STORMWATER MANAGEMENT STRATEGY AND PLAN

SOUTH EAST REGIONAL HOSPITAL (BEGA HOSPITAL)

REPORT NO. R00801-SMP

REVISION A

AUGUST 2012

C&M Consulting Engineers Pty Ltd
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PROJECT DETAILS

Property Address: 1614 Tathra Road, Bega

Development Proposal: South East Regional Hospital (Bega Hospital)

REPORT CERTIFICATION

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REVISION	ISSUE DATE	ISSUED TO	ISSUED FOR
A	August 2012	Johnstaff	Information

EXECUTIVE SUMMARY

This *Stormwater Management Strategy and Plan (SMP)* has been prepared to supplement the Environmental Assessment (EA) for the South East Regional Hospital (Bega Hospital) development.

The SMP addresses the following DGRs:

- Item 11 Staging – Stage 1 Construction Enabling Works, Part 5 – Drainage;
- Item 11 Staging – Stage 2 Main Construction Works, Part 14 – Drainage and Stormwater;

In summary, the stormwater management works required for the proposed development will generally comprise the following:

1. A pipe network system to collect minor storm runoff from surface areas which will minimise nuisance flooding;

2. On-site stormwater detention system(s) to detain storm flows so that they can be slowly released over time to ensure that peak storm flows do not exceed that of the existing site for storm events up to and including a 1 in 2 year storm event. This will assist with maintaining environmental flows and reduce the likelihood of scouring and instability within downstream waterways;

3. Bio-retention basins (constructed within the on-site stormwater detention basins) to provide significant water quality treatment to runoff from impervious areas while at the same time providing additional stormwater detention.

4. Stormwater Quality Improvement Devices (SQIDs) including hydrodynamic separation via Vortex Device(s) or equal to provide water quality treatment to runoff from road and car park areas by removing sediment, oils and hydrocarbons.

5. Vegetated swales or bio swales to convey storm flows from car park areas while providing water quality treatment via filtration;

6. Overland flow paths (such as roads and swales) to carry major storms through the site without causing damage to property from flooding.

The results from the investigations and modelling for this project that have been summarised in this report, indicate that the proposed works with the proposed WSUD strategy and management can help provide a safe and ecologically sustainable environment.

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1. INTRODUCTION

This *Stormwater Management Strategy and Plan (SMP)* has been prepared to supplement the Environmental Assessment (EA) for the South East Regional Hospital (Bega Hospital) development.

The SMP addresses the following DGRs:

- Item 11 Staging – Stage 1 Construction Enabling Works, Part 5 – Drainage;
- Item 11 Staging – Stage 2 Main Construction Works, Part 14 – Drainage and Stormwater;

The scope of this report includes a comprehensive assessment of the requirements for stormwater management for the proposed works at the site. Accordingly, this report includes findings of this assessment and proposes a strategy for the best practice of stormwater management for the development.

The report describes the principles and operation of the proposed stormwater systems as well as the primary components of the drainage system.

The analysis and assessment has been based on and should be read in conjunction with the following documents:

- Concept Architectural Drawings for the proposed development prepared by BVN Architects;
- Concept Civil Engineering Drawings for the proposed development prepared by C&M Consulting Engineers;
- Bega Valley Shire Council Development Control Plan(s);
- “Australian Runoff Quality – A Guide to Water Sensitive Urban Design”, Engineers Australia (2006);
- “Australian Rainfall and Runoff: A Guide to Flood Estimation – Volume 1”, Engineers Australia (1987);

2. STORMWATER MANAGEMENT

2.1 BACKGROUND

The objective is to provide stormwater controls, which ensure that the proposed works do not adversely impact on the stormwater flows and water quality of flow paths within, adjacent and downstream of the site.

Increased impervious surfaces and alteration of the natural topography due to land development has the potential to increase peak storm flows and tends to concentrate these flows. This has the potential to impact on flood regimes and erosion of the downstream drainage system.

To avoid any adverse impact on the downstream drainage systems, the site stormwater system is required to be planned correctly to ensure safe conveyance of flows through the site and within the capacity of the downstream trunk drainage systems.

2.2 KEY ISSUES

The key issues and the mitigating measures to be employed within the proposed development site are:

- **Water Quantity** - Increased impervious surfaces (such as roofs, driveways, etc) have the potential to increase the storm water flows from the site during storm events. To avoid impacting on the downstream drainage system, the site storm water system has been planned to safely convey the flows through the site and within the capacity of the downstream system.

- **Water Quality** - Urban developments have the potential to increase gross pollutants, sediments and nutrient concentrations in storm water runoff. To limit impact on the downstream water quality, pollution control measures will be provided at each storm water outlet prior to discharging to the existing drainage system.

2.3 THE SITE

The description of the site and its context as well as current planning instruments are described in the Environmental Assessment. It is intended to not reiterate these items in this report; however some general drainage issues specific to the site will be described as follows.

The site is located at 1614 Tathra Road, Bega (refer Figure 1).

Figure 1 - Site Location

The site is generally bounded by Tathra Road to the west, Boundary Road to the south and Bega River to the east (but approximately 500m from the hospital site).

The site is a genuine greenfield site. There is no existing development on this site. The site is currently rural and is used as grazing land for cattle.

There is a ridge line through the site generally running from the southwest corner of the site to the northeast corner of the site which splits the site generally into two drainage catchments. Catchment A is approximately 5.3ha and drains to the northern site boundary. Catchment B is approximately 12.4ha and drains to the eastern site boundary (refer Appendix A for Catchment Plan).

The site is approximately 500m west of the Bega River and is located generally on the fringe of the Bega River Floodplain. There are no watercourses on the actual hospital site; however there are two small watercourses near to the northern and eastern site boundaries. These watercourses drain to the nearby Bega River (refer Figure 2).

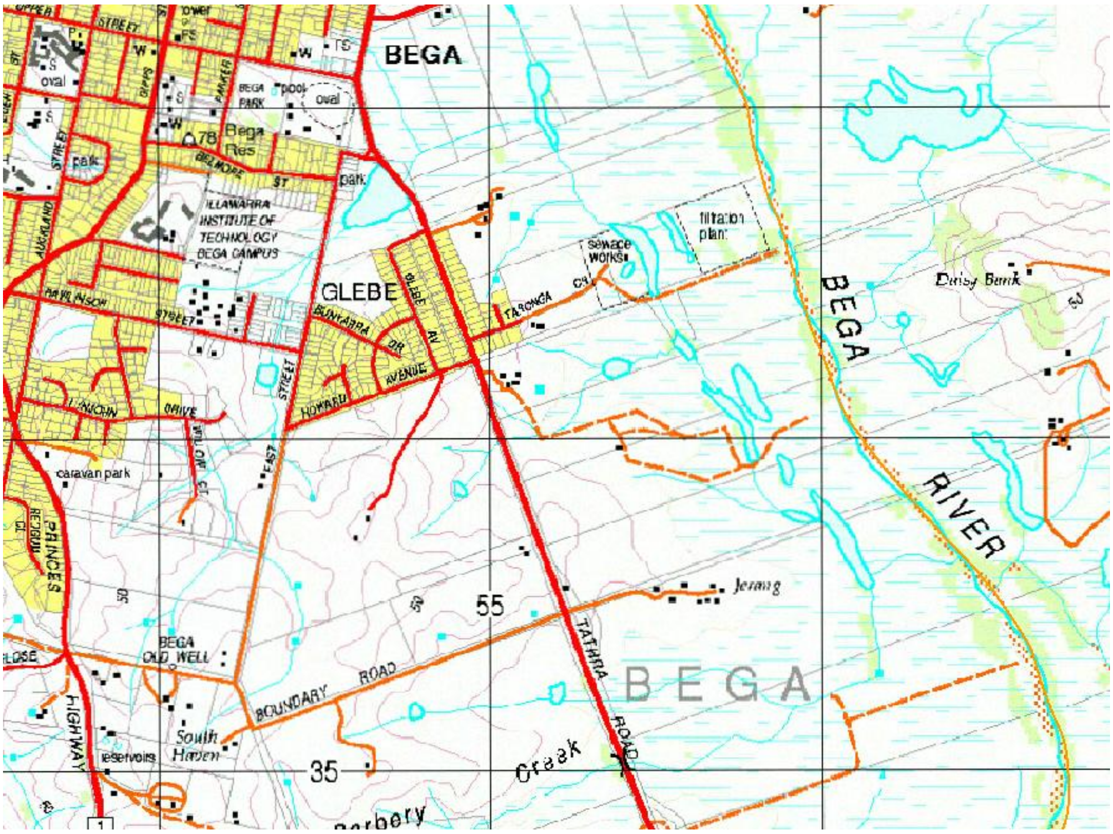


Figure 2 – Topography of the Site

2.4 DESIGN GUIDELINES

The site based stormwater management elements are to be designed and constructed in accordance with the following:

<u>Water Quantity</u>

Bega Valley Shire Council generally would not require On Site Stormwater Detention (OSD) to be provided for this site as it drains almost directly to the Bega River and it would be counterproductive during large storm events to detain stormwater from discharging from the site.

However, from our discussions with Council Engineer’s, it was agreed that for this site, there is merit in providing OSD for more frequent storm events to minimise the impact on the downstream natural environment by maintaining “environmental” peak storm flows to that of the existing site.

By maintaining the current flow volumes and frequencies of storm events post development, there will be positive benefit to the environment by reducing the potential for hydraulic disturbance to the downstream waterways.

In summary, the following OSD design parameters have been adopted for this project:

- Peak discharges from storm events up to and including a 1 in 2 year Average Recurrence Interval (ARI) event post development, shall be maintained at the pre development peak flow for the same storm event.

  Inclusion of an additional flow control measure for storm events up to a 1 in 2 year ARI (as described above) will provide greater control of peak storm flows from more frequent storm events post development. This will reduce the likelihood of scouring and instability within the downstream waterways.

Water Quality

Whilst Bega Valley Shire Council does not have a formal water quality policy for stormwater, it was agreed with Council Engineers that typical industry water quality reduction targets based on "Urban Stormwater Best Practice Environmental Management Guidelines, CSIRO", be adopted for this project. Table 1 indicates the reduction targets to be achieved by this project.

Table 1 - Water Quality Reduction Targets

PARAMETERS	CRITERIA
Gross Pollutants	100% reduction in the average annual load generated from the development site.
Total Suspended Solids	80% reduction in the average annual load generated from the development site.
Total Phosphorus	45% reduction in the mean annual load generated from the development site.
Total Nitrogen	45% reduction in the mean annual load generated from the development site.
Oils and Hydrocarbons	No visible oils and hydrocarbons

Development typically increases the area of impermeable surface (i.e. roofs, roads, car parks, footpaths, etc.) on a given site which leads to an increase in the volume of stormwater runoff from that site during storms. During regular rainfall events, stormwater runoff flushes pollutants that have accumulated on the impermeable surfaces during the dry period prior to the rainfall occurring. These pollutants, if not treated or removed, can impact on downstream receiving waters and the environment.

Council requires that treatment and/or pollutant removal occurs as close as practical to the source so as to maximise the effectiveness of the treatment measure or device.

2.5 OBJECTIVES AND TARGETS

Compatible with the legislation, policy and requirements, the objectives and targets for stormwater management are as provided in Table 2.

Table 2 - Stormwater Management Objectives

STORMWATER MANAGEMENT	OBJECTIVES	TARGET
Quantity	▪ The existing runoff flow regimes for the full storm events should be maintained, and provide safe conveyance systems for the major storm events. ▪ Development should not result in significant changes to runoff quantities or patterns, or flow quantities or patterns.	▪ Maintain existing runoff flow regimes including: – No increase in peak runoff. – No increase in frequency of runoff. – No adverse impact on downstream properties.
Quality	▪ The health of receiving water should be maintained or improved ▪ Development should not result in increased pollutant loads or concentrations.	▪ Runoff from site to have no increase in pollutant loads or concentrations.

2.6 OVERALL STRATEGIES

The proposed stormwater management strategies to manage runoff to ensure no detriment to the receiving environments have been divided into both short and long term strategies as summarised in Table 3.

Table 3 - Stormwater Management Strategies

STRATEGY	DESCRIPTION
Short Term Strategies	Short term strategies generally refer to control of soil and water erosion control during the construction phase. The primary risk occurs while soils are exposed during construction works when suspended sediment and associated pollutants can be washed into downstream waterways. The strategies to prevent this potential degradation include adequate provision of sediment and erosion control measures that should be documented prior to commencement of the works in a Construction Environmental Management Plan (CEMP). The controls will limit movement of sediment in disturbed areas, and will be designed to remove sediment from runoff prior to discharge from site.
Long Term Strategies	Long term strategies to maintain stormwater quality discharged from the site include utilisation of a number of permanent treatment measures to remove litter, suspended solids, and nutrients effectively. The main measures to be implemented include rainwater tanks to collect roof water for water re-use, vegetated swales and bio-retention basins.

This report addresses the long term impacts of the proposed works. For short term effects (i.e. during the construction phase) water quality control is achieved by implementing the measures in the Sedimentation & Erosion Control Plans.

3. STORMWATER QUANTITY CONTROL

3.1 INTRODUCTION

Development which increases the impervious surfaces (such as roofs, car parks, etc) of a site has the potential to increase the peak storm water flows from that site during equivalent storm events. To avoid impacting on the downstream drainage system, site stormwater systems are designed to incorporate controls so that the peak storm out-flows from the developed site can be limited so as not to exceed the capacity of the downstream drainage system. This method is normally referred to as stormwater detention.

The main criterion for the stormwater quantity control is to ensure that the post developed peak flows do not exceed the pre-developed peak flows at the downstream of the development site.

3.2 RUNOFF CONTROL

3.2.1 PROPOSED DRAINAGE SYSTEM

The drainage system for the proposed development will be designed to collect the majority of concentrated flows from impermeable surfaces such as roads, car park areas and buildings. Where possible (and practical), runoff from pervious areas will also be collected.

The drainage system proposed for the development includes:

- Roof drainage including roof drains, gutters and downpipes;
- A pipe network system to collect minor storm runoff from areas;
- Overland flow paths to carry major storms through the site;
- On-site stormwater detention system.

3.2.2 ON-SITE STORMWATER DETENTION (OSD) REQUIREMENTS

In summary, the following design parameters are applicable to the development:

- Peak discharges from storm events up to and including a 1 in 2 year Average Recurrence Interval (ARI) event post development, shall be maintained at the pre development peak flow for the same storm event.

This measure will provide greater control of peak storm flows from more frequent storm events post development. This will reduce the likelihood of scouring and instability within the downstream waterways.

The detention storage was modelled using DRAINS to estimate the minimum storage volumes required to maintain the permissible site discharge. The detention requirements for the proposed redevelopment areas are summarised in Table 4 below.

Table 4 - Summary of OSD Requirements

CATCHMENT AREA	AREA (ha)	PSD Up to 2 YR ARI (l/s)	MINIMUM OSD STORAGE REQUIRED (m^3)	ESTIMATED DISCHARGE AFTER OSD (l/s)
Catchment A – North	7.45	393	935	393
Catchment B – East	10.1	421	1565	421

The results indicate that Catchment A (Northern Catchment) requires a minimum detention storage of 935m^3 and Catchment B (Eastern Catchment) requires a minimum storage volume of 1,565m^3.

4. WATER QUALITY CONTROL

4.1 INTRODUCTION

The quality of runoff from a catchment depends upon many factors such as land use, degree of urbanisation, population density, sanitation and waste disposal practices, landform, soil types, and climate. Pollutants typically transported by runoff include litter, sediment, nutrients, oil, grease, and heavy metals. Whilst these pollutants have a deterious impact on receiving water quality, the suspended solids and nutrients are the most detrimental impact on the environment. Litter, oils, and other surfactants have an aesthetic impact.

Activity within a catchment during urbanisation includes the disturbance of vegetation, removal of topsoil, landshaping, road construction, installation of services, and building works. It is during this phase that the sediment movement is greatest and is estimated that the sediment production levels may be up to 6 times higher than under the existing conditions. However, once development is completed, the sediment loading may return to the existing level or remain at a higher level depending on land management practices.

As with all development projects, soil erosion during the construction phase presents a potential risk to water quality. The primary risk occurs while soils are exposed during earthworks when suspended sediment and associated pollutants can be washed into downstream watercourses.

This section of the report addresses the long term impacts of the development on water quality. For short term effects (i.e. during the construction phase) water quality control is achieved by implementing the measures in the Sedimentation and Erosion Control Plan and the Soil and Water Management Plan for the project.

4.2 WATER QUALITY CONTROL MEASURES

There are number of measures that can reduce pollutant loadings, however, each different type has its own effectiveness in reducing pollutant loadings that depends on land use type, topography and the target control.

The adopted Treatment Train will provide the most efficient and manageable measures, suited to the subject development setting, surrounded by environmentally sensitive areas such as the Bega River.

The measures proposed for the development are summarised in Table 5.

Table 5 - Water Quality Control Measures Included in the MUSIC Modelling

MEASURES	DESCRIPTIONS
Bioretention	▪ A bioretention system is a vertical filtration system that filters stormwater through a prescribed media (e.g. sandy loam) before being collected by an underlying perforated pipe for subsequent discharge to the receiving water. ▪ The filtration media should have a permeability of at least one order of magnitude higher that the surrounding soils to ensure that the pathways of stormwater through the system is well-defined and directed at the perforated pipe underlain. ▪ The standard bioretention basin in this study has a detention depth of 0.40m and the filter media depth of 0.50m.
Vegetated Swale	▪ Vegetated swales are shallow vegetated ephemeral channels effective at reducing stormwater pollution and preventing flooding. The vegetation is often grass, but other types of vegetation may also be appropriate. ▪ Swales are typically located along and on the lower side of roads, carparks, and non-roof areas where flows are intermittent and volumes are manageable. ▪ The standard swale in this study is based on a swale system having a 1.3m top width, 0.3m base width, 0.5m depth and 250mm high grass cover, with the length adjusted to suit the area ratio.
Hydrodynamic Separator – Silt, Oil & Hydrocarbon Arrestor	▪ Hydrodynamic Separator - silt, oil & hydrocarbon arrestor proposed for the development is the Vortex (by Stormwater360). ▪ The device has been chosen for its ability to remove fine sediment, oils and hydrocarbons.
Vegetation Buffers	▪ Natural or landscaped vegetated buffers will be maintained along the edges of roads, accesses, and areas of activity. ▪ These areas will further reduce pollutants and increase the pollutant reduction levels achieved.

4.3 STRATEGY EFFECTIVENESS

The effectiveness of the proposed water quality measures have been assessed using numerical modelling. The results were assessed against the established Council requirements to determine the effectiveness of the proposed strategy.

4.3.1 MUSIC MODELLING

The water quality model adopted for this project is the MUSIC (Model for Urban Stormwater Improvement Conceptualisation) water quality numerical model developed by the MUSIC Development Team of the Cooperative Research Centre for Catchment Hydrology (CRCCH). MUSIC is an event basis model, and will simulate the performance of a group of stormwater management measures, configured in series or in parallel to form a “treatment train”.

The MUSIC User Manual (CRCCH 2004) suggests that the time-step should not be greater than the time of concentration of the smallest sub-catchment, but consideration should also be given to the smallest detention time of treatment nodes in the system. To accurately model the performance of the treatment nodes, a 6-minute time step was chosen.

The MUSIC model was generated using the historical 6-minute rainfall and monthly evapotranspiration data for Wyndham for a period of 10 years from 1997 to 2006 (obtained from the Bureau of Meteorology).

Catchment characteristics were defined using a combination of roof, road, car park and landscape areas with varying imperviousness ratios to replicate the catchment for the post development condition.

4.3.2 EVENT MEAN CONCENTRATION

MUSIC uses different event mean concentrations (EMC) to determine the pollutant loads generated by different land uses. The standard EMCs adopted within MUSIC were based on research undertaken by Duncan (1999) through the CRCCH and the results are reproduced in Australian Runoff Quality – A Guide to Water Sensitive Urban Design (ARQ).

The EMC values used in the MUSIC models for this project were taken from ARQ. Table 6 summarises the parameters used.

Table 6 - EMC Parameters

LAND USE	MEAN BASE FLOW CONCENTRATION PARAMETERS (MG/L)			MEAN STORM FLOW CONCENTRATION PARAMETERS (MG/L)		
	TSS	TP	TN	TSS	TP	TN
Carparks	12.6	0.151	2.09	191	0.251	2.29
Roads & Carparks	12.6	0.151	2.09	191	0.251	2.29
Roofs	n/a (i)	n/a (i)	n/a (i)	35.5	0.129	2.19
Future Development	12.6	0.151	2.09	158	0.355	2.63

(i) Roof area is 100% impervious so there is no base flow generated from these areas.

4.3.3 CONFIGURATIONS

Table 7 and Table 8 provide the catchment areas and the stormwater treatment measures and/or stormwater quality improvement devices (SQID) used in the MUSIC model.

Table 7 - Catchment Areas

LAND USE	CATCHMENT	
	AREA (ha)	% IMPERVIOUS
Catchment A – North		
Carpark Area	0.530	95
Road and Carpark Area	1.047	95
Roof Area	0.344	100
Future Development Area	4.178	80
Catchment B – East		
Carpark Area	1.021	95
Road and Carpark Area	0.538	95
Roof Area	0.898	100
Future Development Area	5.148	80

Table 8 - Stormwater Treatment Measures and/or Stormwater Quality Improvement Devices (SQID)

STORMWATER TREATMENT MEASURE AND/OR STORMWATER QUALITY IMPROVEMENT DEVICE (SQID)	MINIMUM QUANTITY REQUIRED
Catchment A – North	
• Hydrodynamic Separator (Vortex or HumeCeptor)	1
• Bio-retention Area (Basin)	$300m^2$
• Vegetated Swale / Bio Swale	100m
Catchment B – East	
• Hydrodynamic Separator (Vortex or HumeCeptor)	1
• Bio-retention Area (Basin)	$300m^2$
• Vegetated Swale / Bio Swale	100m

4.3.4 RESULTS

The results of the MUSIC modelling are summarised in Table 9.

The total pollutant loads from the development are expressed in kilograms per year. The reduction rate is expressed as a percentage and compares the resulting pollution where treatment measures are provided versus a situation where no treatment is provided (i.e. comparing the development without controls versus development with controls).

Table 9 - Summary of MUSIC Model Results

PARAMETER	TARGET REDUCTION (%)	POST DEVELOPMENT WITH NO TREATMENT (KG/YR)	POST DEVELOPMENT WITH TREATMENT (KG/YR)	% REDUCTION	MEETS THE TARGET
Catchment A – North					
GP	100	975	0.0	100	Yes
TSS	80	5230	781	85.1	Yes
TP	45	10.2	5.2	49.4	Yes
TN	45	82.9	45.4	45.2	Yes
Catchment B – East					
GP	100	1220	0.0	100	Yes
TSS	80	6110	741	87.9	Yes
TP	45	12.4	6.0	51.6	Yes
TN	45	103.0	52.6	49.1	Yes
Combined Effectiveness					
GP	100	2190	0.0	100	Yes
TSS	1	11300	1520	86.6	Yes
TP	45	22.6	11.2	50.5	Yes
TN	45	186.0	98.0	47.4	Yes

Notes:
GP = Gross Pollutants
TSS = Total Suspended Solids
TP = Total Phosphorus
TN = Total Nitrogen

In all instances, the adopted water quality control measures enabled achievement of the required water quality targets confirming that the development can meet the requirements by implementing the proposed treatment measures within the proposed development.

5. FLOODING

The hospital site is generally located on the fringe of the Bega River Floodplain. The intent of the SMP is to address stormwater related issues rather than flooding.

Flooding in the vicinity of the hospital site has been investigated and outlined in the following reports that have been included in the Environmental Assessment and should be referred to for information on flooding:

- "Bega Valley Health Service Hospital Development Flooding Aspects" prepared by WMAwater, March 2012
- "Bega Valley Health Service Hospital Development – Review of Flooding Aspects" prepared by ARUP, May 2012

6. RECOMMENDATIONS

Development of the site could potentially lead to significant changes in water quantity as well as quality if a water sensitive urban design approach is not adopted as part of the redevelopment strategy.

The traditional stormwater management and investigation that only considers impacts of flooding and flood mitigation is a thing of the past. Stormwater management practices must now also consider water quality, aquatic habitats, riparian vegetation, recreation, aesthetic and economic issues.

The key strategies to be adopted include the following:

1. A pipe network system to collect minor storm runoff from surface areas which will minimise nuisance flooding;

2. On-site stormwater detention system(s) to detain storm flows so that they can be slowly released over time to ensure that peak storm flows do not exceed that of the existing site for storm events up to and including a 1 in 2 year storm event. This will assist with maintaining environmental flows and reduce the likelihood of scouring and instability within downstream waterways;

3. Bio-retention basins (constructed within the on-site stormwater detention basins) to provide significant water quality treatment to runoff from impervious areas while at the same time providing additional stormwater detention.

4. Stormwater Quality Improvement Devices (SQIDs) including hydrodynamic separation via Vortex Device(s) or equal to provide water quality treatment to runoff from road and car park areas by removing sediment, oils and hydrocarbons.

5. Vegetated swales or bio swales to convey storm flows from car park areas while providing water quality treatment via filtration;

6. Overland flow paths (such as roads and swales) to carry major storms through the site without causing damage to property from flooding.

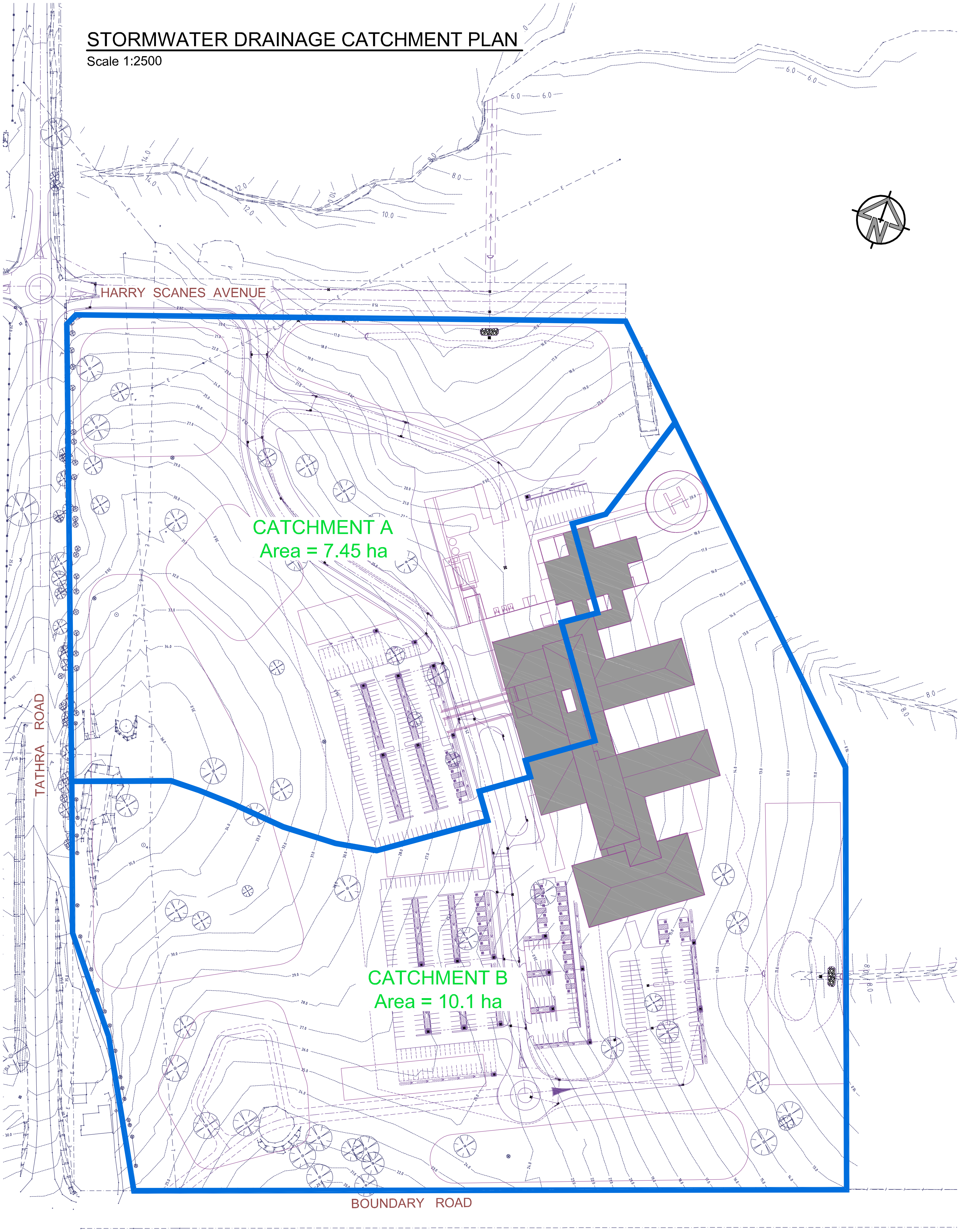
The results from the investigations and modelling for the redevelopment that have been summarised in this report, indicate that the proposed works with the proposed WSUD strategy and management can provide a safe and ecologically sustainable environment.

APPENDIX A

CATCHMENT PLAN

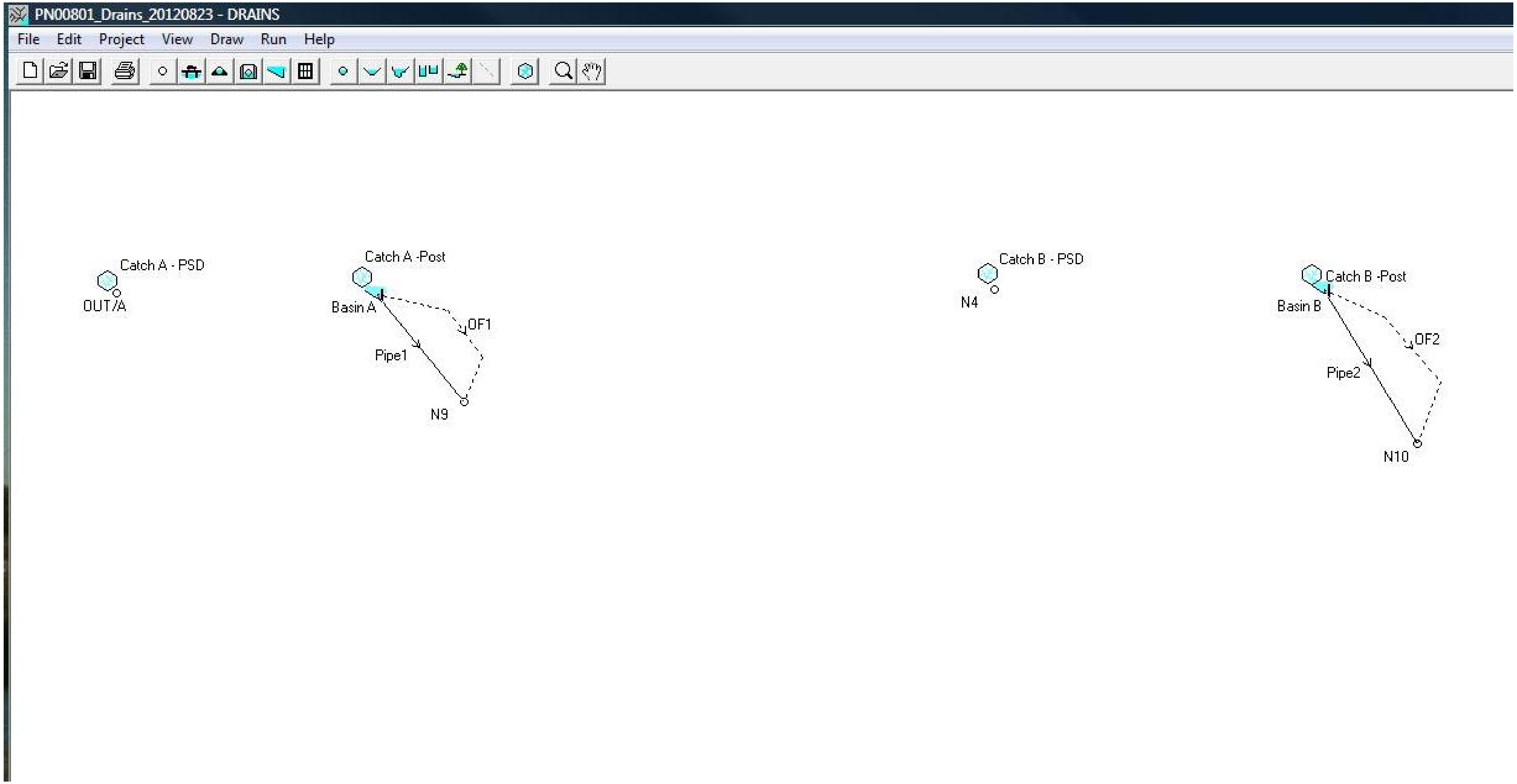
STORMWATER DRAINAGE CATCHMENT PLAN

Scale 1:2500



APPENDIX B

DRAINS MODEL RESULTS


PN00801_Drains_20120823 - DRAINS
File Edit Project View Draw Run Help
Catch A - PSD
OUT/A
Catch A -Post
Basin A
OF1
Pipe1
N9
Catch B - PSD
N4
Catch B -Post
Basin B
OF2
Pipe2
N10

DRAINS DATA

PIT / NODE DETAILS

Name	Type	Family	Version 9 Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss
OUT/A	Node					15		0		167	-202		3	
N4	Node							0		877	-199		7	
N9	Node					14		0		448	-290		21	
N10	Node					11		0		1219	-324		24	

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Init Vol. (cu.m)	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Length(m)
Basin A	13.7	1.44	0	Orifice		354	12.8			377	-203	No		
	14.09	1.44												
	14.1	690												
	14.3	843												
	14.5	1000												
	14.7	1155												
	14.9	1315												
	15.1	1475												
Basin B	8.5	1.44	0	Orifice		354	7.45			1143	-199	No		
	8.89	1.44												
	8.9	1190												
	9.1	1292												
	9.3	1400												
	9.5	1510												
	9.7	1624												
	9.9	1743												
	10.1	1868												

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Paved Time (min)	Grass Time (min)	Paved Length (m)	Grass Length (m)	Paved Slope(%) %	Grass Slope %	Paved Rough	Grass Rough	Lag Time or Factor
Catch A - PSD	OUT/A	7.45	5	95	5	0	300	300	2	2	0.025	0.12	0
Catch B - PSD	N4	10.1	5	95	5	0	400	400	1.5	1.5	0.025	0.12	0
Catch A - Post	Basin A	7.45	75	25	5	0	300	300	1.5	1.5	0.025	0.12	0
Catch B - Post	Basin B	10.1	75	25	5	0	400	400	1.5	1.5	0.025	0.12	0

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg
Pipe1	Basin A	N9	15	12.5	12.35	1	Concrete	600	600	0.3	NewFixed	1	N9	0
Pipe2	Basin B	N10	15	7	6.85	1	Concrete	900	900	0.3	NewFixed	1	N10	0

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	SafeDepth Minor Storms (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %
OF1	Basin A	N9	0.1	16	10	1.7	-	0.2	0.05	0.6	1	0
OF2	Basin B	N10	0.1	13	10	1.7	-	0.2	0.05	0.6	1	0

DRAINS RESULTS

DRAINS results prepared 23 August, 2012 from Version 2007.05

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N9	12.66		0				
N10	7.12		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Catch A - PSD	0.393	0.059	0.376	26.16	54.23	0	AR&R 2 year, 2 hours storm, average 23.8 mm/h, Zone 1
Catch B - PSD	0.421	0.081	0.359	28.28	59.67	0	AR&R 2 year, 1 hour storm, average 35.8 mm/h, Zone 1
Catch A - Post	1.025	0.952	0.083	24.59	50.21	0	AR&R 2 year, 1 hour storm, average 35.8 mm/h, Zone 1
Catch B - Post	1.292	1.208	0.095	28.28	59.67	0	AR&R 2 year, 1 hour storm, average 35.8 mm/h, Zone 1

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Pipe1	0.393	2.7	12.809	12.659	AR&R 2 year, 1.5 hours storm, average 28.3 mm/h, Zone 1
Pipe2	0.421	2.7	7.267	7.117	AR&R 2 year, 2 hours storm, average 23.8 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF1	0	0	7.665	0	0	0	0	
OF2	0	0	7.665	0	0	0	0	

DETENTION BASIN DETAILS

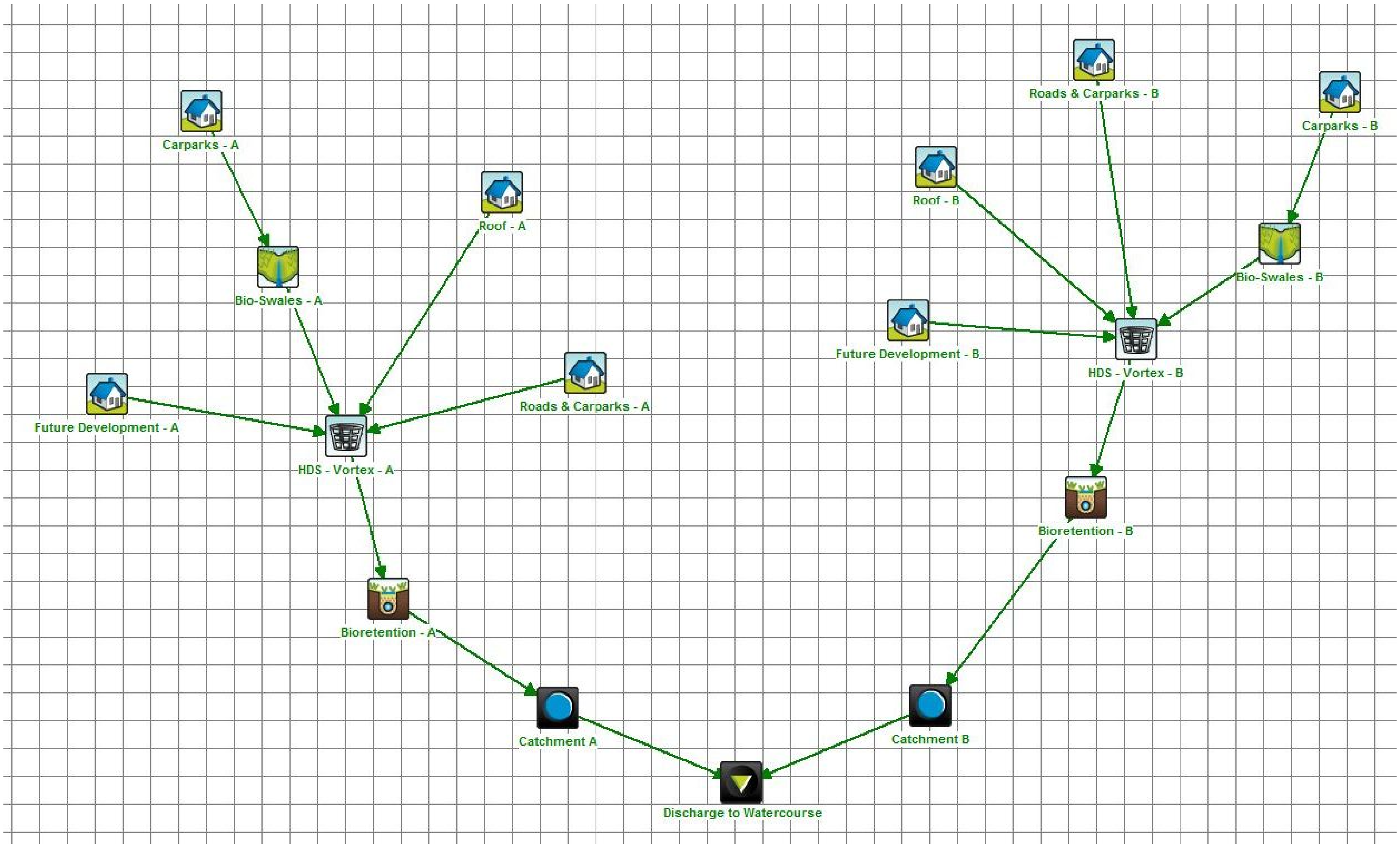
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin A	15	934.2	0.393	0.393	0
Basin B	9.96	1564.6	0.421	0.421	0

CONTINUITY CHECK for AR&R 2 year, 2 hours storm, average 23.8 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
OUT/A	1392.1	1392.1	0	0
N4	1860.28	1860.28	0	0
Basin A	2922.89	2930.38	0	-0.3
N9	2930.38	2930.38	0	0
Basin B	3957.57	3918.49	46.58	-0.2
N10	3918.49	3918.49	0	0

APPENDIX C

MUSIC MODEL RESULTS


Carparks - A
Roof - A
Bio-Swales - A
Future Development - A
Roads & Carparks - A
HDS - Vortex - A
Bioretention - A
Catchment A
Discharge to Watercourse
Catchment B
Bioretention - B
HDS - Vortex - B
Future Development - B
Bio-Swales - B
Roof - B
Roads & Carparks - B
Carparks - B

MUSIC MODEL OUTPUT

```
Source nodes
Location,Future Development - A,Future Development - B,Roads & Carparks,Roof,Landscape,Roof - B,Roads & Carparks - B,Carparks - B,Carparks - A,Roads & Carparks - A,Roof - A
ID,1,2,4,5,6,7,10,11,12,15,22
Node Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,ForestSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Total Area (ha),4.178,5.148,1,1,1,0.898,0.538,1.021,0.53,1.047,0.344
Area Impervious (ha),3.35931439446367,4.12125010380623,0.951325301204819,1,0.0527309236947792,0.898,0.511813012048193,0.97130313253012,0.504202409638554,0.996037590361446,0.344
Area Pervious (ha),0.818685605536332,1.02674989619377,0.0486746987951808,0,0.947269076305221,0,0.0261869879518073,0.0496968674698797,0.0257975903614458,0.0509624096385544,0
Field Capacity (mm),80,80,80,80,80,80,80,80,80,80,80
Pervious Area Infiltration Capacity coefficient - a,200,200,200,200,200,200,200,200,200,200,200
Pervious Area Infiltration Capacity exponent - b,1,1,1,1,1,1,1,1,1,1,1
Impervious Area Rainfall Threshold (mm/day),1,1,1,1,1,1,1,1,1,1,1
Pervious Area Soil Storage Capacity (mm),120,120,120,120,120,120,120,120,120,120,120
Pervious Area Soil Initial Storage (% of Capacity),25,25,30,30,30,30,30,30,30,30,30
Groundwater Initial Depth (mm),10,10,10,10,10,10,10,10,10,10,10
Groundwater Daily Recharge Rate (%),25,25,25,25,25,25,25,25,25,25,25
Groundwater Daily Baseflow Rate (%),5,5,5,5,5,5,5,5,5,5,5
Groundwater Daily Deep Seepage Rate (%),0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Suspended Solids Mean (log mg/L),2.2,2.2,2.28,1.54,1.9,1.55,2.28,2.28,2.28,2.28,1.55
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.32,0.32,0.32,0.2,0.32,0.32,0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean
Stormflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Phosphorus Mean (log mg/L),-0.45,-0.45,-0.6,-0.85,-1.1,-0.89,-0.6,-0.6,-0.6,-0.6,-0.89
Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.25,0.25,0.25,0.22,0.25,0.25,0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean
Stormflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Nitrogen Mean (log mg/L),0.42,0.42,0.34,0.42,-0.075,0.34,0.36,0.36,0.36,0.36,0.34
Stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.24,0.19,0.19,0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean
Stormflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Suspended Solids Mean (log mg/L),1.1,1.1,1.1,1.1,0.9,1.1,1.1,1.1,1.1,1.1,1.1
Baseflow Total Suspended Solids Standard Deviation (log mg/L),0.17,0.17,0.17,0.17,0.13,0.17,0.17,0.17,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Phosphorus Mean (log mg/L),-0.82,-0.82,-0.82,-0.82,-1.5,-0.82,-0.82,-0.82,-0.82,-0.82,-0.82
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.13,0.19,0.19,0.19,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean
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Baseflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Nitrogen Mean (log mg/L),0.32,0.32,0.32,0.32,-0.14,0.32,0.32,0.32,0.32,0.32,0.32
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12,0.12,0.13,0.12,0.12,0.12,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean,Mean
Baseflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0,0
OUT - Mean Annual Flow (ML/yr),21.6,26.7,5.97,6.23,1.23,5.60,3.21,6.09,3.16,6.25,2.14
OUT - TSS Mean Annual Load (kg/yr),3.36E3,4.14E3,1.13E3,216,61.2,199,609,1.16E3,600,1.19E3,76.1
OUT - TP Mean Annual Load (kg/yr),7.59,9.35,1.50,0.880,73.3E-3,0.721,0.805,1.53,0.793,1.57,0.276
OUT - TN Mean Annual Load (kg/yr),56.7,69.8,13.1,16.4,0.977,12.2,7.35,14.0,7.24,14.3,4.69
OUT - Gross Pollutant Mean Annual Load (kg/yr),648,798,169,174,11.6,156,91.1,173,89.8,177,59.8
Rain In (ML/yr),29.5293,36.3851,7.06779,7.06779,7.06779,6.3469,3.80247,7.21622,3.74594,7.39999,2.43132
ET Loss (ML/yr),7.88685,9.71789,1.09932,0.836539,5.82956,0.751197,0.591435,1.1224,0.582639,1.15099,0.287765
Deep Seepage Loss (ML/yr),0,0,0,0,0,0,0,0,0,0,0
Baseflow Out (ML/yr),0.451518,0.556347,0.0270176,0,0.513335,0,0.0145355,0.027585,0.0143193,0.0282875,0
Imp. Stormflow Out (ML/yr),20.8274,25.6629,5.91971,6.23127,0.311564,5.59568,3.18481,6.04402,3.13745,6.19793,2.14356
Perv. Stormflow Out (ML/yr),0.358058,0.441188,0.0214252,0,0.407079,0,0.0115268,0.0218751,0.0113554,0.0224322,0
Total Stormflow Out (ML/yr),21.1855,26.1041,5.94113,6.23127,0.718642,5.59568,3.19633,6.0659,3.1488,6.22036,2.14356
Total Outflow (ML/yr),21.637,26.6604,5.96815,6.23127,1.23198,5.59568,3.21087,6.09348,3.16312,6.24865,2.14356
Change in Soil Storage (ML/yr),0.0054636,0.0067321,0.0003269,0,0.0062116,0,0.0001759,0.0003338,0.0001733,0.0003423,0
TSS Baseflow Out (ML/yr),5.68428,7.004,0.340132,0,4.07757,0,0.182991,0.347275,0.18027,0.356119,0
TSS Total Stormflow Out (ML/yr),3357.67,4137.21,1132.06,216.061,57.0838,198.542,609.048,1155.83,599.992,1185.27,76.0563
TSS Total Outflow (ML/yr),3363.35,4144.22,1132.4,216.061,61.1613,198.542,609.231,1156.18,600.172,1185.62,76.0563
TP Baseflow Out (ML/yr),0.0683401,0.0842065,0.0040893,0,0.0162331,0,0.0022,0.0041752,0.0021673,0.0042815,0
TP Total Stormflow Out (ML/yr),7.51688,9.26207,1.49234,0.880191,0.0570838,0.720864,0.802881,1.52369,0.790943,1.56249,0.276144
TP Total Outflow (ML/yr),7.58522,9.34628,1.49643,0.880191,0.0733169,0.720864,0.805081,1.52786,0.79311,1.56677,0.276144
TN Baseflow Out (ML/yr),0.943356,1.16237,0.0564478,0,0.371878,0,0.030369,0.0576333,0.0299174,0.0591009,0
TN Total Stormflow Out (ML/yr),55.7234,68.6606,12.9978,16.3899,0.604662,12.242,7.32237,13.8962,7.21348,14.25,4.68959
TN Total Outflow (ML/yr),56.6668,69.823,13.0542,16.3899,0.97654,12.242,7.35274,13.9538,7.2434,14.3091,4.68959
GP Total Outflow (ML/yr),649.036,799.721,169.451,173.764,11.9876,156.04,91.1648,173.01,89.8091,177.415,59.7747

No Imported Data Source nodes

USTM treatment nodes
Location,Bio-Swales - A,Bio-Swales - B,Bioretention - B,Bioretention - A
ID,13,14,16,17
Node Type,SwaleNode,SwaleNode,BioRetentionNodeV4,BioRetentionNodeV4
Lo-flow bypass rate (cum/sec),0,0,0,0
Hi-flow bypass rate (cum/sec), , ,100,100
Inlet pond volume, , , ,
Area (sqm), , ,1090,490
Extended detention depth (m),0.5,0.5,0.4,0.4
Permanent Pool Volume (cubic metres), , , ,
Proportion vegetated, , , ,
Equivalent Pipe Diameter (mm), , , ,
Overflow weir width (m),13,13,2,2

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Notional Detention Time (hrs), , , ,
Orifice Discharge Coefficient, , , ,
Weir Coefficient, , ,1.7,1.7
Number of CSTR Cells,10,10,3,3
Total Suspended Solids - k (m/yr),8000,8000,8000,8000
Total Suspended Solids - C* (mg/L),20,20,20,20
Total Suspended Solids - C** (mg/L),14,14, ,
Total Phosphorus - k (m/yr),6000,6000,6000,6000
Total Phosphorus - C* (mg/L),0.13,0.13,0.13,0.13
Total Phosphorus - C** (mg/L),0.13,0.13, ,
Total Nitrogen - k (m/yr),500,500,500,500
Total Nitrogen - C* (mg/L),1.4,1.4,1.4,1.4
Total Nitrogen - C** (mg/L),1.4,1.4, ,
Threshold Hydraulic Loading for C** (m/yr),3500,3500, ,
Horizontal Flow Coefficient, , ,3,3
Extraction for Re-use,Off,Off,Off,Off
Annual Re-use Demand - scaled by daily PET (ML), , , ,
Annual Re-use Demand - scaled by daily PET - Rain (ML), , , ,
Constant Daily Re-use Demand (kL), , , ,
User-defined Annual Re-use Demand (ML), , , ,
Percentage of User-defined Annual Re-use Demand Jan, , , ,
Percentage of User-defined Annual Re-use Demand Feb, , , ,
Percentage of User-defined Annual Re-use Demand Mar, , , ,
Percentage of User-defined Annual Re-use Demand Apr, , , ,
Percentage of User-defined Annual Re-use Demand May, , , ,
Percentage of User-defined Annual Re-use Demand Jun, , , ,
Percentage of User-defined Annual Re-use Demand Jul, , , ,
Percentage of User-defined Annual Re-use Demand Aug, , , ,
Percentage of User-defined Annual Re-use Demand Sep, , , ,
Percentage of User-defined Annual Re-use Demand Oct, , , ,
Percentage of User-defined Annual Re-use Demand Nov, , , ,
Percentage of User-defined Annual Re-use Demand Dec, , , ,
User-defined Re-use File, , , ,
Filter area (sqm), , ,300,300
Filter perimeter (m), , ,14,14
Filter depth (m), , ,0.5,0.5
Filter Median Particle Diameter (mm), , , ,
Saturated Hydraulic Conductivity (mm/hr), , ,100,100
Infiltration Media Porosity, , ,0.35,0.35
Length (m),100,100, ,
Bed slope,0.01,0.01, ,
Base Width (m),0.3,0.3, ,
Top width (m),1.3,1.3, ,
Vegetation height (m),0.25,0.25, ,
Vegetation Type, , ,Vegetated with Effective Nutrient Removal Plants,Vegetated with Effective Nutrient Removal Plants
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Total Nitrogen Content in Filter (mg/kg), , ,800,800
Orthophosphate Content in Filter (mg/kg), , ,55,55
Is Base Lined?, , ,No,No
Is Underdrain Present?, , ,Yes,Yes
Is Submerged Zone Present?, , ,No,No
Submerged Zone Depth (m), , , ,
B for Media Soil Texture,-9999,-9999,13,13
Proportion of upstream impervious area treated, , , ,
Exfiltration Rate (mm/hr),0,0,0,0
Evap Loss as proportion of PET, , , ,
Depth in metres below the drain pipe, , , ,
TSS A Coefficient, , , ,
TSS B Coefficient, , , ,
TP A Coefficient, , , ,
TP B Coefficient, , , ,
TN A Coefficient, , , ,
TN B Coefficient, , , ,
Sfc, , ,0.61,0.61
S*, , ,0.37,0.37
Sw, , ,0.11,0.11
Sh, , ,0.05,0.05
Emax (m/day), , ,0.008,0.008
Ew (m/day), , ,0.001,0.001
IN - Mean Annual Flow (ML/yr),3.16,6.09,41.6,33.2
IN - TSS Mean Annual Load (kg/yr),600,1.16E3,3.78E3,3.15E3
IN - TP Mean Annual Load (kg/yr),0.793,1.53,11.8,9.89
IN - TN Mean Annual Load (kg/yr),7.24,14.0,102,82.0
IN - Gross Pollutant Mean Annual Load (kg/yr),89.8,173,35.7,22.7
OUT - Mean Annual Flow (ML/yr),3.16,6.10,40.8,32.5
OUT - TSS Mean Annual Load (kg/yr),105,288,741,781
OUT - TP Mean Annual Load (kg/yr),0.465,0.960,6.00,5.20
OUT - TN Mean Annual Load (kg/yr),6.34,12.7,52.6,45.4
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00
Flow In (ML/yr),3.1599,6.087,41.5147,33.1485
ET Loss (ML/yr),0,0,0.745489,0.737908
Infiltration Loss (ML/yr),0,0,0,0
Low Flow Bypass Out (ML/yr),0,0,0,0
High Flow Bypass Out (ML/yr),0,0,0,0
Orifice / Filter Out (ML/yr),3.12959,5.86875,25.2057,18.9266
Weir Out (ML/yr),0.0316501,0.220107,15.5898,13.5079
Transfer Function Out (ML/yr),0,0,0,0
Reuse Supplied (ML/yr),0,0,0,0
Reuse Requested (ML/yr),0,0,0,0
% Reuse Demand Met,0,0,0,0
% Load Reduction,-0.0425457,-0.0304288,1.73257,2.15385
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TSS Flow In (kg/yr),600.046,1156.03,3776.63,3146.83
TSS ET Loss (kg/yr),0,0,0,0
TSS Infiltration Loss (kg/yr),0,0,0,0
TSS Low Flow Bypass Out (kg/yr),0,0,0,0
TSS High Flow Bypass Out (kg/yr),0,0,0,0
TSS Orifice / Filter Out (kg/yr),98.5301,245.361,63.1142,48.751
TSS Weir Out (kg/yr),6.03076,41.9402,677.873,731.874
TSS Transfer Function Out (kg/yr),0,0,0,0
TSS Reuse Supplied (kg/yr),0,0,0,0
TSS Reuse Requested (kg/yr),0,0,0,0
TSS % Reuse Demand Met,0,0,0,0
TSS % Load Reduction,82.5745,75.1475,80.3797,75.1933
TP Flow In (kg/yr),0.792088,1.52589,11.8194,9.88141
TP ET Loss (kg/yr),0,0,0,0
TP Infiltration Loss (kg/yr),0,0,0,0
TP Low Flow Bypass Out (kg/yr),0,0,0,0
TP High Flow Bypass Out (kg/yr),0,0,0,0
TP Orifice / Filter Out (kg/yr),0.456031,0.903695,3.1626,2.39301
TP Weir Out (kg/yr),0.0079501,0.0552883,2.83058,2.80704
TP Transfer Function Out (kg/yr),0,0,0,0
TP Reuse Supplied (kg/yr),0,0,0,0
TP Reuse Requested (kg/yr),0,0,0,0
TP % Reuse Demand Met,0,0,0,0
TP % Load Reduction,41.4231,37.1524,49.294,47.3754
TN Flow In (kg/yr),7.23185,13.9368,101.987,81.9078
TN ET Loss (kg/yr),0,0,0,0
TN Infiltration Loss (kg/yr),0,0,0,0
TN Low Flow Bypass Out (kg/yr),0,0,0,0
TN High Flow Bypass Out (kg/yr),0,0,0,0
TN Orifice / Filter Out (kg/yr),6.25469,12.1553,17.0324,13.4111
TN Weir Out (kg/yr),0.0725062,0.504237,35.5632,31.9939
TN Transfer Function Out (kg/yr),0,0,0,0
TN Reuse Supplied (kg/yr),0,0,0,0
TN Reuse Requested (kg/yr),0,0,0,0
TN % Reuse Demand Met,0,0,0,0
TN % Load Reduction,12.5092,9.16493,48.4293,44.5657
GP Flow In (kg/yr),89.7769,172.952,35.7335,22.7341
GP ET Loss (kg/yr),0,0,0,0
GP Infiltration Loss (kg/yr),0,0,0,0
GP Low Flow Bypass Out (kg/yr),0,0,0,0
GP High Flow Bypass Out (kg/yr),0,0,0,0
GP Orifice / Filter Out (kg/yr),0,0,0,0
GP Weir Out (kg/yr),0,0,0,0
GP Transfer Function Out (kg/yr),0,0,0,0
GP Reuse Supplied (kg/yr),0,0,0,0
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GP Reuse Requested (kg/yr),0,0,0,0
GP % Reuse Demand Met,0,0,0,0
GP % Load Reduction,100,100,100,100

Generic treatment nodes
Location,Humeceptor - Original from Humes,Copy of Gross Pollutant Trap - Vortex Type ,HDS - Vortex - A,HDS - Vortex - B
ID,3,18,20,21
Node Type,GenericNode,GPTNode,GPTNode,GPTNode
Lo-flow bypass rate (cum/sec),0,0,0,0
Hi-flow bypass rate (cum/sec),100,0.3,0.3,0.3
Flow Transfer Function
Input (cum/sec),0,0,0,0
Output (cum/sec),0,0,0,0
Input (cum/sec),1000,10,10,10
Output (cum/sec),1000,10,10,10
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Gross Pollutant Transfer Function
Input (kg/ML),0,0,0,0
Output (kg/ML),0,0,0,0
Input (kg/ML),1000,15,15,15
Output (kg/ML),0,0,0,0
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
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Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Total Nitrogen Transfer Function
Input (mg/L),0,0,0,0
Output (mg/L),0,0,0,0
Input (mg/L),1000,50,50,50
Output (mg/L),550,50,50,50
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Total Phosphorus Transfer Function
Input (mg/L),0,0,0,0
Output (mg/L),0,0,0,0
Input (mg/L),0.5,0.5,0.5,0.5
Output (mg/L),0.5,0.5,0.5,0.5
Input (mg/L),40,5,5,5
Output (mg/L),24,3.5,3.5,3.5
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
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Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Total Suspended Solids Transfer Function
Input (mg/L),0,0,0,0
Output (mg/L),0,0,0,0
Input (mg/L),75,75,75,75
Output (mg/L),75,75,75,75
Input (mg/L),1000,1000,1000,1000
Output (mg/L),250,300,300,300
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
IN - Mean Annual Flow (ML/yr),0.00,0.00,33.2,41.6
IN - TSS Mean Annual Load (kg/yr),0.00,0.00,4.73E3,5.24E3
IN - TP Mean Annual Load (kg/yr),0.00,0.00,9.89,11.8
IN - TN Mean Annual Load (kg/yr),0.00,0.00,82.0,102
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,885,1.05E3
OUT - Mean Annual Flow (ML/yr),0.00,0.00,33.2,41.6
OUT - TSS Mean Annual Load (kg/yr),0.00,0.00,3.15E3,3.78E3
OUT - TP Mean Annual Load (kg/yr),0.00,0.00,9.89,11.8
OUT - TN Mean Annual Load (kg/yr),0.00,0.00,82.0,102
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,22.7,35.7
Flow In (ML/yr),0,0,33.1485,41.5147
ET Loss (ML/yr),0,0,0,0
Infiltration Loss (ML/yr),0,0,0,0
Low Flow Bypass Out (ML/yr),0,0,0,0
High Flow Bypass Out (ML/yr),0,0,2.53719,3.89191
Orifice / Filter Out (ML/yr),0,0,0,0
Weir Out (ML/yr),0,0,0,0
Transfer Function Out (ML/yr),0,0,30.6143,37.6254
Reuse Supplied (ML/yr),0,0,0,0
Reuse Requested (ML/yr),0,0,0,0
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% Reuse Demand Met,0,0,0,0
% Load Reduction,0,0,-0.00890779,-0.00633848
TSS Flow In (kg/yr),0,0,4724.17,5233.46
TSS ET Loss (kg/yr),0,0,0,0
TSS Infiltration Loss (kg/yr),0,0,0,0
TSS Low Flow Bypass Out (kg/yr),0,0,0,0
TSS High Flow Bypass Out (kg/yr),0,0,388.351,548.113
TSS Orifice / Filter Out (kg/yr),0,0,0,0
TSS Weir Out (kg/yr),0,0,0,0
TSS Transfer Function Out (kg/yr),0,0,2758.88,3229.47
TSS Reuse Supplied (kg/yr),0,0,0,0
TSS Reuse Requested (kg/yr),0,0,0,0
TSS % Reuse Demand Met,0,0,0,0
TSS % Load Reduction,0,0,33.3804,27.8186
TP Flow In (kg/yr),0,0,9.88141,11.8195
TP ET Loss (kg/yr),0,0,0,0
TP Infiltration Loss (kg/yr),0,0,0,0
TP Low Flow Bypass Out (kg/yr),0,0,0,0
TP High Flow Bypass Out (kg/yr),0,0,0.786092,1.16464
TP Orifice / Filter Out (kg/yr),0,0,0,0
TP Weir Out (kg/yr),0,0,0,0
TP Transfer Function Out (kg/yr),0,0,9.09533,10.6554
TP Reuse Supplied (kg/yr),0,0,0,0
TP Reuse Requested (kg/yr),0,0,0,0
TP % Reuse Demand Met,0,0,0,0
TP % Load Reduction,0,0,-9.91761E-5,-0.00511276
TN Flow In (kg/yr),0,0,81.9078,101.987
TN ET Loss (kg/yr),0,0,0,0
TN Infiltration Loss (kg/yr),0,0,0,0
TN Low Flow Bypass Out (kg/yr),0,0,0,0
TN High Flow Bypass Out (kg/yr),0,0,6.36342,9.71359
TN Orifice / Filter Out (kg/yr),0,0,0,0
TN Weir Out (kg/yr),0,0,0,0
TN Transfer Function Out (kg/yr),0,0,75.5489,92.2817
TN Reuse Supplied (kg/yr),0,0,0,0
TN Reuse Requested (kg/yr),0,0,0,0
TN % Reuse Demand Met,0,0,0,0
TN % Load Reduction,0,0,-0.00552487,-0.00792815
GP Flow In (kg/yr),0,0,885.161,1045.67
GP ET Loss (kg/yr),0,0,0,0
GP Infiltration Loss (kg/yr),0,0,0,0
GP Low Flow Bypass Out (kg/yr),0,0,0,0
GP High Flow Bypass Out (kg/yr),0,0,22.7341,35.7335
GP Orifice / Filter Out (kg/yr),0,0,0,0
GP Weir Out (kg/yr),0,0,0,0

GP Transfer Function Out (kg/yr),0,0,0,0
GP Reuse Supplied (kg/yr),0,0,0,0
GP Reuse Requested (kg/yr),0,0,0,0
GP % Reuse Demand Met,0,0,0,0
GP % Load Reduction,100,100,97.4316,96.5827

Other nodes
Location,Catchment A,Catchment B,Discharge to Watercourse
ID,8,9,19
Node Type,JunctionNode,JunctionNode,ReceivingNode
IN - Mean Annual Flow (ML/yr),32.5,40.8,73.3
IN - TSS Mean Annual Load (kg/yr),781,741,1.52E3
IN - TP Mean Annual Load (kg/yr),5.20,6.00,11.2
IN - TN Mean Annual Load (kg/yr),45.4,52.6,98.0
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00
OUT - Mean Annual Flow (ML/yr),32.5,40.8,0.00
OUT - TSS Mean Annual Load (kg/yr),781,741,0.00
OUT - TP Mean Annual Load (kg/yr),5.20,6.00,0.00
OUT - TN Mean Annual Load (kg/yr),45.4,52.6,0.00
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00

Links
Location,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,12,11,16,17,8,9,1,13,15,20,2,7,10,14,21,22
Target node ID,13,14,9,8,19,19,20,20,20,17,21,21,21,21,16,20
Muskingum-Cunge Routing,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed
Muskingum K, , , , , , , , , , , , , , , ,
Muskingum theta, , , , , , , , , , , , , , , ,
IN - Mean Annual Flow (ML/yr),3.16,6.09,40.8,32.5,32.5,40.8,21.6,3.16,6.25,33.2,26.7,5.60,3.21,6.10,41.6,2.14
IN - TSS Mean Annual Load (kg/yr),600,1.16E3,741,781,781,741,3.36E3,105,1.19E3,3.15E3,4.14E3,199,609,288,3.78E3,76.1
IN - TP Mean Annual Load (kg/yr),0.793,1.53,6.00,5.20,5.20,6.00,7.59,0.465,1.57,9.89,9.35,0.721,0.805,0.960,11.8,0.276
IN - TN Mean Annual Load (kg/yr),7.24,14.0,52.6,45.4,45.4,52.6,56.7,6.34,14.3,82.0,69.8,12.2,7.35,12.7,102,4.69
IN - Gross Pollutant Mean Annual Load (kg/yr),89.8,173,0.00,0.00,0.00,0.00,648,0.00,177,22.7,798,156,91.1,0.00,35.7,59.8
OUT - Mean Annual Flow (ML/yr),3.16,6.09,40.8,32.5,32.5,40.8,21.6,3.16,6.25,33.2,26.7,5.60,3.21,6.10,41.6,2.14
OUT - TSS Mean Annual Load (kg/yr),600,1.16E3,741,781,781,741,3.36E3,105,1.19E3,3.15E3,4.14E3,199,609,288,3.78E3,76.1
OUT - TP Mean Annual Load (kg/yr),0.793,1.53,6.00,5.20,5.20,6.00,7.59,0.465,1.57,9.89,9.35,0.721,0.805,0.960,11.8,0.276
OUT - TN Mean Annual Load (kg/yr),7.24,14.0,52.6,45.4,45.4,52.6,56.7,6.34,14.3,82.0,69.8,12.2,7.35,12.7,102,4.69
OUT - Gross Pollutant Mean Annual Load (kg/yr),89.8,173,0.00,0.00,0.00,0.00,648,0.00,177,22.7,798,156,91.1,0.00,35.7,59.8