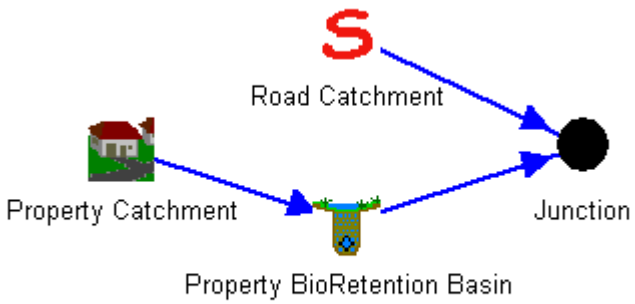
7. Water Quality Management

7.1 Water Quality Modelling – Onsite Treatment

Prediction of pollutant loads and concentrations were developed by modelling the conceptual drainage system and associated treatment processes. The Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 3), developed by the Cooperative Centre for Catchment Hydrology, was used as a numerical simulation of property-scale hydrology and water quality treatment to assess the performance of the design, outlined in the Drainage Concept Plan (Section 6), in improving water quality.

The model uses historically observed rainfall data to calculate runoff and pollutant fluxes associated with the proposed land use. Simulation of flow routing and pollutant removal associated with bioretention swales allows prediction of overall pollutant removal at the property scale. Conceptually the property scale model consists of four nodes as illustrated below. Base flow and storm flow volumes and water quality properties are generated in the catchment nodes. These flows are transmitted to treatment nodes, which simulate removal of pollutants and compensation of flow.



7.1.1 Selection of Parameters for the Runoff and Treatment Model

To predict pollutant concentrations of discharge water, MUSIC takes observed rainfall and evaporation data and applies algorithms firstly to predict runoff generation and then pollutant removal associated with each treatment measure. Base flow and Storm flow water quality is stochastically generated from mean and standard deviation of contaminant concentrations. Parameters associated with each treatment process are selected to best represent the conceptual design. Pollutant concentration parameters are taken from Chapter 3 of Australian Rainfall Quality (Draft 2003). An overview of selected key parameters is outlined in Table 4 below.

Table 4 Key Parameters used to model Runoff and Pollutant Concentrations in the Water Quality Model

Property Catchment	
Nominal Area	1 hectares
Effective Impervious fraction	70%
TSS Base Flow Concentration (Mean / Sdev)	1.16 / 0.5 [log mg/L]
TSS Storm Flow Concentration (Mean / Sdev)	2.16 / 0.5 [log mg/L]
Total P – Base Flow Concentration (Mean / Sdev)	-0.830 / 0.58 [log mg/L]
Total P – Storm Flow Concentration (Mean / Sdev)	-0.5 / 0.25 [log mg/L]
Total N – Base Flow Concentation (Mean / Sdev)	0.3 / 0.3 [log mg/L]
Total N – Storm Flow Concentation (Mean / Sdev)	0.35 / 0.25 [log mg/L]
Road Catchment	
Nominal Area	0.075 hectares
Effective Impervious fraction	95%
TSS Base Flow Concentration (Mean / Sdev)	1.16 / 0.5 [log mg/L]
TSS Storm Flow Concentration (Mean / Sdev)	2.4 / 0.5 [log mg/L]
Total P – Base Flow Concentration (Mean / Sdev)	-0.830 / 0.58 [log mg/L]
Total P – Storm Flow Concentration (Mean / Sdev)	-0.6 / 0.5 [log mg/L]
Total N – Base Flow Concentation (Mean / Sdev)	0.3 / 0.3 [log mg/L]
Total N – Storm Flow Concentation (Mean / Sdev)	0.3 / 0.28 [log mg/L]
Property Bioretention Basin	
Detention Surface Area	616 m^2
Detention Depth	0.55 m
Seepage Loss	6.25 mm/hr
Filter Area	10 m^2
Filter Depth	0.6 m
Filter Medium – Effective Particle Diameter	0.25 mm
Filter Medium - Saturated Hydraulic Conductivity	180 mm/hr
Overflow Weir Width	0.5 m
Depth below collection pipe (% Filter Depth)	10%

7.1.2 Model Results – Property Scale Treatment

Model results are presented in the form of statistics of flow properties and mean annual loads, into and out of each treatment and source node. The overall effectiveness of the treatment measures are assessed by comparing the mean annual load and flow-based median concentration of contaminants coming off the catchments, to the mean annual load and flow-based median concentration of contaminants leaving the system. The design was modelled using 20 years of 6-minute data from Perth Airport, from Janurary 1976 to December 1995. An interpretation of model results is presented in Table 5.

Table 5 Interpretation of MUSIC water quality modelling results

	Catchment Runoff Quality	Runoff Quality after property treatment	Percent Reduction
Flow based Median Concentration (mg/L)			
Flow (m^3/s)	7.13E-06	2.86E-05	-300
Total Suspended Solids	14.76	2.53	83
Total Phosphorus	0.15	0.06	60
Total Nitrogen	1.92	1.17	39
Mean Annual Load (kg/yr)			
Flow (ML/yr)	5.4	2.6	53
Total Suspended Solids	1459	250	83
Total Phosphorus	2.1	0.4	82
Total Nitrogen	14.1	3.56	75
Gross Pollutants	188.6	17.6	91

Flow-Weighted Median Concentration

Comparing flow-based median concentrations of flow and contaminants pre- and post-treatment, the model predicts a reduction of TSS, TN and TP concentrations of 83%, 39% and 60% respectively. Median flow is significantly higher at the outlet than runoff observed from the catchments, this is a reflection of the compensation capacity of the Bio-retention basins, were small flows have less influence on calculation of the median flow rate.

Comparison of predicted median concentrations of contaminants leaving the system against long term SCCP waterway targets for TN : 1.0 mg/L and TP : 0.1 mg/L suggests that while the target for Total Phosphorus concentration achieved, the water leaving the property scale treatment measures may not comply with long term waterway targets for Total Nitrogen. Further treatment in Multiple Use Corridors of flows from the piped drainage network will be necessary to meet the long-term target.

Mean Annual Loads

Mean Annual Loads of contaminants and flow provide an interpretation of the overall effectiveness of stormwater treatment at the property/road scale. MUSIC predicts reductions in TSS, TP, TN and Gross Pollutant load of 83%, 82%, 75% and 91% respectively, and a reduction of Mean Annual flow of approximately 80%. The reduction in flow is consistent with what would be expected, where all flows up to the 1 in 2 year ARI event are detained by the bioretention/infiltration basins.

7.2 Multiple Use Corridors

The drainage concept design proposes that treatment of stormwater originating from the road catchments is treated by passive treatment measures including vegetated swales and ephemeral living streams in the downstream multiple use corridors. Due to uncertainty in performance of these treatment measures at low concentrations, the use of numerical models such as MUSIC to model of water quality improvement in the MUCs may produce misleading results. A more detailed assessment of options for water quality treatment in the proposed multiple use corridors will be necessary at the detailed design stage.

7.3 Non-structural measures

Non-structural measures to control and reduce discharge of contaminants to the stormwater system are based on source control of stormwater. Non-structural source control can include:

- actions that aim to change behaviour such public awareness campaigns and community education,
- local government operations and maintenance activities such as street sweeping and waste management, and
- land use and management measures, such as sediment and erosion control during construction and permeable pavements.
- Non-structural measures have been shown to be cost-effective long-term methods of improving stormwater quality and reducing contamination.
- The following section suggests some measures that the City of Gosnells could include in development guidelines for the proposed Maddington-Kenwick Industrial Area.

Nutrient control and landscaping

- Develop landscaping guidelines for the proposed development area that recommend the use of appropriate native species in landscaping and provide advice on the responsible use of fertilisers and herbicides.
- Use Multiple-use Corridors, road verges and other public open space areas managed by the City of Gosnells to demonstrate best practice through appropriate plant selection and maintenance.

Sediment and litter control and construction management

- Provide an effective waste-management plan for the area to ensure that litter and other waste does not collect in the bio-retention basins and drainage system.
- Require all development construction projects, including road and infrastructure construction, to implement sediment and erosion control measures.
- Monitor illegal waste dumping, removing waste and enforcing penalties.

Pollution control

» Where proposed development includes storage or handling of chemicals or other potential contaminants, require development applications to include appropriate waste-management and pollution control measures.

» Monitor and enforce regulations related to waste-management, hazardous chemicals and other pollutants.

» Develop and publish a pollution response plan for dealing with pollution incidents in the industrial area.

Community awareness and education

» Provide information on Greater Brixton Street Wetlands and Canning River, identifying environmental values that are being protected and linking catchment management practices to wetland and waterway health.

» Actively seek out opportunities to directly engage the community in catchment management through programs such as Ribbons of Blue.

» Develop community awareness campaigns and supporting material to communicate the importance of all of the non-structural source control measures described above.

7.4 Water Quality Monitoring

Pre-development surface water quality monitoring

It is recommended that the City of Gosnells implement a pre-development monitoring program to establish existing water quality in Yule Brook and Bickley Brook.

A key objective of the drainage strategy for the proposed Maddington-Kenwick Industrial Area is that surface water run-off from the area will not cause any increase in nutrient or sediment load to the receiving waterways. There is currently insufficient baseline data in Yule Brook to confirm the impact of any future development.

In the absence of suitable water quality data for Yule Brook it has been necessary to develop water quality related design objectives based on the observed stormwater quality data presented in Australian Runoff Quality (ARQ) (National Committee on Water Engineering and Engineers Australia (2003). Pre-development monitoring will confirm existing water quality in Yule Brook and in existing drainage channels so that the water quality related design objectives can be reviewed.

It is recommended that water quality monitoring initially be undertaken monthly for two years, after which the program should be reviewed. The monitoring program is intended to measure low flow (baseflow) water quality, not storm events. The Swan River Trust and the Water Corporation should be consulted during the development of the monitoring program for advice and to coordinate data collection with other monitoring programs in the catchment.

The recommended locations for pre-development monitoring points are:

- Yule Brook: two locations – immediately south of Welshpool Road and immediately east of Roe Highway. These two monitoring points will establish baseline water quality in the reach of Yule Brook that runs through the proposed Maddington-Kenwick Industrial Area and identify any changes in water quality currently caused by runoff from that area.
- Bickley Brook: two locations – immediately west of Tonkin Highway and immediately east of Albany Highway. These two monitoring points will establish baseline water quality in the reach of Bickley Brook that runs through the existing Maddington Industrial Area and identify any changes in water quality currently caused by runoff from that area.
- Existing open drains: three locations – Brentwood Road, Victoria Road and Kenwick Road. These drains will provide representative runoff water quality from the proposed development area. These drains are not expected to run all year.

Water quality parameters to be measured should include the following key physical and chemical stressors:

- temperature;
- conductivity;
- pH;
- total suspended solids (TSS);
- dissolved oxygen;
- nutrients (nitrate, ammonia, total nitrogen, filterable reactive phosphorous, total phosphorous) ;
- heavy metals (cadmium, copper, Chromium, Lead, Manganese, Nickel and Zinc);
- thermotolerant coliforms; and
- chlorophyll A.

Post-development surface water quality monitoring

It is recommended that the surface water quality monitoring be extended (or re-instated) after development commences to confirm the post-development water quality of runoff discharged to Yule Brook and Bickley Brook. Post-development monitoring will allow the performance of the stormwater quality treatment measures to be assessed and modified if necessary.

In addition to the pre-development monitoring locations in Yule Brook and Bickley Brook, it is recommended that the post-development monitoring program include the following monitoring points:

- Proposed “MUC 2: Boundary Road to Brentwood Road” outlet: This monitoring point will measure water quality of runoff from Area 2, discharging to Yule Brook.
- Proposed “MUC 5: Kenwick Road” outlet: This monitoring point will measure water quality of runoff from Area 1, discharging to Bickley Brook.

It is recommended that water quality monitoring initially be undertaken every three months until two years after development is completed, after which the program should be reviewed. The monitoring program is intended to measure low flow (baseflow) water quality, not storm events.

Water quality parameters to be measured should include the key physical and chemical stressors measured included in the pre-development monitoring program and listed above. The water quality data should be compared to the SCCP water quality targets for Yule Brook and Bickley Brook and the water quality related design objectives set for the development.

Groundwater monitoring

It is recommended that groundwater monitoring bores be installed across the proposed development area to investigate groundwater levels and groundwater water quality.

The presence of important wetlands and groundwater dependent ecosystems is a critical issue for the sustainable development of the proposed Maddington-Kenwick Industrial Area. There are currently no groundwater monitoring bores in the area of the development that are able to establish existing conditions or monitor any potential impacts.

The recommended locations for pre-development monitoring points be established at a density of at least 1 bore every 10 ha. In addition, monitoring bores should be installed at the following locations:

» Boundary Road: This monitoring bore will measure groundwater levels and groundwater water quality immediately adjacent to the Greater Brixton Street wetlands.

» Brentwood Road: This monitoring bore will measure groundwater levels and groundwater water quality at proposed MUC 3, which is expected to be a site of potential interaction between groundwater and the surface water drainage system.

It is recommended that the groundwater monitoring wells be established at least two years before development commences to enable existing conditions to be established in time to be included in detailed drainage design. It is recommended that groundwater monitoring initially be undertaken monthly for standing water levels, pH, salinity, and quarterly for a suite of nutrients, metals and hydrocarbons. After development commences, groundwater monitoring should be undertaken every three months until two years after development is completed, after which the program should be reviewed.

The Department of Environment should be consulted before installing the groundwater monitoring bores for advice and to coordinate data collection with other groundwater monitoring programs in the area.