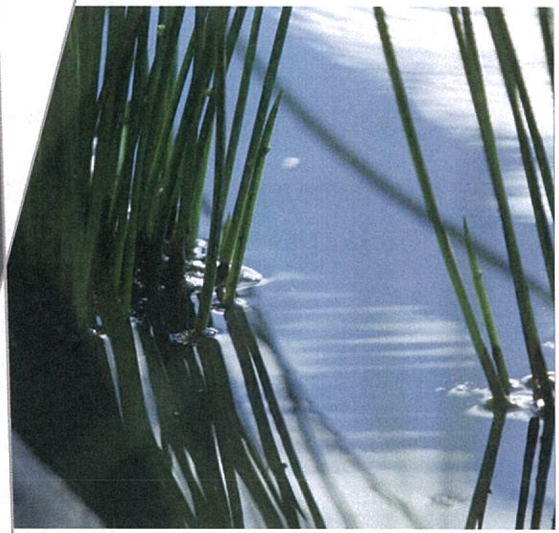
PLANS AND DOCUMENTS
referred to in the PDA APPROVAL
26 MAR 2014
MEDQ

Ripley Valley Secondary Urban Centre East - Southern and Eastern Precincts

Stormwater Management Report

7901/47-27



Prepared for
AMEX Corporation Pty Ltd

14 February 2014

Cardno
Shaping the Future

Cardno (Qld) Pty Ltd
ABN 57 051 074 992
Level 11 Green Square North Tower
515 St Paul's Terrace
Fortitude Valley Qld 4006
Locked Bag 4006 Fortitude Valley
Queensland 4006 Australia
Telephone: 07 3369 9822
Facsimile: 07 3369 9722
International: +61 7 3369 9822
cardno@cardno.com.au
www.cardno.com.au

Document Information

Prepared for	AMEX Corporation Pty Ltd
Project Name	Ripley Valley Secondary Urban Centre East - Southern and Eastern Precincts
File Reference	O:\7901-47-22\WP\Stg1 SUCE Report\Southern and Eastern Precincts\SWMv6-Southern and Eastern Precincts\Ripley Valley SWMv6 - Southern and Eastern Precincts.docx
Job Reference	7901/47-27
Date	14 February 2014

Document Control

Version	Date	Author	Author Initials	Reviewer	Reviewer Initials
1	15 June 2012	Anisha Vytla	AV	Martin Giles	MG
2	22 June 2012	Anisha Vytla	AV	Martin Giles	MG
3	29 June 2012	Anisha Vytla	AV	Martin Giles	MG
4	30 November 2012	Anisha Vytla/Helen Doherty	AV/HD	Martin Giles	MG
5	7 February 2014	Netsanet Ejigayehu	NE	Martin Giles	MG
6	14 February 2014	Netsanet Ejigayehu	NE	Martin Giles	MG

Table of Contents

Tables

Figures

Appendices

1 Introduction

1.1 Context

This Stormwater Management Plan has been prepared by Cardno in support of the application lodged with the ULDA in relation to the development of the Southern and Eastern precincts of the Secondary Urban Centre East land controlled by AMEX. The area which is included in the current Stormwater Management Plan is shown in Figure 1.

This report describes the analyses and sizing work undertaken with respect to stormwater quality management to determine the devices required to ensure that the water quality objectives applicable to the region can be achieved. In particular, the current version of the report reflects the removal of the requirement from the *Queensland Development Code* for the use of rainwater tanks.

Stormwater quantity management has been addressed as part of the flood analysis for the site as the detention basins were included in the overall flood modelling for the development. Based on a review of the current layout, it was determined that the base assumptions made in the previous report remain valid and that the overall detention volumes presented in the previous Cardno report, namely *Ripley Valley Secondary Urban Centre East, Flood Study* (Version 5, February 2014) are applicable to the current layout.

It can be noted that the report does not include Stages 1 to 6 of the development (refer Figure 1) which were the subject of previous approvals and in the case of Stages 1 to 3, Operational Works design. Details of the treatment requirements for these stages can be found in the following documents.

- *Ripley Valley Secondary Urban Centre East – Southern and Eastern Precincts- Stages 1-3, Stormwater Management Report*. Version 1, May 2013.
- *Ripley Valley Secondary Urban Centre East – Southern and Eastern Precincts- Stages 4-6, Stormwater Management Report*. Version 1, May 2013.

As noted above, the previously prepared report (Version 4, November 2012) has been updated to reflect the deletion of the requirement for roofwater tanks in the Queensland Development Code and additional work in relation to the definition of catchments as part of civil design.

2 Design Criteria

The *Ripley Structure Plan* (November 2007) presents a number of design criteria with respect to Water Cycle Management. Those criteria relating to stormwater management are as follows (Section 10.1.3.1):

- **Stormwater - Quality Management**

  Water quality objectives will be in accordance with South East Queensland Healthy Waterways publication *Water Sensitive Urban Design, Developing Design Objectives for Water Sensitive Urban Development in South East Queensland* (October 2006) best practice treatment design objectives as follows:

  - 80% reduction in sediment load;
  - 60% reduction in total phosphorus load;
  - 45% reduction in total nitrogen load; and
  - 90% reduction in gross pollutant load.

  No use is to be made of existing watercourses or waterway vegetation for the treatment of runoff. It is necessary to treat all runoff from development areas discharging directly to second order streams identified in the planning process.

  It is envisaged that the form of first order streams within identified development areas will be significantly modified by development and, therefore, it is not proposed to require runoff directed to first order streams to be treated to meet the water quality objectives. The only exception to this would occur if the stream were to be retained as a feature of the area under development, in which case the water objectives would be applicable.

  The water quality objectives defined in the Structure Plan are consistent with those nominated in the December 2013 *State Planning Policy.*

To ensure compliance with current best practice, other criteria nominated in the *State Planning Policy* and the previously applicable *Urban Stormwater Quality Planning Guidelines* have also been considered. The requirements for this are detailed below.

- **Waterway Stability**

  The *State Planning Policy* nominates a design criterion based on waterway stability. The intent of this criterion is to reduce the impact of urban development on channel bed and bank erosion by limiting the post-development one year average recurrence interval event discharge within the receiving waters to the pre-development peak.

  Compliance with this requirement is addressed through the use of detention basins. The flood analysis completed with respect to the site details the achievement of the waterway stability criterion.

- **Frequent Flow Management**

  The *Urban Stormwater Quality Planning Guidelines 2010* nominate a design criterion based on the management of frequent flows. The intent of this criterion is to reduce the impact of development on the frequency at which runoff occurs. To satisfy this criterion, it is necessary to capture and manage the first 15 mm of runoff from impervious surfaces where the fraction impervious is greater than 40 percent and the first 10 mm of runoff from impervious surfaces where the fraction impervious is less than 40 percent.

  While the frequent flow management criterion is not part of the new *State Planning Policy*, given its previous currency and inclusion in the Ripley Valley Structure Plan, it was considered prudent to continue to demonstrate that the criterion can be met.

3 Stormwater Quality Management – Construction Phase

3.1 General

During the construction phase, the potential exists for increases in the amount of pollutants, particularly sediment, exported from the site. Throughout the construction phase, an Erosion and Sediment Control Plan will be required as part of the overall Environmental Management Plan.

The objective of the plan will be to control soil erosion on the site and prevent sediment discharge to downstream local water courses during storm events for the construction phase of the project.

3.2 Water Quality Objectives

The National Water Quality Management Strategy (which is annexed by the *Environmental Protection Act* (1994) and subordinate *Environmental Protection (Water) Policy* (1997)) indicates that increases in suspended particulate should be limited such that the mean turbidity of receiving waters, either fresh or marine, does not increase by more than 10 percent. In general terms, the concentration of suspended sediment discharged from the site should not exceed 50mg/L.

In conjunction with the above, the local Council (Ipswich City Council) recommends that construction phase concentrations should be in accordance with *Best Practice Erosion and Sediment Control* published by the International Erosion and Sediment Control Association Australasia. It is considered that this represents best practice and has been adopted for the purposes of the preparation of the Stormwater Management Plan.

Based on the above information, the release criteria for pumped discharges from the construction site shall be as shown in Table 3-1 below.

Table 3-1 Construction Phase Water Quality Objectives

Parameter	Release Criteria	Criteria Type
pH	6.5 – 9.0	Range
Suspended Solids	<50 mg/L	Maximum
Dissolved Oxygen	>6 mg/L	Minimum
Hydrocarbons	No visible sheen on receiving water	Descriptive
Litter	No visible litter washed from site	Descriptive

4 Stormwater Quality Management – Operational Phase

4.1 Available Treatment Measures and their Suitability

A wide range of stormwater management practices are available to achieve the principles of Water Sensitive Urban Design. All have been shown to be successful when correctly designed; however, selection of the most appropriate practices for a particular development is highly dependent on site conditions.

The table below lists the most common stormwater management practices currently used, along with opportunities and constraints for their use. This table forms the starting point for stormwater management for the development. Considering the site's constraints, not all of the measures outlined in the table are suitable. Each treatment option is therefore discussed in more detail and comment made on the suitability of each in the context of the development.

Table 4-1 Stormwater Management Practices

Practice	Opportunities			Constraints
	Pollutants removed	Scale	Other	
Litter baskets/racks	Litter and debris – M	Local	Pre-treatment for other practices	Require frequent maintenance
Sediment traps	Coarse sediment – H Suspended solids – L	Regional		Aesthetic and safety issues
Gross pollutant traps (GPTs)	Litter and debris – M Coarse sediment – H Suspended solids – L	Regional	Pre-treatment for other practices	Require regular maintenance
Filter strips/ buffer strips	Litter and debris – M Coarse sediment – H Suspended solids – H Nutrients – M	Lot/Local	Peak flow management	Require flat terrain
Grass swales	Litter and debris – M Coarse sediment – H Suspended solids – H Nutrients – M	Local	Peak flow management	Require flat terrain
Vegetated swales	Litter and debris – M Coarse sediment – H Suspended solids – H Nutrients – H	Local	Peak flow management	Require flat terrain
Extended detention basins	Coarse sediment – M Suspended solids – M Nutrients – L	Regional	Peak flow management	Requires pre-treatment Large land area required
Infiltration trenches	Suspended solids – H Nutrients – M	Local	Peak flow management	Requires pre-treatment
Bio-retention systems	Coarse sediment – H Suspended solids – H Nutrients – H	Local	Peak flow management	Requires pre-treatment
Roof Gardens	Coarse sediment – H Suspended solids – H Nutrients – H	Local	Peak flow management	Probably not practicable for individual houses
Porous pavements	Suspended solids – H Total phosphorus – M	Local	Peak flow management	Not appropriate for steep sites

Practice	Opportunities			Constraints
	Pollutants removed	Scale	Other	
	Total nitrogen – L			
Constructed wetlands	Coarse sediment – H Suspended solids – H Total phosphorus – M Total nitrogen – L	Regional	Peak flow management	Requires pre-treatment Not appropriate for steep sites Requires large area of land
Rainwater tanks	N/A	Lot	Peak flow management	Mandatory
Community education	Litter and debris – L Nutrients – L	Regional	Other benefits include weed control, reduced water use	Community participation

Note: Data taken from NSW EPA Managing Urban Stormwater – Treatment Techniques, 1997
L – 10 – 50% removal
M – 50 – 75% removal
H – 75 – 100% removal
Scales Lot less than 1 ha
Local 1 – 10 ha
Regional greater than 10 ha

Each of the techniques described in the previous table is further assessed below, with regard to the site's specific opportunities and constraints.

Litter Baskets/racks

The primary purpose for litter baskets is to remove medium sized litter and debris from the site. Apart from high density areas, significant litter generation is not expected. It is therefore suggested that consideration be given to the use of litter baskets in gully pits as necessary within the development.

Sediment Traps

Sediment traps will be required during the construction phase to limit the transport of sediment off site. Following construction, sediment levels will return to a low level, and traps are therefore not considered necessary as a long-term water quality measure.

Gross Pollutant Traps

Gross pollutant traps (GPTs) are predominantly used for the removal of litter and hydrocarbons – although they have been shown to effectively remove coarse sediment and suspended solids (Brisbane City Council, 1999). It is expected that GPT's would only be necessary where the potential exists for significant oil and grease deposition (eg car parks). In this case, it is proposed to use surface level bioretention systems to treat car park runoff, obviating the need for GPTs.

Filter Strips/Buffer Strips

Buffer strips are areas of land left in their natural state that act to reduce peak runoff flows and improve the quality of stormwater runoff. This treatment improves the aesthetic and biodiversity value of the development and provides significant quality and quantity improvements.

Grass Swales

Grass swales are considered a highly effective and aesthetic water quality (and to a lesser extent, water quantity) control measure, when placed in flat areas. Given the slopes that occur across the catchment, the opportunities for the use of swales within the development footprint may be limited.

Vegetated Swales

Vegetated swales require similar conditions as those outlined for grass swales above, and wherever slopes are sufficiently low they would provide effective stormwater treatment for the site.

Extended Detention Basin

Extended detention basins are designed to generally store runoff for 1-2 days. Their main purpose is the reduction of the peak discharge from the site during a storm event, and the retention of particulate matter. Detention basins will ultimately be included across the development. However, the basins will not store runoff for such a period and so will not function as extended detention basins.

Infiltration Trenches

Infiltration trenches allow pre-treated stormwater runoff to infiltrate into surrounding soils and groundwater, and as such are not a treatment device in themselves. Where space is limited, bio-retention systems are preferred.

Bio-retention Systems

Bioretention systems effectively combine a grass or vegetated swale with an infiltration trench. They are considered to be extremely effective in removing sediment and nutrients. Bioretention basins will be employed across the development, located in the base of the aforementioned detention basins in order to treat stormwater to an appropriate standard prior to release.

Roof Gardens

Roof gardens offer the potential to capture and treat incident rainfall at source, offering benefits in terms of peak flow reduction and amenity if used as an integral part of a building (for instance as part of a roof top recreation/ lunch area). Their use would be encouraged for suitable developments. However, the majority of the development contains residential properties, for which the use of roof gardens is not considered to be viable.

Porous Pavements

Porous pavements are not appropriate for high traffic areas due to increased maintenance requirements. They are also less effective in steep areas. However, for relatively flat, low traffic roads they could be suitable for this development, although their perceived expense often leads to the preference of other measures in reaching quantity and quality objectives.

Constructed Ponds and Wetlands

Wetlands require reasonably large flat areas of land. It would be possible to incorporate relatively large wetlands in the lower parts of the Secondary Urban Centre East or to distribute wetlands within urban areas at suitable locations. However, this is not the preferred option due to concerns in relation to the viability of such systems given the low rainfall climate in Ripley Valley.

Rainwater Tanks

Rainwater tanks are no longer compulsory due to recent changes to the Queensland Development Code. Therefore, while measures aimed at reducing the demand for potable water would always be encouraged, as their use cannot be guaranteed rainwater tanks do not form part the current stormwater management plan.

4.2 Adopted Treatment Measures

Based on the review of available treatment options, bio-retention basins were adopted for the development. Runoff from low flow events will be directed to bio-retention basins for treatment. Runoff from larger events would bypass each basin. The basins also allow frequent flow requirements to be met.

4.3 MUSIC Model

A MUSIC (Model for Urban Stormwater Improvement Conceptualisation, CRC for Catchment Hydrology, Version 5.1.16) model of the development was established to assess the quality of the stormwater discharge from the site.

In accordance with current best practice, the site was divided into various components for the purposes of modelling:

- Roof;
- Road;
- Ground; and
- Landscaped Areas (open space).

Appropriate rainfall-runoff and pollutant export parameters for the site were derived in accordance with the recommendations of the Water by Design (2010), *MUSIC Modelling Guidelines*. The parameters adopted for each source node are listed below in Table 4-2.

Table 4-2 Rainfall Runoff Parameters

Input	Data Used in Modelling
Rainfall station	*40004 Amberley*
Time step	*6 minute*
Modelling period	*1/1/1990-31/12/1999*
Mean annual rainfall (mm)	*762*
Evapotranspiration	*Ipswich west (Table 3.1 MUSIC Modelling Guidelines)*
Rainfall runoff parameters	*Urban (Table 3.7 MUSIC Modelling Guidelines)* *Commercial for town centre*
Pollutant export parameters	*Urban split catchments (Table 3.8 MUSIC Modelling Guidelines)* *Commercial split catchments for town centre*

The catchment was divided into a number of subareas. Areas of each land use type were determined based on a preliminary layout of the development. These areas were then further subdivided to allow for a split catchment analysis. The size and type of land use within each subarea is listed in Table 4-3.

Table 4-3 Music Model Areas

Catchment	Node Name	Surface Type	Description	Area (ha)	Fraction Impervious (%)
3a	Roof 3a	Urban roof	Roof area	1.075	100
	Road 3a	Urban road	Road and road reserve areas	0.975	60
	Ground 3a	Urban ground	Remainder of lot area	1.871	50
	Open Space 3a	Open Space	Area of district park and stormwater management	0.160	0
3b	Roof 3b	Urban roof	Roof area	1.290	100
	Road 3b	Urban road	Road and road reserve areas	1.715	60
	Ground 3b	Urban ground	Remainder of lot area	1.527	50
	Open Space 3b	Open Space	Area of district park and stormwater management	0.160	0
3c	Roof 3c	Urban roof	Roof area	12.067	100
	Road 3c	Urban road	Road and road reserve areas	9.282	60
	Ground 3c	Urban ground	Remainder of lot area	14.673	50
	Open Space 3c	Open Space	Area of district park and stormwater management	1.708	0
4	Roof 4	Urban roof	Roof area	15.945	100
	Road 4	Urban road	Road and road reserve areas	12.265	60
	Ground 4	Urban ground	Remainder of lot area	17.619	50
	Open Space 4	Open Space	Area of district park and stormwater management	3.232	0
	Town Centre	Commercial lumped	Town Centre	12.700	90
5	Roof 5	Urban roof	Roof area	4.284	100
	Road 5	Urban road	Road and road reserve areas	3.296	60
	Ground 5	Urban ground	Remainder of lot area	4.413	50
	Open Space 5	Open Space	Area of district park and stormwater management	1.480	0
6a	Roof 6a	Urban roof	Roof area	2.951	100
	Road 6a	Urban road	Road and road reserve areas	2.270	60
	Ground 6a	Urban ground	Remainder of lot area	3.651	50
	Open Space 6a	Open Space	Area of district park and stormwater management	0.388	0

Catchment	Node Name	Surface Type	Description	Area (ha)	Fraction Impervious (%)
6b	Roof 6b	Urban roof	Roof area	4.215	100
	Road 6b	Urban road	Road and road reserve areas	3.242	60
	Ground 6b	Urban ground	Remainder of lot area	5.151	50
	Open Space 6b	Open Space	Area of district park and stormwater management	0.361	0
6c	Roof 6c	Urban roof	Roof area	2.014	100
	Road 6c	Urban road	Road and road reserve areas	1.550	60
	Ground 6c	Urban ground	Remainder of lot area	2.475	50
	Open Space 6c	Open Space	Area of district park and stormwater management	0.159	0
7a	Roof 7a	Urban roof	Roof area	1.554	100
	Road 7a	Urban road	Road and road reserve areas	1.195	60
	Ground 7a	Urban ground	Remainder of lot area	1.729	50
	Open Space 7a	Open Space	Area of district park and stormwater management	0.303	0
7b	Roof 7b	Urban roof	Roof area	0.738	100
	Road 7b	Urban road	Road and road reserve areas	0.568	60
	Ground 7b	Urban ground	Remainder of lot area	0.966	50
	Open Space 7b	Open Space	Area of district park and stormwater management	0.123	0

4.4 Treatment Device Design

To satisfy the water quality objectives nominated in Section 2, it is proposed to construct bioretention basins to service the contributing catchments. The proposed location of each basin is shown in Figure 1.

The bioretention basins serving Catchment 2 are located within the footprint of the detention basin proposed to offset the impact of development of the southern section of the Secondary Urban Centre East.

To ensure that the basins have sufficient immunity against flooding, the bioretention basins will be set at a level sufficient to be immune to flooding for the 10 year event.

The properties of the proposed bioretention systems are presented in Table 4-4. It can be noted that in cases where a surface area in excess of 1,000 m^2 is proposed, then the bioretention system will be divided into an appropriate number of cells to ensure that the basins can be constructed and maintained in accordance with Healthy Waterways' *Bioretention Technical Design Guidelines*.

Sediment forebay areas were calculated in accordance with Healthy Waterways' *Bioretention Technical Design Guidelines*, assuming all recommended values for capture efficiency, sediment loading rate, target sediment and turbulence or short circuiting parameter.

The footprint area is dependent on the following factors:

- filter area;
- sediment forebay area;
- extended detention depth
- size of stormwater drainage entering the bioretention system;
- slope of the land; and
- batter slopes used for the bio-retention storage area.

The footprint includes the filter area (which covers the base of the bio-retention system), an allowance for the batters (1 in 4 over a minimum depth of detention of 0.30m at the downstream end and a minimum depth of 1.2m at the upstream end to allow for inlet pipes) and ground slope, and an area for a sediment basin (size varies with bio-retention system size). All of these factors were taken into account when determining the basin footprints. The approximate footprint areas are provided in Table 4-4. These areas will be confirmed in the detailed design phase.

Table 4-4 Properties of Bioretention Systems

Parameters	3a	3b	3c	4	5	6a	6b	6c	7a	7b
Storage Properties (MUSIC)										
Extended detention depth (m)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Surface Area (m^2)	750	750	3200	4000	1500	900	1000	800	600	350
Infiltration Properties (MUSIC)										
Filter Area (m^2)	750	750	3200	4000	1500	900	1000	800	600	350
Saturated Hydraulic Conductivity (mm/hr)	200	200	200	200	200	200	200	200	200	200
Filter Depth (m)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
TN content of filter media (mg/kg)	400	400	400	400	400	400	400	400	400	400
Orthophosphate content of filter media (mg/kg)	50	50	50	50	50	50	50	50	50	50
Geometric Properties										
Sediment forebay/inlet pond area (m^2)	85	85	415	435	200	100	110	90	70	26
Sediment forebay depth (m)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Approximate Total Footprint (m^2)	1515	1515	5600	6300	2700	1700	1850	1500	880	1200

4.5 Water Quality Modelling Results

The results of the MUSIC analysis are presented in Table 4-5. This table shows the quantities, expressed in kilograms each year, of pollutants exported from the site in the existing and proposed (including mitigation) situations, and the percentage reduction afforded by the proposed treatment measures.

Table 4-5 MUSIC Results

Pollutant	Prior to Treatment (kg/y)	Post Treatment (kg/y)	Percentage Reduction (%)	Target Reduction (%)
Total Suspended Solids	130,000	22,100	83	80
Total Phosphorus	292	116	60	60
Total Nitrogen	1,710	831	51	45
Gross Pollutants	22,400	0	100	90

With reference to Table 4-5 it can be concluded that the adopted water quality objectives will be achieved.

4.6 Life Cycle Costs

A life cycle costing was completed with respect to the proposed works for consistency with the Stage 1 reporting.

Life cycle costs for the proposed treatment train (i.e bioretention systems) were determined using the recommended parameters in MUSIC. These include:

- Real discount rate 5.5%
- Annual inflation rate 2.0%
- Base year for costing 2012
- Life Cycle 50 years
- Renewal/adaptation period 20 years
- Annual maintenance cost MUSIC “expected value”
- Annualised renewal cost MUSIC “expected value”
- Decommissioning cost MUSIC “expected value”

The design and construction costs for the bioretention systems will be borne by the developer, not by Ipswich City Council (the ultimate device owner). However, the total acquisition (in this case construction) not land purchase costs of each treatment device have been shown in Table 4-6.

The calculated life cycle costs for all of the stormwater quality treatment devices to be maintained by Council are shown in Table 4-7.

Table 4-6 Treatment Train Life Cycle Costs

Cost Component	3a	3b	3c	4	5	6a	6b	6c	7a	7b
Total Acquisition (construction) Cost	$72,937	$72,937	$222,033	$263,498	$124,145	$83,889	$90,953	$76,640	$61,460	$40,642
Annual Maintenance Cost	$7,984	$7,984	$13,045	$14,068	$10,095	$8,492	$8,800	$8,160	$7,403	$6,169
Renewal/Adaptation Cost	$33,363	$33,363	$101,561	$120,528	$56,786	$38,372	$41,603	$35,056	$28,113	$18,590
Decommissioning Cost	$33,354	$33,354	$101,535	$120,497	$56,772	$38,362	$41,593	$35,047	$28,106	$18,586
Life Cycle Cost ($2012)	$225,345	$225,345	$496,108	$564,929	$324,620	$247,533	$261,515	$232,922	$201,279	$154,575
Equivalent Annual Payment Cost of the Asset ($2012/annum)	$4,507	$4,507	$9,922	$11,299	$6,492	$4,951	$5,230	$4,658	$4,026	$3,091
Equivalent Annual Payment /kg Total Suspended Solids/annum	$1.55	$1.22	$0.40	$0.25	$0.80	$1.07	$0.51	$1.16	$1.28	$1.67
Equivalent Annual Payment /kg Total Phosphorus/annum	$910.76	$731.05	$256.69	$149.12	$471.19	$668.96	$326.17	$723.20	$800.47	$1,053.32
Equivalent Annual Payment /kg Total Nitrogen/annum	$178.34	$156.35	$50.86	$30.97	$88.24	$126.48	$67.92	$136.65	$151.19	$199.78
Equivalent Annual Payment /kg Gross pollutant/annum	$8.00	$6.84	$1.85	$1.22	$3.66	$5.34	$2.15	$5.80	$6.42	$8.37

Table 4-7 Total Treatment Train Life Cycle Cost

Cost Component	Bioretention Basins (all)
Total Acquisition (construction) Cost	$1,109,134
Annual Maintenance Cost	$92,200
Renewal/Adaptation Cost	$507,335
Decommissioning Cost	$507,335
Life Cycle Cost ($2012)	$2,934,171
Equivalent Annual Payment Cost of the Asset ($2012/annum)	$58,683
Equivalent Annual Payment /kg Total Suspended Solids/annum	$10
Equivalent Annual Payment /kg Total Phosphorus/annum	$6,091
Equivalent Annual Payment /kg Total Nitrogen/annum	$1,187
Equivalent Annual Payment /kg Gross pollutant/annum	$50

The relative distribution of all costs elements in the life cycle costs, for each treatment device, has been provided in Appendix B.

5 Stormwater Quantity Management

5.1 Waterway Stability and Peak Flow Impacts

The proposed development involves a significant increase in the impervious area of the catchment. Impacts on peak flow rates are therefore likely to occur without some form of stormwater quantity management. It is proposed that a number of detention basins be constructed to ensure that peak flow rates for the full range of flood events from the 1 year average recurrence interval (ARI) through to the 100 year ARI are not increased as a result of the development.

As the flood model of the area includes the areas in which the proposed detention basins will be located, the basins have been included in the flood model of the area. As such, the proposed detention basins and the amelioration of development impact afforded by the basins are described in the updated Flood Study prepared to address the information request (Cardno 2012). With reference to the flood study, the detention basins will ensure that the peak flow discharged from the site does not increase for the 1 year event, thereby satisfying the waterway stability criterion.

5.2 Frequent-Flow Management

As part of the stormwater management plan for the development, it is proposed to capture and manage the frequent flows generated from the impervious surfaces on the development site, in accordance with the *Urban Stormwater Quality Planning Guidelines 2010.*

According to these guidelines, for a development that has an impervious fraction of greater than 40% (as this development does), the first 15 mm of runoff from the impervious surfaces should be captured. This volume of storage should be available again within 24 hours.

In the case of the site, the storage will be achieved by reuse from the rainwater tanks and filtration through the bioretention system. Conservatively, the reuse available through the rainwater tanks proposed on each lot was not included in the analysis.

Consideration was therefore given to the storage available in the extended detention depth above the filter media in the bioretention system. It can be noted that the bioretention system will drain relatively rapidly as the saturated hydraulic conductivity of the filter media is 200 mm/h. This is faster than the drawdown rate required to drain the frequent flow storage in 24 hours. To assess the amount of runoff that passes through the bioretention system and whether the frequent flow criterion is satisfied, the MUSIC model was used to provide the following information:

- Daily rainfall
- Daily inflow to each bioretention system
- Daily treated outflow from each bioretention system (taken as the inflow to the system minus any bypassed flows)

Based on this information, the average annual impervious runoff from the first 15 mm of rainfall was determined. This value was then compared to the average annual volume of treated flow. The results of this analysis are presented in Table 5-1.

Table 5-1 Frequent Flow Analysis

Parameter	Value
Average annual runoff from site (ML/yr)	777.9
Treated outflow (ML/yr)	529.0
Average annual runoff produced by first 15 mm of runoff from impervious areas	516.3

As the annual volume of runoff that is treated by the bioretention system is greater than the annual runoff that the first 15mm of runoff from impervious areas accounts for, it can be concluded that the frequent flow management criterion is satisfied.

6 Conclusion

It is proposed that urban development occur in the Southern and Eastern precincts of the Secondary Urban Centre East land controlled by AMEX.

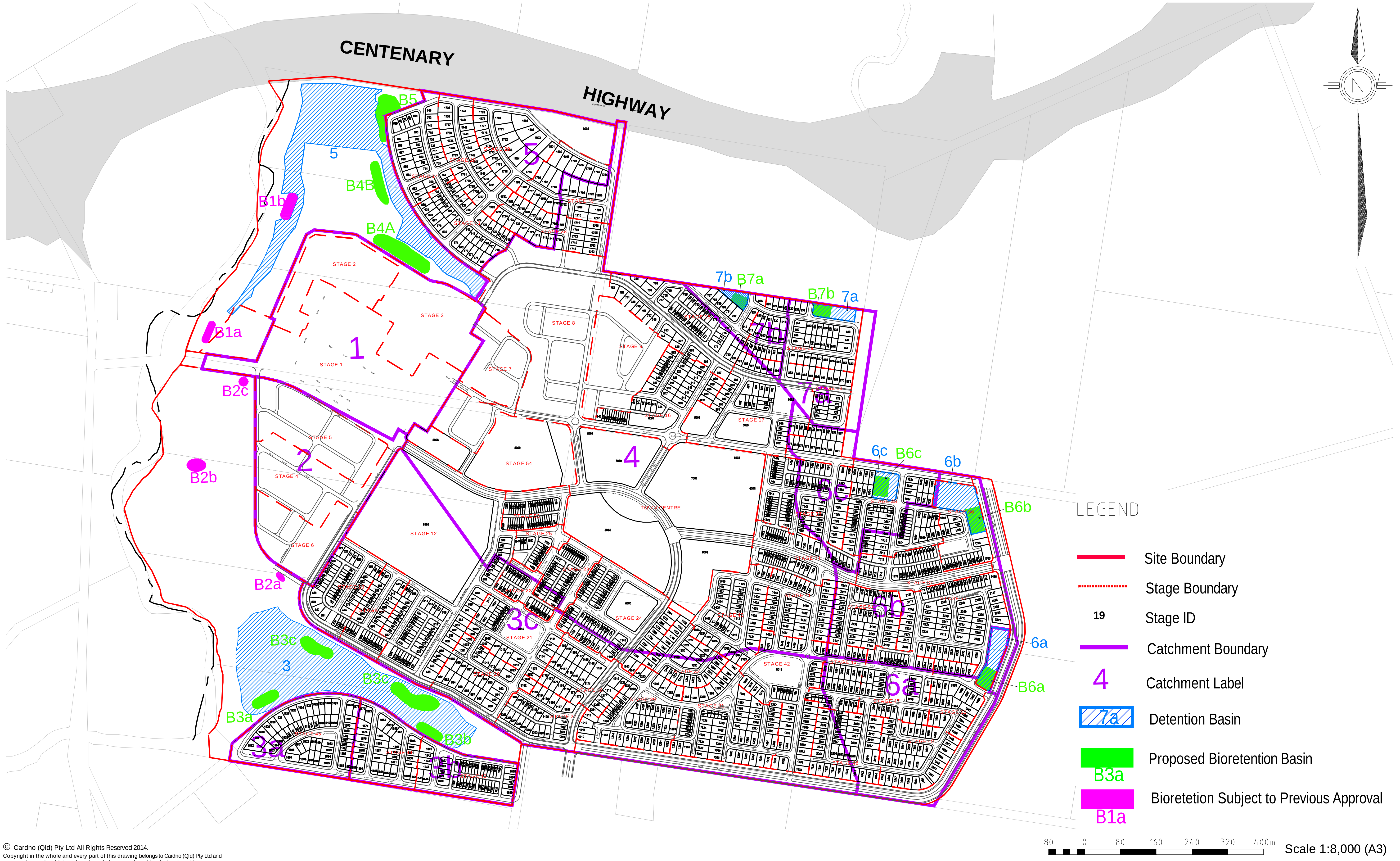
A stormwater management plan has been prepared for the proposed development detailing measures proposed to ensure that stormwater quality impacts as a result of the development are minimised. Stormwater quantity impacts are discussed in the Flood Study (Cardno, February 2013) for the site.

The proposed stormwater quality management plan includes several bioretention systems.

Modelling has been used to demonstrate that the stormwater quality management plan ensures that water quality objectives for the site are met.

Ripley Valley Secondary Urban Centre East - Southern and Eastern Precincts

FIGURES



Scale 1:8,000 (A3)

FIGURE 1

STORMWATER MANAGEMENT MEASURES

Rev: Orig. Date: 14 February 2014

Project No.: 7901/47

Amex Corporation Pty Ltd

PRINT DATE: 14 February, 2014 - 11:08am

CAD FILE: O:\7901-47-22\ACAD\Southern and Eastern Precincts\SMP\Figure 1_v4.dwg
XREF's:

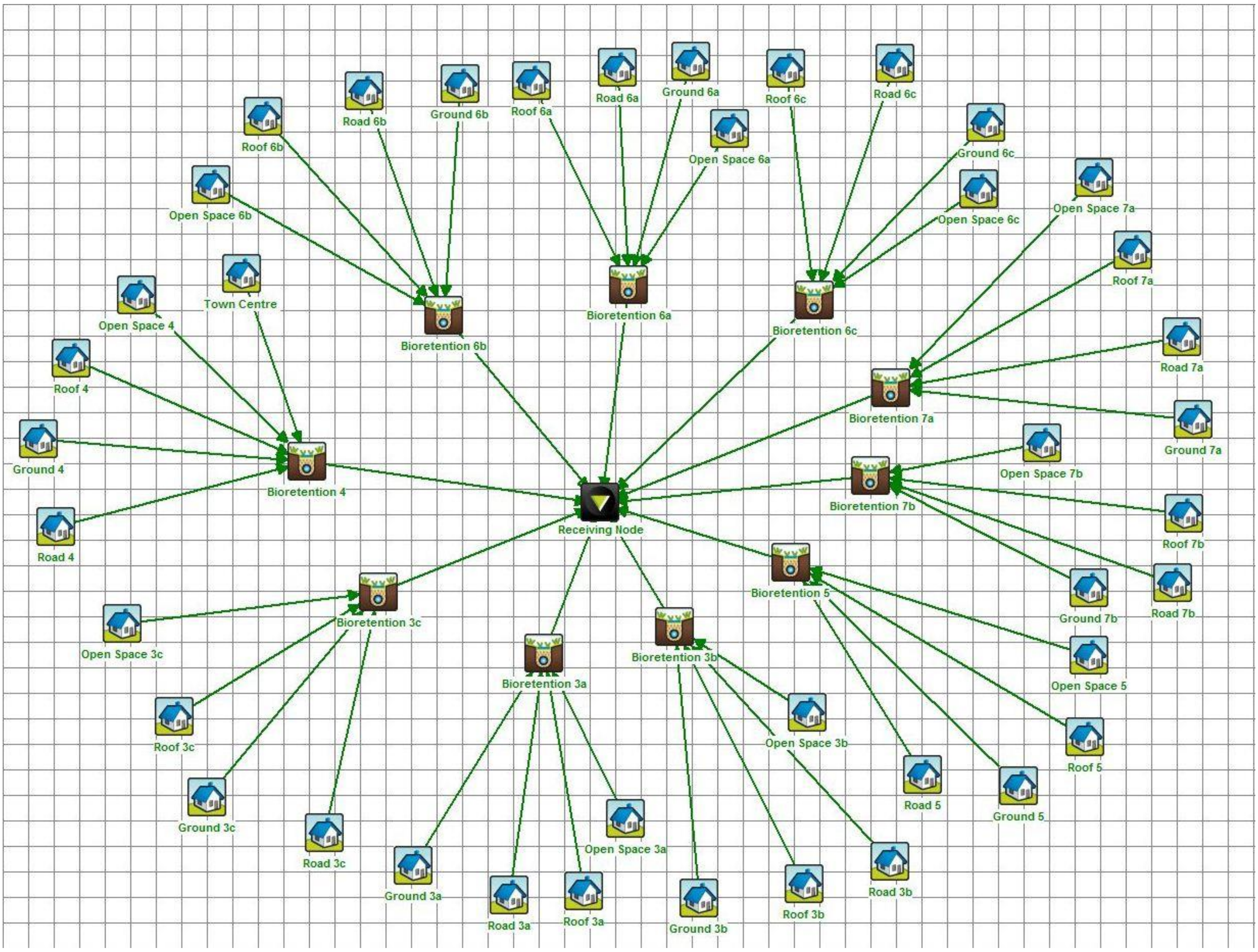
Ripley Valley Secondary Urban Centre
East - Southern and Eastern Precincts

APPENDIX

A

MUSIC Model Schematic

Cardno
Shaping the Future

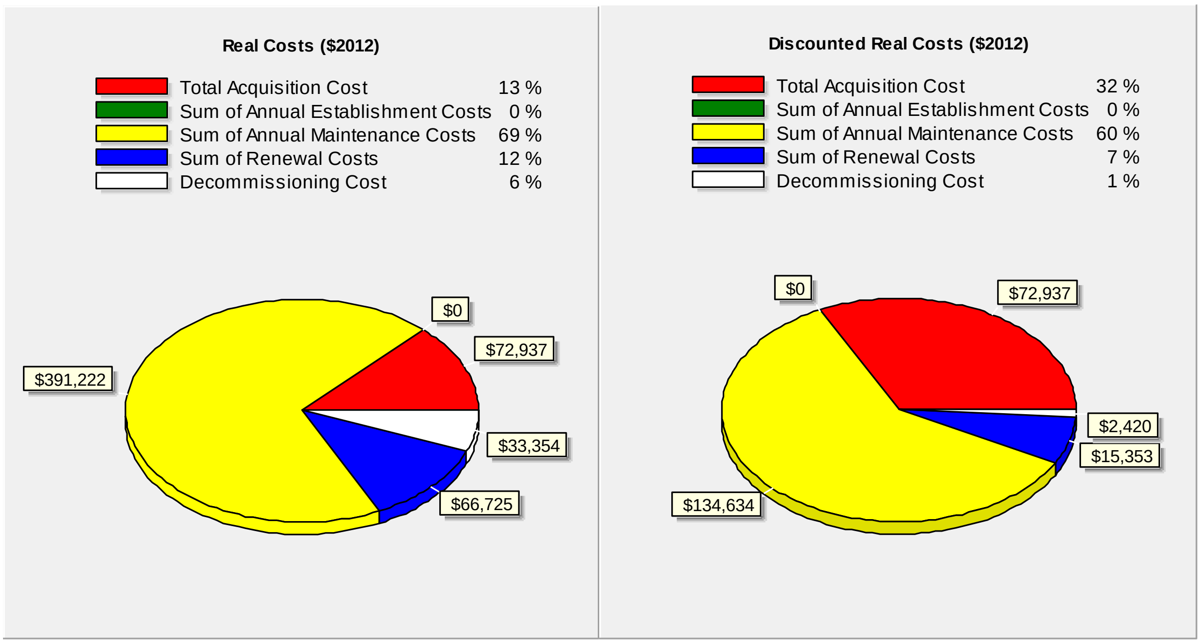

Road 6a
Ground 6a
Roof 6c
Road 6c
Road 6b
Ground 6b
Roof 6a
Roof 6b
Open Space 6a
Ground 6c
Open Space 6b
Open Space 6c
Open Space 7a
Town Centre
Bioretention 6a
Roof 7a
Open Space 4
Bioretention 6b
Bioretention 6c
Roof 4
Road 7a
Bioretention 7a
Ground 7a
Ground 4
Bioretention 4
Open Space 7b
Bioretention 7b
Receiving Node
Roof 7b
Road 4
Bioretention 5
Road 7b
Ground 7b
Bioretention 3c
Open Space 3c
Bioretention 3b
Bioretention 3a
Open Space 5
Roof 3c
Open Space 3b
Roof 5
Road 5
Ground 3c
Ground 5
Open Space 3a
Road 3c
Ground 3a
Road 3b
Road 3a
Roof 3a
Ground 3b
Roof 3b

Ripley Valley Secondary Urban Centre East - Southern and Eastern Precincts

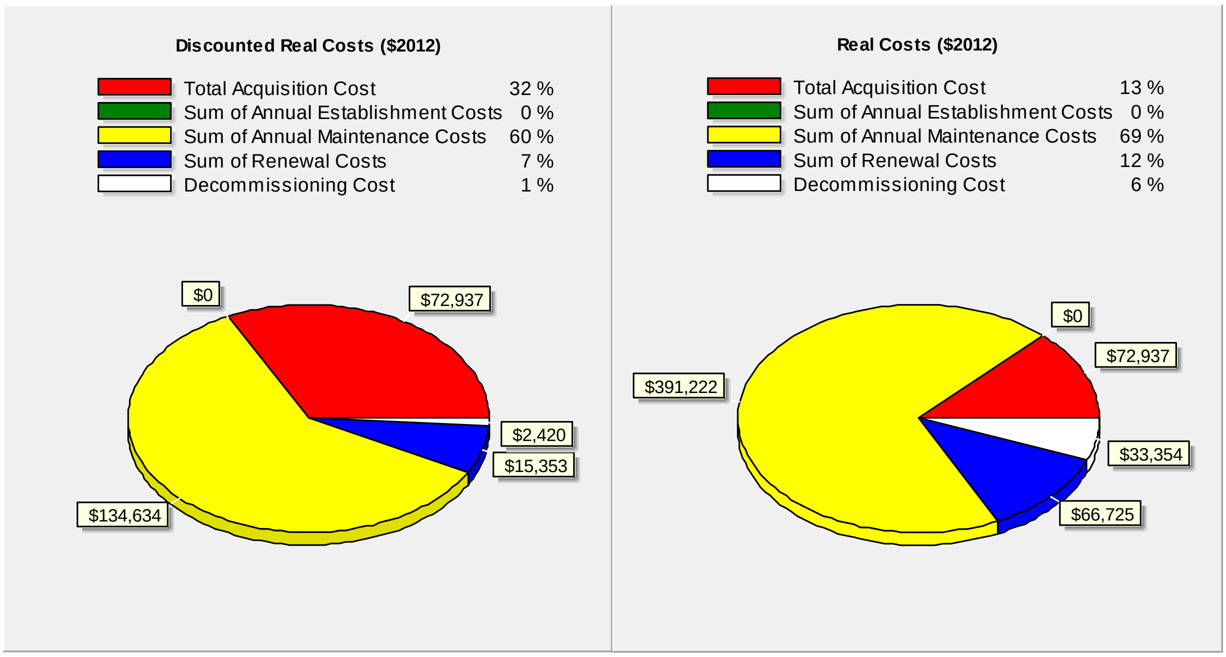
APPENDIX

B

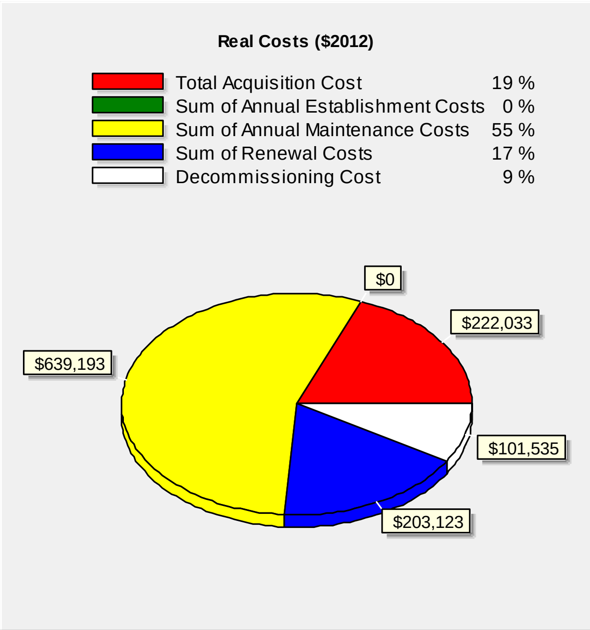
Relative Cost Distribution of all Cost Elements

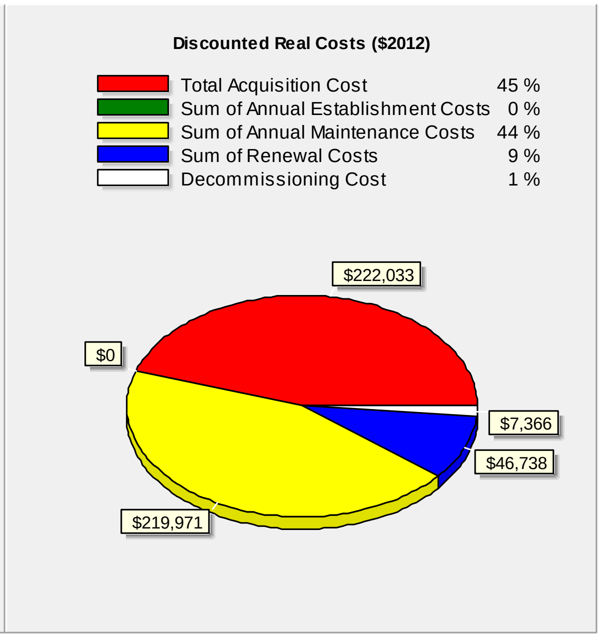


Bioretention Basin 3a

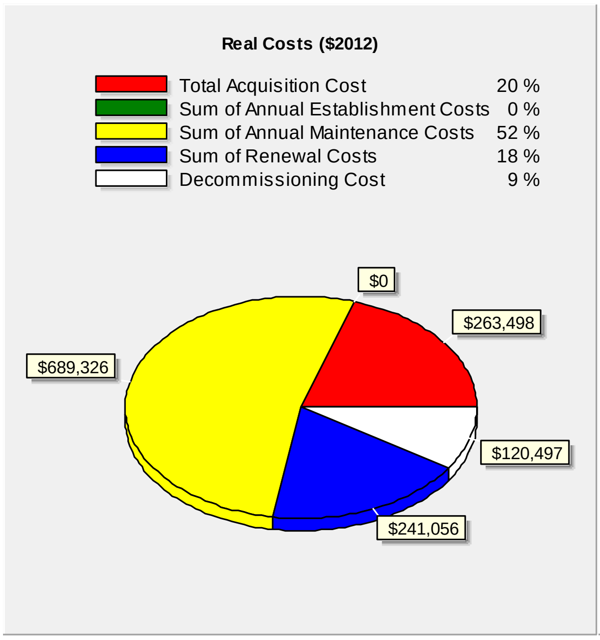


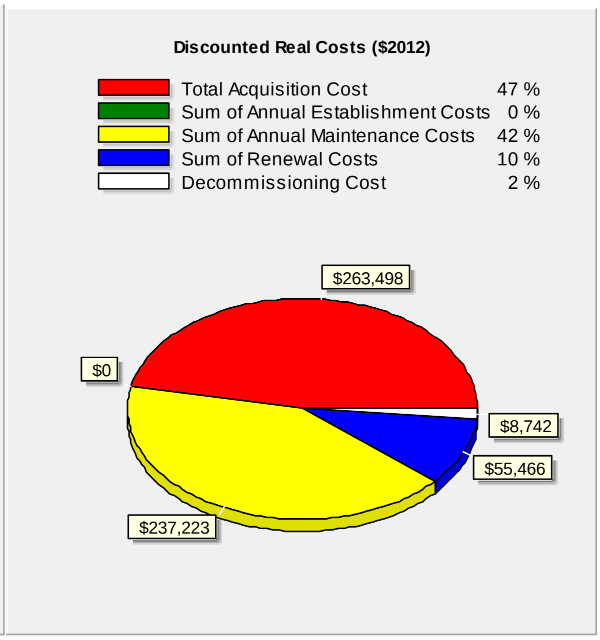
Bioretention Basin 3b



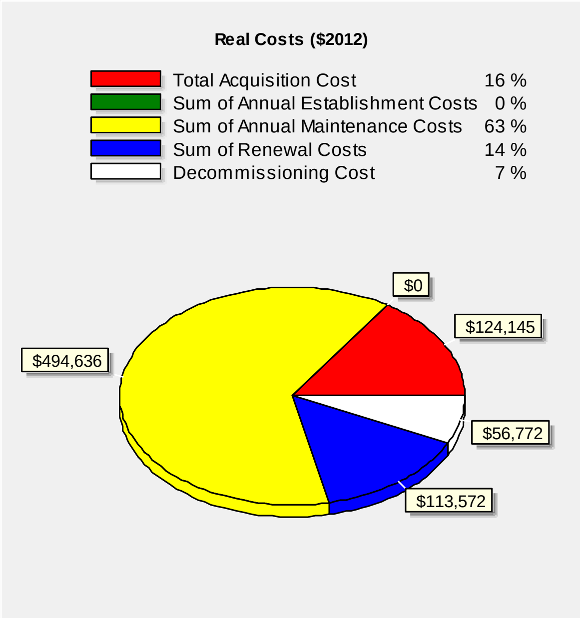


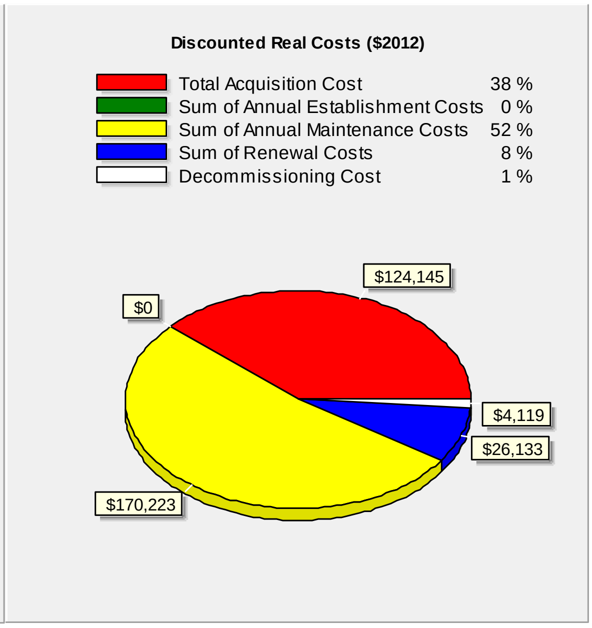
Bioretention Basin 3c



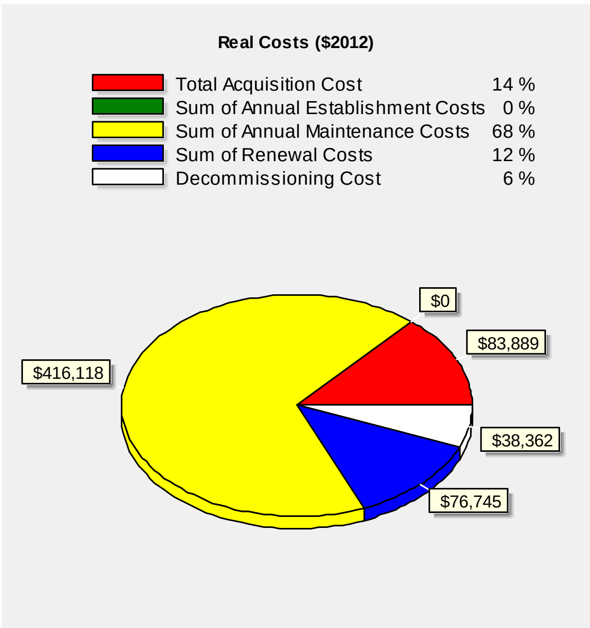


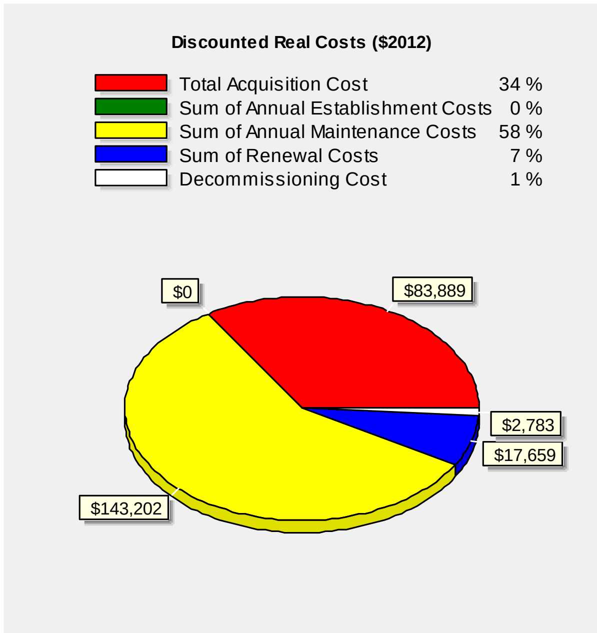
Bioretention Basin 4



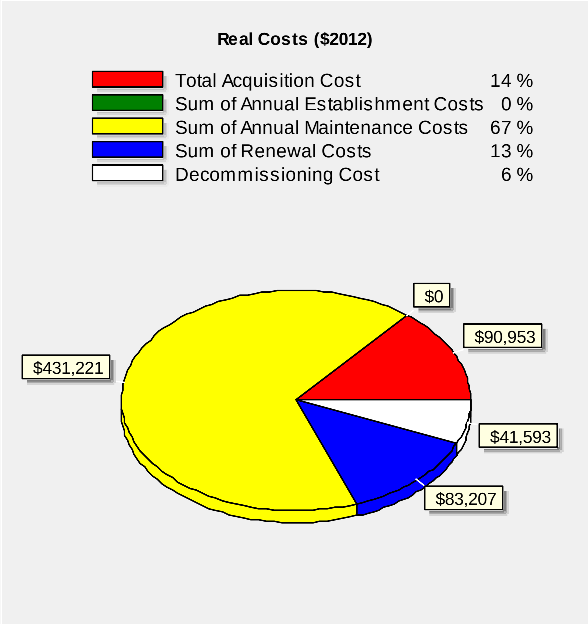


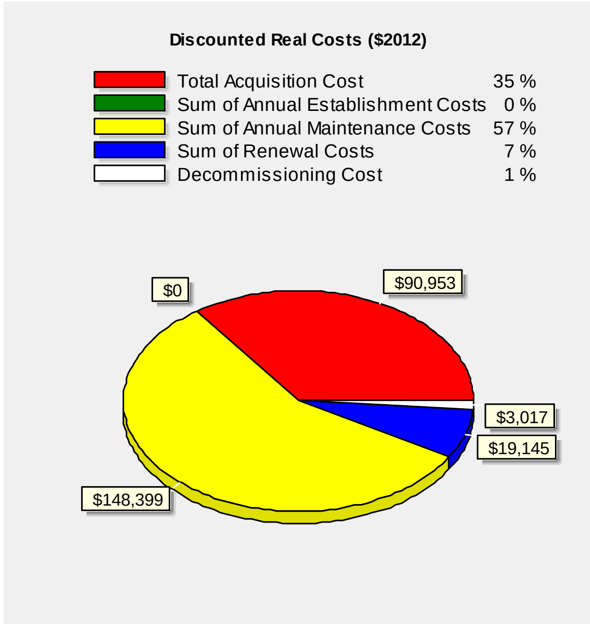
Bioretention Basin 5



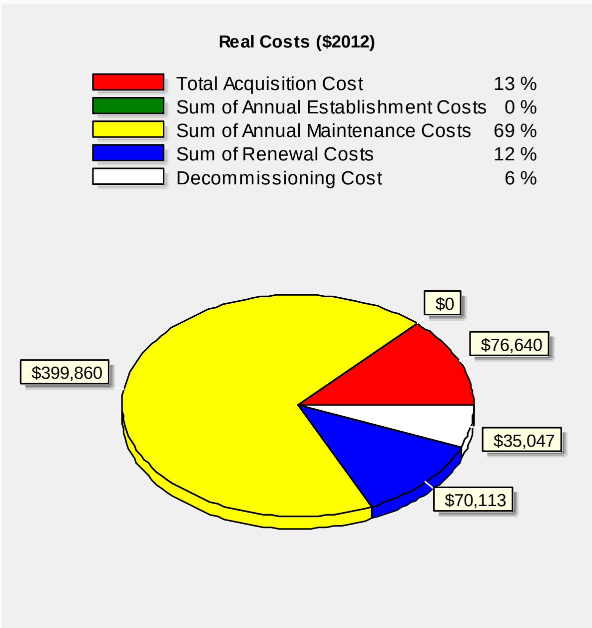


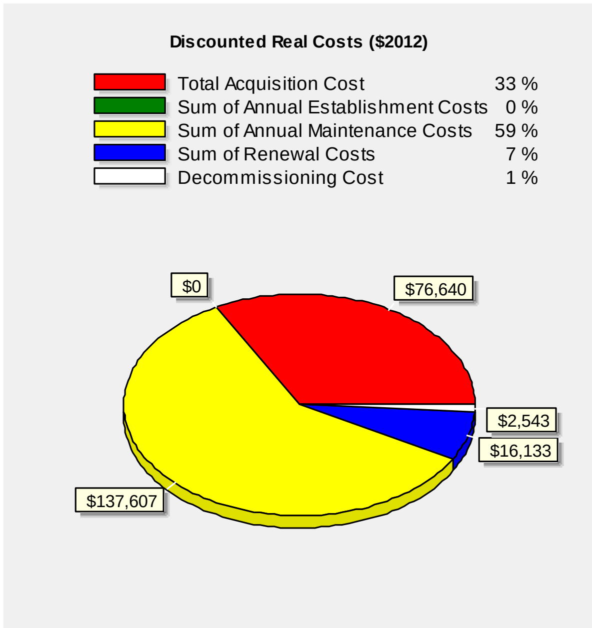
Bioretention Basin 6a



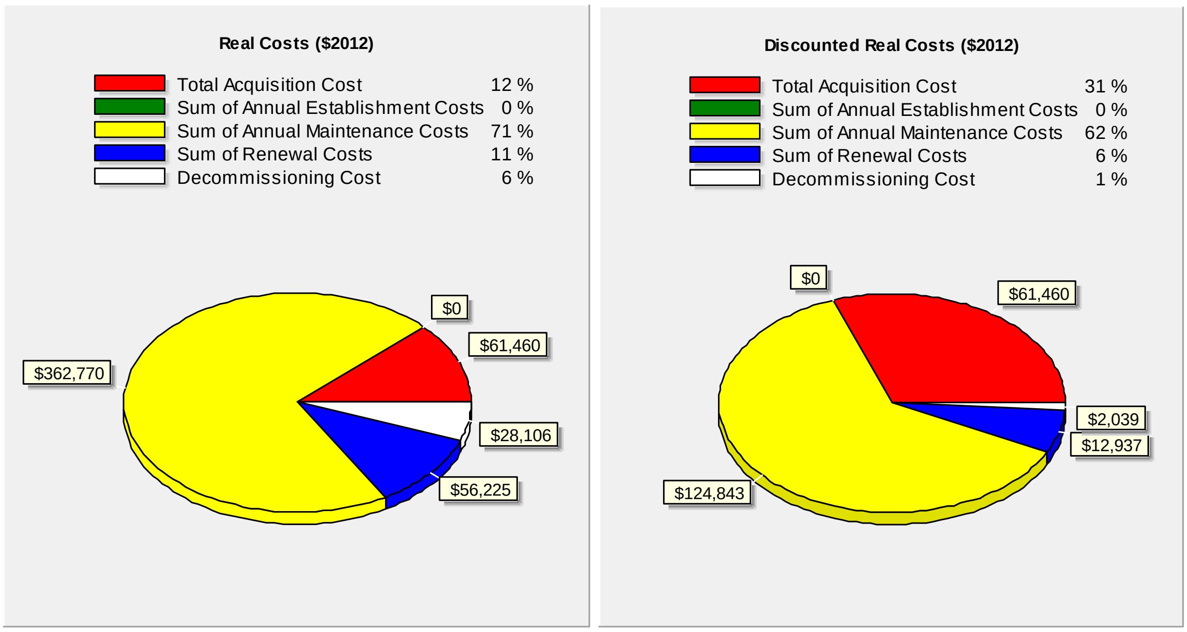


Bioretention Basin 6b

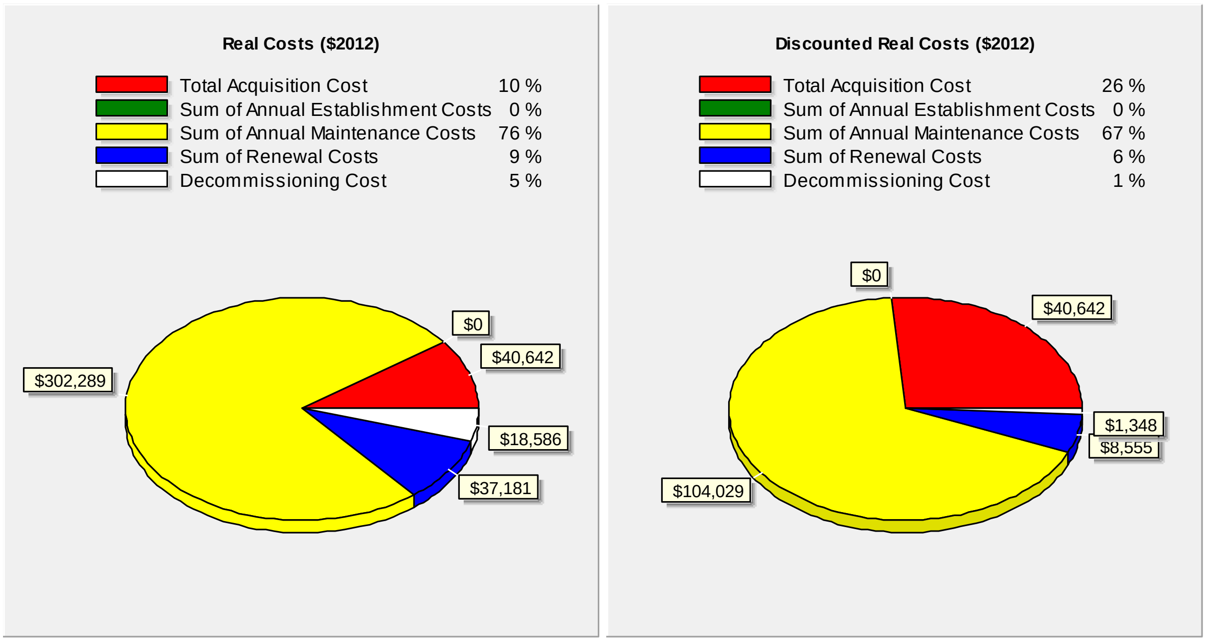




Bioretention Basin 6c



Bioretention Basin 7a



Bioretention Basin 7b