Shepherds Bay - Renewal

Overall Concept & Public Domain Plan

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Supporting document : WSUD STRATEGY

15th May 2013 Rev D

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contents -

Water Sensitive Urban Design Strategy -
(PART B - Modifications - Amended Concept Plan)

This document has been produced to meet the requirements of B1 (e) - "Provide an integrated water sensitive urban design strategy for the entire site"

In the preparation of this WSUD Strategy for the MeadowBank site, we have complied with and referenced the City of Ryde WSUD Tools to meet the WSUD DCP Objectives. The document combines work by the Hydraulic Engineer and Landscape Architect to provide a fully integrated concept WSUD strategy that meets the requirements of Ryde City Council.

The Strategy for Meadowbank includes:

- Summary of background information / relevant site studies
- Site constraints and opportunities
- Outline of standard WSUD objectives for the site
- Integrated water cycle management balance plan
- Music Modelling Guideline for the site
- Integration of WSUD with the Urban Design -
  Plans showing integration of Bio-Retention basins across the landscape
- Example Imagery of typical treatments proposed throughout the site
- A vegetation selection Guideline for the site
- WSUD Standard Drawings for the site
- Maintenance outline of WSUD elements

WSUD - Principles for the Meadowbank site

A best practice approach to urban stormwater management – water sensitive urban design (WSUD) - provides for the sustainable management and improvement of water quality entering waterways from urban regions; opportunities for stormwater and greywater harvesting and reuse; and innovative reductions in potable water demand.

WSUD contributes to urban sustainability and provides the conditions for attractive, human-scale living environments through integration of urban planning and design with the management, protection and conservation of the whole water cycle.

WSUD is centred on integration at a number of levels:

- The integrated management of the three urban water streams of potable water, wastewater and stormwater
- The integration of the scale of urban water management from individual allotments and buildings, to precincts and regions
- The integration of sustainable urban water management into the built form, incorporating building architecture, landscape architecture and public art
- The integration of structural and non-structural sustainable urban water management initiatives.

Above: Water can be captured and reused for house hold use, landscape irrigation or for water features and play elements.

Above: A constructed wetland is juxtaposed with sitting steps for viewing and enjoyment.

key principles of WSUD

Consistent with the Urban Stormwater: Best Practice Environmental Management Guidelines (CSIRO 1999),

The key principles of WSUD from a stormwater management and planning perspective are:

- Protect natural systems – protect and enhance natural water systems (creeks, rivers, wetlands) within urban developments
- Protect water quality – improve the quality of water draining from urban developments into creeks, rivers and bay environments
- Integrate stormwater treatment into the landscape – use stormwater treatment systems in the landscape by incorporating multiple uses that will provide multiple benefits, such as water quality treatment, wildlife habitat, public open space, recreational and visual amenity for the community
- Reduce runoff and peak flows – reduce peak flows from urban development by on site temporary storage measures (with potential for reuse) and minimise impervious areas
- Add value while minimising development costs – minimise the drainage infrastructure cost of development
- Reduce potable water demand – use stormwater as a resource through capture and reuse for non-potable purposes (e.g. toilet flushing, garden irrigation, laundry).

WSUD applications

WSUD applications can provide water based or natural vegetated features that add community value, while performing a treatment function through filtering of stormwater runoff. These applications include (not limited to):

- Grassed or landscaped swales
- Infiltration trenches and bio retention systems
- Wetlands
- Urban Forests
- Rainwater tanks – stormwater harvesting & reuse
- Greywater harvesting & reuse
- Rain gardens, rooftop greening, urban forests
- Porous pavements

Above: Urban forests filter air, water, sunlight, provide shelter to animals and recreational areas for people

Below: Urban plazas and water features function to improve water quality while contributing to ecological character and providing educational benefits through interpretation and art

WSUD objectives

Masterplan Water Sensitive Urban Design Objectives include:

/ New development should demonstrate current best practice environmental sustainability
/ Use landscape design as a filtering mechanism for low flows
/ Adopt a precinct-wide total water management strategy and treat stormwater in a visible way that is integrated within the public domain.
/ Reduce degradation of water bodies by limiting the discharge of nutrient, sediment and gross pollutant loads
/ Reduce future pressure on water resources
/ Respond to Ryde city Council's public domain technical manual and integrate any mitigating suggestions as appropriate
/ Restore stream-groundwater interactions
/ Raise awareness of sustainable initiatives in place
/ Encourage interaction and understanding of the urban water cycle

WSUD strategies

Through collaborative efforts WSUD is being incorporated into urban developments and road designs. Strategies that may be applicable include:

/ Water harvesting and reuse. Blackwater, greywater, and stormwater can be treated, stored and reused through residential and commercial buildings for toilet flushing, air-conditioning, cooling etc.
/ Collect and treat rainwater to be stored and reused in buildings and landscapes.
/ Retrofit existing downpipes to divert to treatment and storage locations.
/ Rooftop gardens and green walls - improve insulation and outlook of buildings.
/ Permeable paving – incorporate permeable paving systems where appropriate.
/ Street tree planting – kerb inlets can be connected to tree pits to slow initial flows and provide irrigation.
/ Sediment control programs during construction
/ Integrate stormwater management WSUD design in new infrastructure
/ On-site stormwater detention
/ Upper catchment stormwater detention

Above: Permeable pavements minimise impervious areas and allow for stormwater infiltration.

Above left: Constructed stormwater basin with weirs and planting.

Left: Boardwalks and platforms enable interaction and experience with functioning ecosystems.

Below: Section diagram showing potential riparian park / plaza with integrated stormwater filtration and detention.

(Source: Equatica for Green Sq Town Centre)

Above: Drainage grates and segmented kerbs create visual associations with stormwater, the urban water cycle and sustainable initiatives.

landscape masterplan detail areas

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DETAIL AREA LEGEND

A. PRIMARY WSUD OPPORTUNITIES

. Through site drainage easement
. Significant low flow storage opportunities
. Nutrient stripping and sedimentation ponds
. Bio - swales, rain gardens and water quality ponds

CONDARY WSUD OPPORTUNITIES

. Moderate low flow mitigation opportunities
. Nancarrow street rain gardens

C. TERTIARY WSUD OPPORTUNITIES

. Internalised bio - swales and rain gardens
. Semi formal courtyard water features.

D. MINIMAL WSUD OPPORTUNITIES

. Bowden street
. Constitution road
. Belmore street

E. NIL WSUD ZONES

. Formal Chlorinated water features, cascades and swimming pools

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area 1

Detention Basin

Feature paving areas

Footpath

Street tree rain garden (approx 4m x 2m) to Council specifications

0 20 40 60 80 100M
SCALE 1:1500 @ A3

N

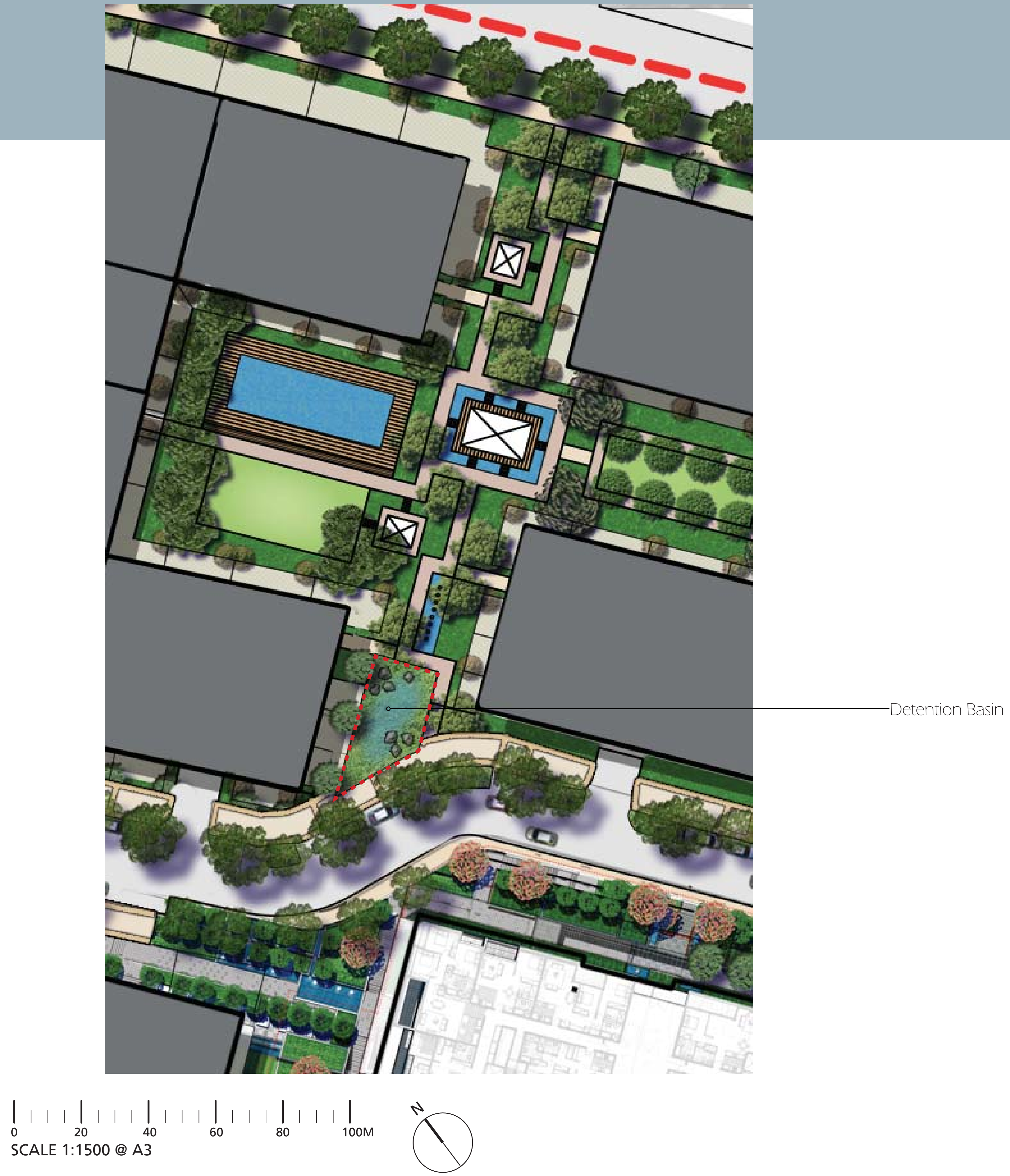
design intent

Water Quality area: 50m^2 approx.
Refer to Cardno drawings for detailed modelling

Principles

- Bioretention system located along pedestrian paths. Both boardwalk and hard landscape paths integrate the bioretention basin into the residential landscape
- Nancarrow Road design inline with 'Public Domain Technical Manual'
- Rain gardens placed at equal intervals along the street edge, creating a shaded space for parking as well as WSUD systems.

area 2



design intent

Water Quality area: 115m² approx.
Refer to Cardno drawings for detailed modelling

Principles

- Bioretention system located along pedestrian footpath to the road edge and also as a feature entering and exiting the residential complex garden areas.

area 3

design intent

Water Quality area: 155m² & 100m² approx. areas.
Refer to Cardno drawings for detailed modelling

Principles

- Designed to be viewed by passing pedestrians around the site.
- Interest by adding path networks and feature rocks placed between planting.

area 4

design intent

Water Quality area: 110m² approx.
Refer to Cardno drawings for detailed modelling

Principles

- Framed by hard landscape zones this spaces will have interest of sculptural timber pieces and feature rocks.
- Functional as a detention basin and a sculptural landscape piece.

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area 5

0 20 40 60 80 100M
SCALE 1:1500 @ A3

N

design intent

Water Quality area: 60m^2 approx. combined areas.
Refer to Cardno drawings for detailed modelling

Principles

- Placed at the lower aspects of the courtyard space the bioretention area will collect surface water from the courtyard spaces.
- The basin area will be integrated into the surrounding landscape areas to create a seamless transition in the public space.

area 6

0 20 40 60 80 100M
SCALE 1:1500 @ A3

N

design intent

Water Quality area: Stage 1 future developement area
Refer to Cardno drawings for detailed modelling

Principles

- Functional as a detention basin and a sculptural landscape piece.
- Visual piece from pedestrian footpath area.

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Nancarrow Road WSUD design

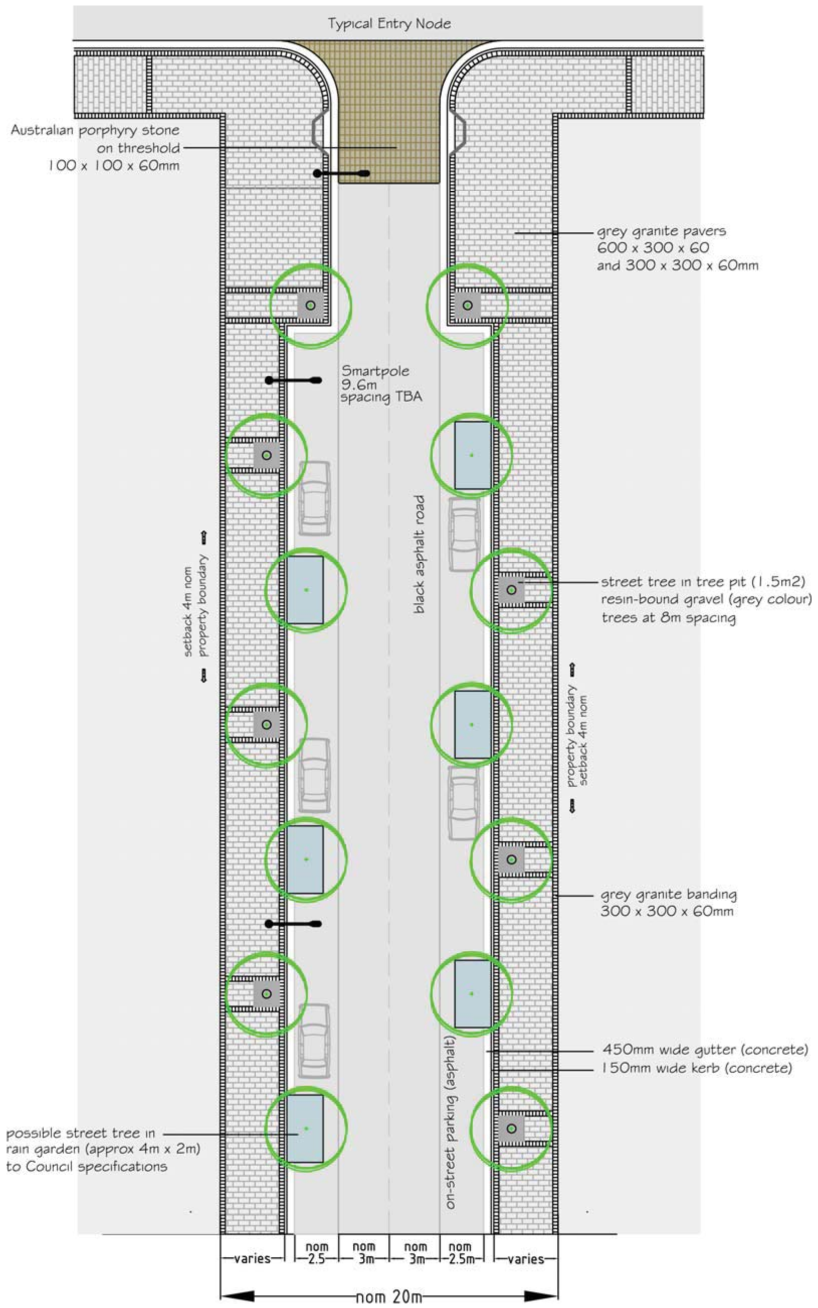
Nancarrow Road has the design principles that are reflective of a contemporary urban village and its geology is represented by natural materials such as granite, sandstone and timber. A healthy tree cover are vital to modify the microclimate and provide shade, wind control, habitat and beauty.

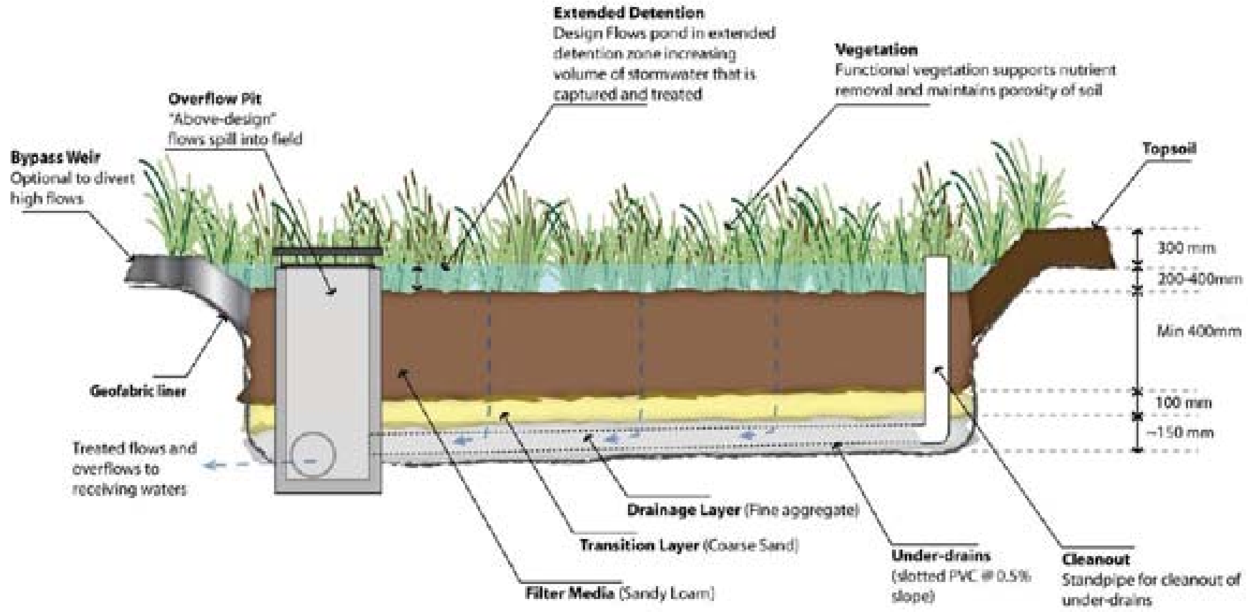
Principles

- Rain gardens with street tree planting, approx 4m x2m to Council specifications.
- Appropriate streetscape tree selection.
- Australian porphyry stone.
- Grey granite pavers & banding.
- Provides 46 on street car park spaces.

0 10 20 30 40 50M
SCALE 1:1000 @ A3
N

Nancarrow Road and new streets (plan)





© Copyright , Healthy Waterways Limited
(Construction and Establishment Guidelines V1.1 April 2010; Image 3.1, Typical cross section through a bioretention system)

The City of Ryde: Water Sensitive Urban Design tools to meet DCP objectives

WSUD report from Cardno

Integrated Water Management & WSUD Masterplan Report

Shepherds Bay Urban Renewal

600283

Prepared for Robertson Marks Architects

24/04/2013

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1 Introduction

The proposed Shepherds Bay Urban Renewal Project will occupy several sites generally bounded by Constitution Road to the North, Belmore Street to the East, Sydney Harbour fronted Rothesay Avenue to the South and Bowden Street to the West.

The site will be developed over several years with an ultimate objective of providing up to 3,000 new dwellings proximate to public transport and main road corridors.

The site presently exists as a mix of industrial, warehouse and commercial buildings.

The topography of the site consists of a relatively steep gradient from Constitution Road towards the Harbour.

This report discusses the Integrated Water Management Considerations of the proposed development and documents a site wide Water Sensitive Urban Design (WSUD) strategy.

2 Site Conditions

2.1 Climate and Rainfall

Site climate and rainfall was based on observed data at the nearest Bureau of Meteorology gauging station located at Olympic Park approximately 3.5km south of the site. **Figures 3.1.1 to 3.1.3** summarise temperature and rainfall data referenced for this study*.

It is noted that Sydney Airport gauging station is required to be referenced for water quality modelling work in accordance with Ryde Council's Draft MUSIC Modelling Guidelines.

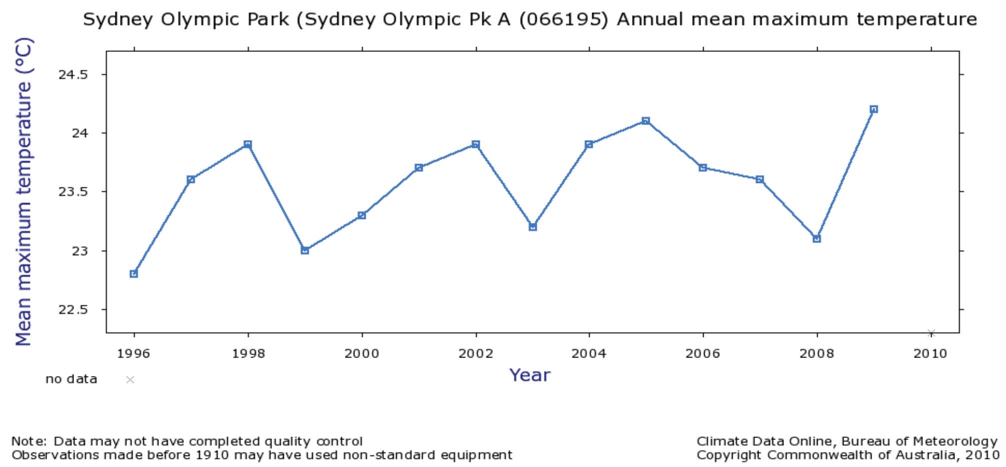

Figure 2-1 Mean Maximum Temperature

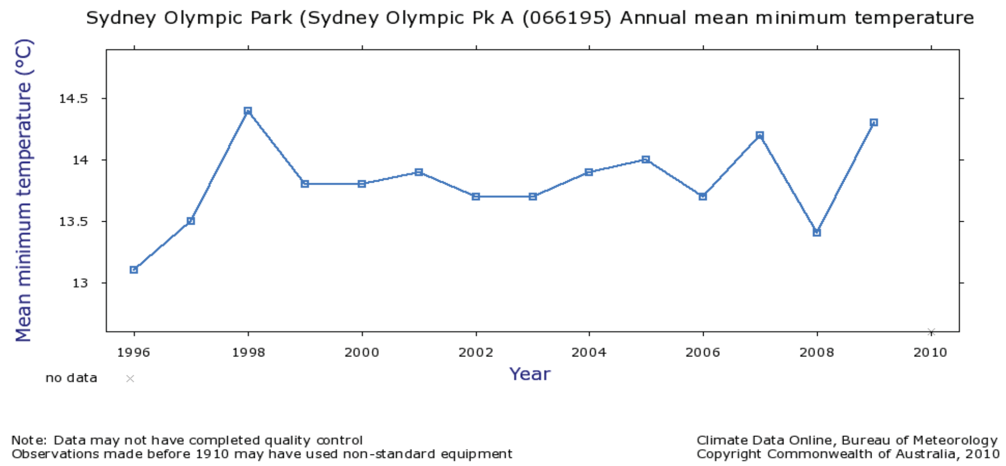

Figure 2-2 Mean Minimum Temperature

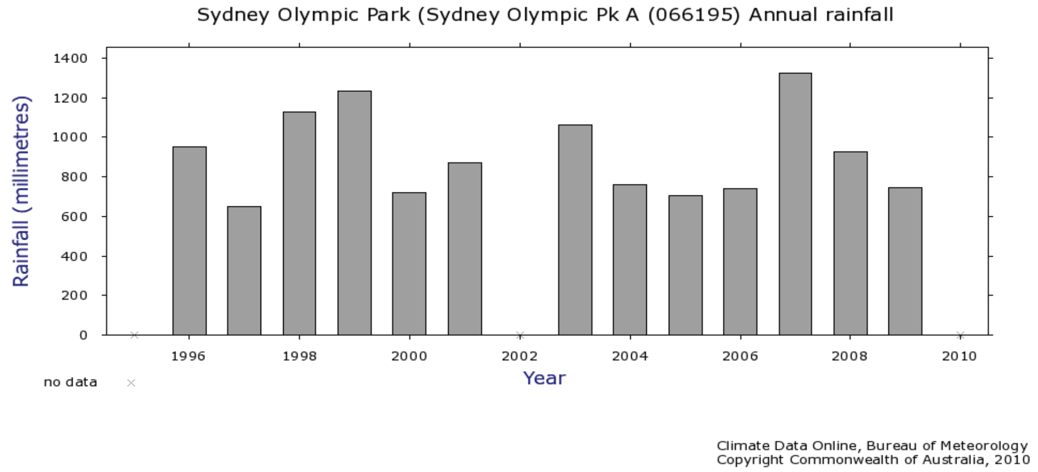

Figure 2-3 Mean Annual Rainfall

2.2 Receiving Waters

As detailed in Section 3.2, the existing site drains directly to the river via underground pipes linked to outlet headwalls integral with the sea wall and by overland flow topping the crest of the sea wall. Stormwater pipes and overland flows from the site do not traverse any private property, flowing a short distance through public land (predominantly land associated with a Council Car Park).

Water quality within Parramatta River and Sydney Harbour is well documented elsewhere and is not intended to form part of this study. The quality of the habitat and extent of biodiversity at the Shepherds Bay foreshore has been heavily compromised by decades of previous upstream industrial land use.

Notwithstanding this, Mangrove vegetation does exist along the sea wall frontage. The newly constructed Belmore Street stormwater system has been constructed with concrete and stone energy dissipaters at the outlet in order to minimise scour on the harbour bed and limit the impact on the Mangrove vegetation.

The older stormwater system outlets further to the west do not include any such energy dissipation measures.

3 Integrated Water Management Considerations

3.1 Potable Water Supply and Wastewater Management

Potable water supply will be via connection to Sydney Water's piped reticulation network. Water will be supplied to the site via various amplifications to existing including mains in Well Street from 150mm diameter to 200mm diameter and mains in Belmore Street from 100mm to 200mm.

Sydney Water has indicated that they presently do not have any plans to supply re-cycled water via to the Shepherds Bay Urban Renewal Project and that it is unlikely that such a scheme will be implemented in the future.

Waste water from the proposed development will be connected to Sydney Water's sewer system via augmented reticulation.

3.2 Flooding

The Shepherds Bay Urban Renewal area is subject major overland flows from an extensive upstream catchment. A Flood Assessment Report has been prepared by Cardno for the Shepherds Bay Urban Renewal project (reference: W4855:BCP/bcp, dated 19 November 2010).

Extensive drainage upgrades are required to ensure flows from the Ann Thorne Park Catchment are conveyed safely through the development.

Flood behaviour for the Shepherds Bay Urban Renewal project was modelled by Cardno using a two dimensional flood model (TUFLOW). The results of depth velocity product analysis in the vicinity of the Stage 1 development, which is measure of safety for flood flows are shown in Figure 3-1 on the following page. Note that a depth velocity product equal to or above 0.4m/s is considered unsafe for pedestrians.

The safe depth velocity product is exceeded at the intersection of Rothesay Avenue and Belmore Street. The presence of a low point on Rothesay Avenue and a low capacity pit and pipe system in this location results in a ponding depth of up to 0.5m (approximate RL 2.3m) at the frontage of the Stage 1 development. In Stage 1, the minimum proposed ground floor apartment level is RL5.2m well above this level. The lowest habitable floor level of the proposed development is a ground floor lobby on the west wing at RL3.65m, which provides ample freeboard to the 100 yr ARI flood level. All stair and driveway entries to basement levels will need to be a minimum of 0.3m above the flood level.

Details of habitable flood levels for subsequent development stages are subject to further detailed design.

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Figure 3-1 100yr ARI Existing Stormwater Inundation Profile – Depth Velocity Product

3.3 Stormwater Quantity

The proposed stormwater network will be augmented to the Shepherds Bay Urban Renewal Project. Due to its proximity to Parramatta River and wholesale upgrade of trunk drainage infrastructure that will be implemented to the development, On-Site Detention (OSD) is not proposed for this development.

The development of the Stage 1 stormwater system is documented on Cardno drawings 600283-100 to 140 and involves the removal of the stormwater network within the Stage 1 boundary (private property) and replacement with a network to suit the proposed multistorey residential building configuration and to meet current accepted best practice performance standards.

The piped system network was sized for the 20 year ARI (downpipes to 100 yr ARI) and the network modelling using DRAINS software. The proposed system will involve a network of downpipes to drain the 0.5Ha roof surface to the re-use system and system outlet. Courtyard drainage and planter bed drainage will be diverted to a dedicated biofiltration area (rain garden) for treatment prior to connection to an upgraded Council system.

An indicative stormwater layout for the fully developed site has been prepared to complement the Concept Water Sensitive Urban Design Strategy Masterplan (refer Cardno drawing 600283-SK001 Rev3) included in Appendix A of this report.

The proposed system for future stages will adopt a broadly similar approach as Stage 1; whereby roof water is routed to the re-use system and runoff from the Courtyard is routed through water quality devices for treatment prior to discharge to Parramatta River.

3.4 Soil and Water Management during Construction

Given the location of the works immediately adjacent to Parramatta River it is essential that appropriate sediment and erosion control measure are implemented and maintained during construction.

As Soil And Water Management Plan has been prepared for Stage 1 of the development (refer Cardno drawing 600283-120) and is aimed at a multi-staged approach to managing sediment laden runoff in accordance with Council standards and the NSW Governments "Managing Urban Stormwater Manual – Soils and Construction".

Diversion drains have been incorporated where appropriate to divert clean upstream runoff around disturbed areas in order to limit flow rated from exposed soil surfaces. Runoff from disturbed surfaces will be managed by the provision of sediment traps to pit inlets. Further protection of downstream waters will be achieved by the provision of silt fences and finally a floating silt boom as an emergency capture measure. The boom will be installed in a "U" shape linked to the bank and will ensure that any silt plume resulting from an unexpected failure of the on-site measures will be contained in a discreet area.

Basement areas will act as temporary sediment basis. Water will be pumped to Council's stormwater system only when water quality meeting NSW Office of Water Requirements can be met.

3.5 Climate Change

The stormwater system for Stage 1 of the development has been designed with a tail water level for Parramatta River based on the 2050 climate change sea level rise scenario and 20 year and 100 year river flood event. The tail water level for this situation is estimated to beRL1.48m in the 100 yr ARI event. In this scenario, upwelling is evident in one stormwater pit only, located at the low point in Rothesay Avenue.

As discussed in Section 3.2, habitable floor levels have adequate freeboard to the ponded water in the area adjacent to Stage 1. More detailed discussion regarding climate change is contained in Cardno's Flooding Report. Further discussion and reporting will be required as details of future development stages are determined.

4 Water Sensitive Urban Design (WSUD)

4.1 Objective

Water quality control for the site is an important part of the proposed development. This section of the report outlines the proposed WSUD strategy for the fully developed site to achieve Ryde Council's pollutant removal targets:

> 85% reduction in the average annual total suspended solids load (TSS)

> 65% reduction in the average annual total phosphorus load (TP)

> 45% reduction in the average annual total nitrogen load (TN)

4.2 MUSIC model set-up

Assessment of the proposed water quality devices was carried out using the software program "MUSIC" (Version 5, Build 11.00).

Daily rainfall and evapotranspiration data was sourced from the Bureau of Meteorology. The closest rain gauging station at Homebush Bay was ignored in favour of the Sydney Airport gauging station which is considered to be closely representative of the long term average rainfall in the Ryde area.

The source nodes within the MUSIC model adopt the default rainfall-runoff modelling parameters for Sydney. The base flow concentration parameters and storm flow concentration parameters for TSS, TP and TN are based on the information provided in the Draft MUSIC Modelling Guidelines for NSW and attached in Appendix C.

Given the large footprint of the development and the impervious areas at or above podium level, a percent impervious of 100% was adopted for these source nodes. Courtyard and planter bed areas drain to the water quality devices proposed. The extent of the water quality catchment is shown on Cardno drawing 600283-SK001 (Rev3).

4.3 Proposed stormwater treatment measures

The proposed stormwater treatment measures for the site utilises the following elements to achieve the required pollutant removal targets:

> Humegard – Gross Pollutant Trap (Humes product)

> Hydrofilter (Humes product)

> Rainwater Tank

> Bioretention (Raingardens)

4.3.1 Humegard Gross Pollutant Trap (GPT)

The Humegard GPT is a proprietary precast concrete product installed underground and is manufactured by Humes Water Solutions. Its primary focus is to capture coarse sediment, litter, vegetation matter, and to a small degree also remove hydrocarbons carried in stormwater runoff. Typically, these devices are effective in removing solids conveyed within stormwater larger than 100 microns.

The GPT is used as the primary treatment element in the stormwater treatment train.

A technical note for the Humegard is included in Appendix B. MUSIC modelling parameters for the Humegard treatment node were sourced from this document in consultation with Humes.

4.3.2 Hydrofilter

The Hydrofilter is a proprietary precast concrete filtration solution product installed underground and is manufactured by Humes Water Solutions. The Hydrofilter typically removes particulates down to 10 microns. For the specified treatable flow, the device efficiently removes hydrocarbons, suspended solids, nitrogen and phosphorus from stormwater runoff.

This device is used as a secondary treatment in the stormwater treatment train.

A technical note for the Hydrofilter is included in Appendix B. MUSIC modelling parameters for the Hydrofilter treatment node were sourced from this document in consultation with Humes.

4.3.3 Rainwater Tanks

The size of the re-use tanks was based off the requirements set by the Stage 1 development. The site will utilise stormwater runoff from the roof surface for use in a car washing bay and for irrigation of 1,500 sq.m of garden and turfed areas within the site.

The size of the tank required has been calculated in accordance with the procedures prescribed by the NSW Governments "Guidance on Use of Rainwater Tanks". A tank with a storage volume of 50kL is satisfactory for the harvested water demands noted. The tank will be built into each building structure and connected to a rainwater reticulation network and irrigation system to deliver water the demand locations. An automatic top up will be connected to Sydney Water's potable water network to guard against severe dry periods (noting >95% reliability of rain water system).

4.3.4 Bioretention System (Raingarden)

The bioretention systems are a combination of vegetation and filter substrate that provides treatment of stormwater through filtration, extended detention and some biological uptake.

A typical section of a bioretention area is shown on Cardno drawing 600283-SK001 (Rev3) in Appendix A.

4.4 MUSIC modelling results

Table 4-1 below shows a summary of the water quality loads from the developed site. It demonstrates the water quality loads discharging from the site following treatment by the WSUD treatment train. These results have been sourced from the 'Receiving Node' shown in Figure 4-1.

Table 4-1 Results of MUSIC modelling

TREATMENT	SOURCE (as generated by the proposed facilities on site)	RESIDUAL (loading after treatment by WSUD elements)	% REDUCTION (after treatment)	COUNCIL TARGETS
Flow (ML/yr)	79.2	73.2	7.5%	
TSS (kg/yr)	9860.0	1340.0	86.4%	>85%
TP (kg/yr)	20.2	6.13	69.6%	>65%
TN (kg/yr)	175.0	58.5	66.6%	>45%
GP (kg/yr)	1900.0	34.0	98.2%	

TSS – Total Suspended Solids
TP – Total Phosphorus
TN – Total Nitrogen
GP – Gross Pollutants

The table demonstrates the proposed water quality treatment train meets Council's requested target criteria. A layout of the MUSIC model used to obtain the above results is illustrated Figure 4-1 on the following page.

An electronic copy of the MUSIC model can be provided to Council on request.

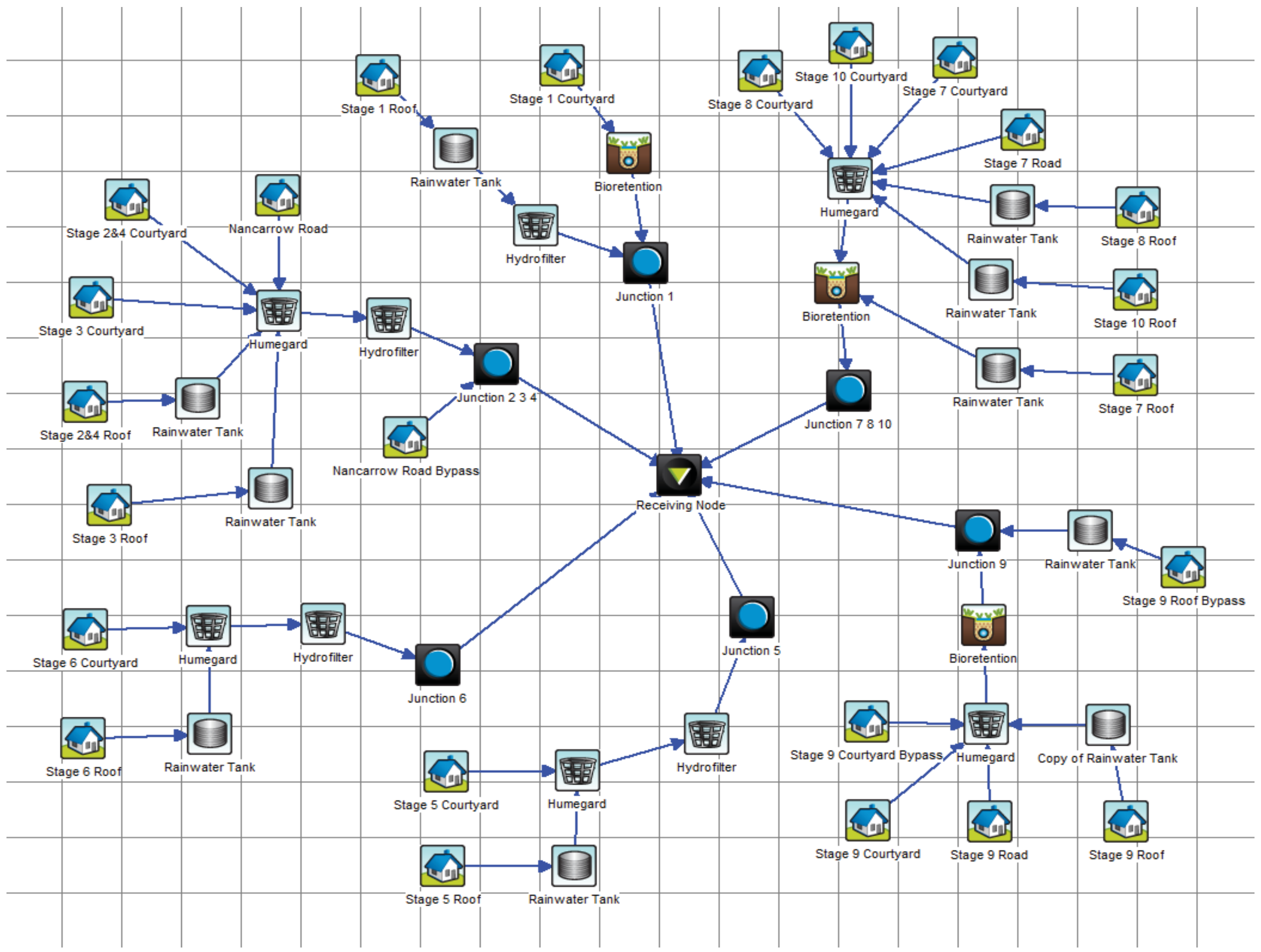

Figure 4-1 MUSIC model layout of developed site

4.5 Comments

The location, size and configuration of the various WSUD elements across the whole development site are indicative only and are subject to change pending further detailed design. Cardno's WSUD Masterplan, drawing 600283-SK001 (Rev3) provided in Appendix A is a water quality strategy for the whole site based on the information available to Cardno at the time.

The results demonstrate the full site complies with Council's water quality pollutant removal targets. In terms of staging, there should be no issues with meeting Council's water quality targets if the stages are developed in sequential order and the relevant stormwater quality devices are installed treating stormwater runoff from each stage. The scope of works of each stage should be clarified at detailed design.

5 WSUD Maintenance

5.1 Introduction

The rainwater tanks, raingardens (bio-retention areas), grassed swales and gross pollutant trap utilise a number of physical and biological processes to remove pollutants from stormwater. Sediment accumulation within the WSUD measures affects the performance and as such, should be removed periodically.

5.2 Inspection Frequency and Procedure

The WSUD measures should be inspected at intervals not exceeding three (3) months. Inspections should be undertaken by suitably qualified persons with an understanding and experience in the operation of similar systems.

5.3 Maintenance Frequency and Procedure

Routine maintenance of the WSUD measures should be undertaken as required following the above 3-monthly inspections.

5.3.1 Gross Pollutant Trap & Pit and Pipe System

Maintenance of the GPT & pit and pipe system should be undertaken as required following the above 3-monthly inspections. Maintenance of the GPT should also be undertaken in accordance with the manufacturer's specifications.

Typical maintenance procedures that would need to be undertaken include:

> Removal of sediment, debris, litter or other foreign material

5.3.2 Bioretention areas (raingardens)

Routine maintenance may include the replanting of localised areas or the pruning or trimming of existing vegetation.

Additionally, once 100mm of sediment has been accumulated it will be necessary to strip and replant the raingardens.

5.3.3 Overland Flow Paths

Maintenance of the overland flow swales may be separated into regular and routine tasks.
Regular maintenance includes frequently undertaken maintenance tasks such as mowing of grassed swales.
Routine maintenance involves maintenance tasks that are undertaken as site conditions require. These tasks may include:

> Removal of sediment build up

> Removal of weeds or foreign species

> Restoration of swale due to scour or erosion

5.3.4 Subsoil Drainage

Maintenance of the flushing points and subsoil pipe system should be undertaken as required following the above 3-monthly inspections.

Typical maintenance procedures that would need to be undertaken include replacement of access and clean out points as required.

Additionally, the subsoil system should be flushed not less than once during the first 12-months of operation and intervals not exceeding 24 months thereafter.

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5.4 Summary of Maintenance Requirements

5.4.1 Every Three (3) Months

Gross Pollutant Trap & Pit and Pipe Network – Check:

> All pit grates and lids are secure

> All GPT & pits for sediment accumulation

> All pipes for blockage by sediment

> Headwall for damage and evidence of scour

Raingardens – Check:

> Plant growth and health

> For evidence of scour

> For sediment accumulation

Overland Flow Paths – Check:

> Signs of scour or erosion

> Sediment deposition

> Channel capacity has not been reduced

> For weed infestation

> Vegetation health and height

> For scour or sediment accumulation at outlet

Subsoil Drainage – Check:

> Access and clean out points

> Outlet points

5.4.2 Every Five (5) to Ten (10) Years

Bioretention areas – As required:

> Strip sediment and vegetation and replant bioretention area

Rainwater Tank – Every 5 years:

> Drain the tank completely dry and remove all silt and sediment material.

Note that the above intervals are recommendations only. That actual frequency may be adjusted to suit the conditions found on site. It is however, recommended that the above maintenance intervals be adhered for at least the establishment periods of the bioretention area, typically 1 to 2 years.

6 Conclusions

The Shepherds Bay Urban Renewal project will enable rejuvenation of what is presently a poorly controlled urban catchment into one that meets current best practice standards with respect to flood management, sustainable water management, Water Sensitive Urban Design and water quality management.

The Integrated Water Management Plan and Water Sensitive Urban Design Masterplan presented in this report will result in improvements to public safety during flood events, improvements to runoff quality to Parramatta River, more sustainable use of water to and compliance with current urban catchment management standards.

These objectives can be met by the measures described in this report and subsequent stages of the Shepherds Bay Urban Renewal project will be developed to an equivalent standard which will evolve with improvements in water management technology and practices over the extended timeframe for wider development.

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Shepherds Bay Urban Renewal

APPENDIX A
CONCEPT WATER SENSITIVE URBAN DESIGN MASTERPLAN

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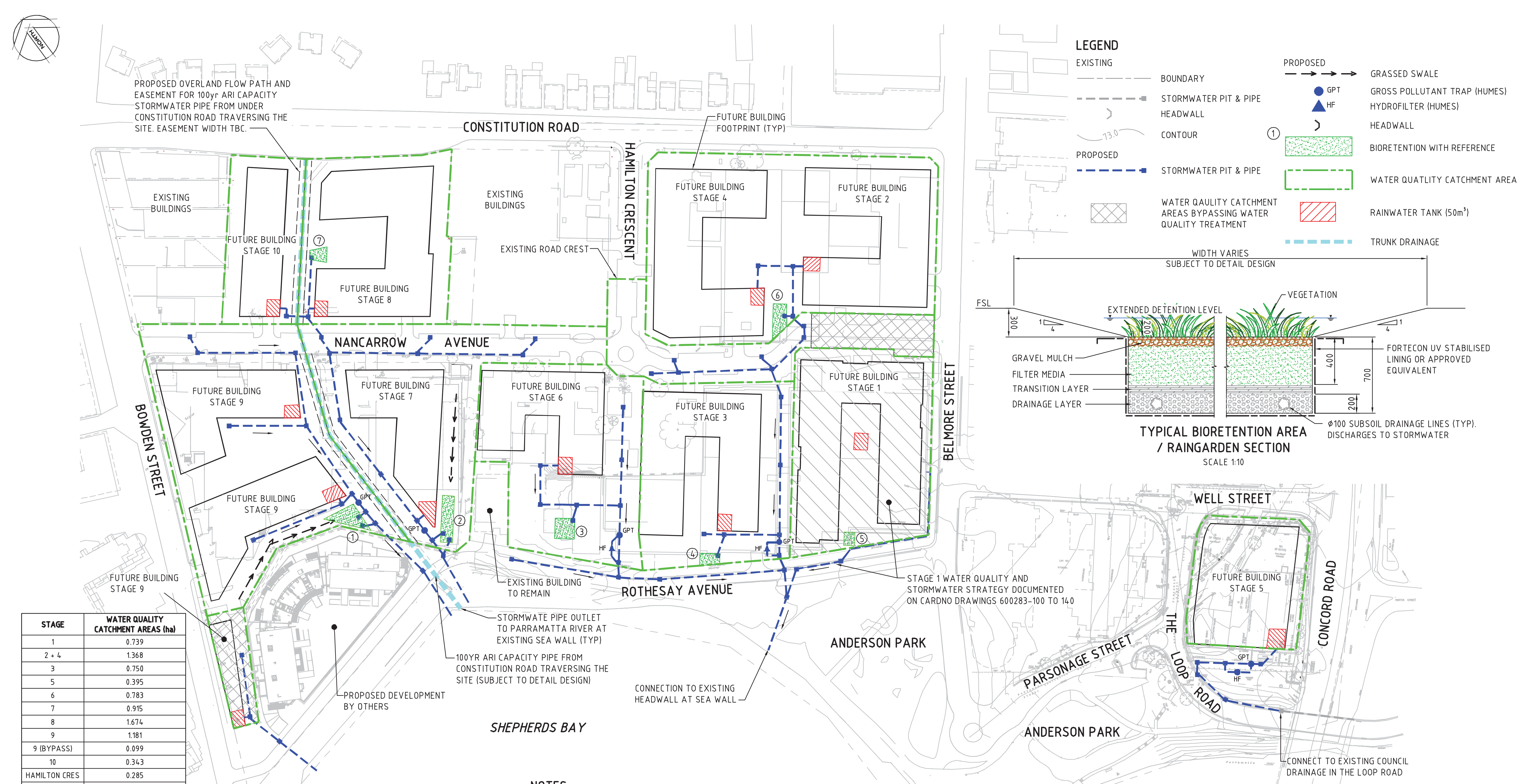

STAGE	WATER QUALITY CATCHMENT AREAS (ha)
1	0.739
2 + 4	1.368
3	0.750
5	0.395
6	0.783
7	0.915
8	1.674
9	1.181
9 (BYPASS)	0.099
10	0.343
HAMILTON CRES	0.285
HAMILTON CRES (BYPASS)	0.126
TOTAL	7.809

BIORETENTION AREAS (FILTER MEDIA AREA m^2)	
1	155
2	100
3*	110
4*	60
5*	40
6*	115
7*	50
TOTAL	630

*BIORETENTION TO CAPTURE AND TREAT SURFACE RUNOFF ONLY

NOTES

- STORMWATER PIT & PIPE LAYOUT INDICATIVE ONLY. STORMWATER DESIGN BASED ON EXISTING ROAD GRADES & SUBJECT TO DETAILED DESIGN OF FUTURE BUILDING STAGES
- EXISTING SERVICES NOT SHOWN ON PLAN FOR CLARITY. ALL PROPOSED SERVICES SUBJECT TO AGREEMENT WITH RELEVANT AUTHORTIES.
- LOCATION, SIZE & ARRANGEMENT OF BIORETENTION BASINS RAINWATER TANKS & OTHER WATER QUALITY TREATMENT DEVICES ARE INDICATIVE ONLY & SUBJECT TO DETAILED DESIGN. FOR DETAILS OF WATER QUALITY ASSESSMENT, REFER TO CIVIL ENGINEERING REPORT BY CARDNO.
- DRAWING TO BE READ IN CONJUNCTION WITH LANDSCAPE ARCHITECTURAL PLANS BY PLACE DESIGN.

WATER QUALITY TREATMEN RESULTS :

TREATMENT	SOURCE	RESIDUAL	% REDUCTION	COUNCIL TARGETS
FLOW	79.2	73.2	7.50%	
TSS	9860.0	1340.0	86.40%	>85%
TP	20.2	6.1	69.60%	>65%
TN	175.0	58.5	66.60%	>45%
GP	1900.0	34.0	98.20%	

TSS - TOTAL SUSPENDED SOLIDS
TP - TOTAL PHOSPHORUS
TN - TOTAL NITROGEN
GP - GROSS POLLUTANTS

SCALE 1:1000
SCALE 1:10

NOT CONSTRUCTION ISSUE

Rev	Date	Description	Drawn	Appr.
3	24/04/2013	WSUD MASTERPLAN FOR APPROVAL	MJM	CEV
2	22/04/2013	PRELIMINARY WSUD MASTERPLAN	MJM	DPS
1	10/04/2013	CONCEPT WATER QUALITY MASTERPLAN	MJM	CEV

ROBERTSON + MARKS

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Quality System
Quality Endorsed Company

Drawn	MJM	19/04/2013
Checked	DPS	19/04/2013
Designed	DPS	19/04/2013
Verified	CEV	24/04/2013
Approved	CEV	24/04/2013

Client ROBERTSON MARKS ARCHITECTS

SHEPHERDS BAY URBAN RENEWAL, MEADOW BANK

WSUD MASTERPLAN

Status NOT FOR CONSTRUCTION

Date	Datum	Scale	Size
19/04/2013	AHD	AS SHOWN	A1

Drawing Number 600283-SK001 Revision 3

ON A1 ORIGINAL

DATE PLOTTED: 24 April 2013 9:19 AM BY : MATTHEW MCDONALD (SYDNEY)

XREFs: X-GRP-A1-SHT; X-SYD-A1-Logo; X-Survey; X-Arch; X-Catchments; X-Design
CAD FILE: N:\Urban\6000 - 6099\600283 - Sheaphards Bay Meadow Bank\3 Drafting\Sketches\600283-SK001(3).dwg

Shepherds Bay Urban Renewal

APPENDIX B
TECHNICAL NOTES FOR HUMES WATER QUALITY DEVICES

PLACE
PLANNING DESIGN ENVIRONMENT

Cardno
Shaping the Future

Humes
Water Solutions

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Technical Note

Subject: Humegard® Pollutant removal Capabilities

1. Background & Assumptions

The performance of Gross Pollutant Traps generally and Humegard® specifically has been predominantly focussed on their ability to remove litter and other natural or anthropogenic wastes from stormwater runoff. More than 5 years of research has been undertaken by Swinburne University on the ability of the Humegard® to remove pollutants from stormwater (1997 - 2002). As part of this research, it was concluded that the Humegard® GPT captures > 90% of granular material with particle size > 100 microns (*Ecorecycle Victoria 1998, Swinburne University 2000*).

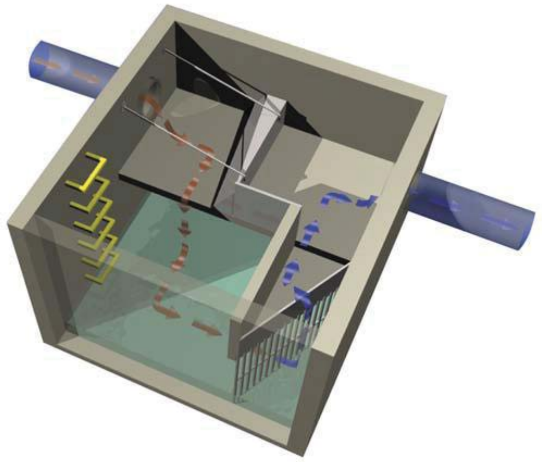

Figure 1, standard Humegard® GPT

Nutrients, including nitrogen and phosphorous, are known to exist in a variety of forms and can be identified in two main groups based upon their state. These are; dissolved and particulate-bound/ organic forms. In this regard, we can make the following assumptions:

- Australian Runoff Quality (Engineers Australia 2006) states that (90-95)% of total phosphorus (TP) is in particulate form susceptible to sedimentation.
- Nitrites (NO2), nitrates (N03) and Ammonium (NH4) are dissolved pollutants in stormwater runoff. These contribute about 40% of total nitrogen (TN) (*CRCFE 2001*).

Based on analysing a range of particulates to determine what percentage of the pollutants is adsorbed across the particle size grading for a range of soils and pollutants, the following correlations have been established (*CRCFE 1998*):

- TP (μg/gm of suspended particulate material) = $0.7\ d^{-02}$
- TN (μg/gm of suspended particulate material) = $11\ d^{-02}$

Where d is the particulate material dia in μm

2. Calculations

The following table shows calculations of particulate-bound TP and TN that are associated with total suspended solids (TSS) based on particle size distribution for urban runoff derived from Australian Runoff Quality as shown in Figure 2 below (*Engineers Australia 2006*).

Particle size (μm)	TSS individual retention%	TSS cumulative retention%	TP adsorption μg/g TSS	TP individual retention%	TP cumulative retention%	TN adsorption μg/g TSS	TN individual retention%	TN cumulative retention%
1	0.1	100%	0.70	0%	100%	11.00	0%	100%
2	1.9	99.9%	0.61	4%	100%	9.58	4%	100%
4	1	98%	0.53	2%	96%	8.34	2%	96%
8	2	97%	0.46	3%	94%	7.26	3%	94%
16	5	95%	0.40	7%	91%	6.32	7%	91%
32	10	90%	0.35	12%	84%	5.50	12%	84%
64	25	80%	0.30	26%	72%	4.79	26%	72%
128	32	55%	0.27	29%	46%	4.17	29%	46%
256	18	23%	0.23	14%	18%	3.63	14%	18%
500	5	5%	0.20	3%	3%	3.17	3%	3%

Table (1), calculations of TSS and particulate-bound TP and TN

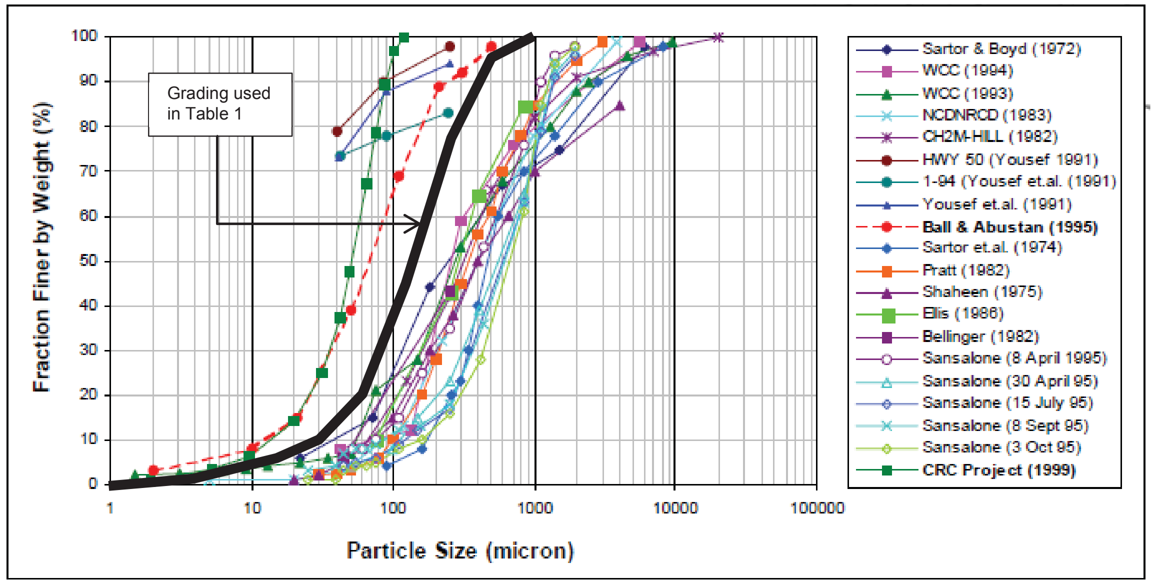

Figure 2, particle size grading used in this technical note compared to the compilation of observed particle size grading of sediment transported in urban stormwater as presented in ARQ (*Engineers Australia 2006*)

The Humegard® pollutant reduction performance in relation to TSS, TP and TN is determined as follows:

- TSS removal is based on 90% removal of TSS > 100 microns = 0.9 x 55% (from Table 1) = 50%
- TP removal is based on 90% removal of TP > 100 microns x 0.9 (90% of TP is particulate-bound)
  = 0.9 x 46% (from Table 1) x 0.9 = 37%
- TN removal is based on 90% removal of TN > 100 microns x 0.6 (60% of TN is particulate-bound)
  = 0.9 x 46% (from Table 1) x 0.6 = 25%

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3. Modelling (MUSIC) pollutant removal efficiency

For the design treatable flow, Humegard® can achieve the following performance:

Pollutant	Removal efficiency
Gross Pollutants	98%
TSS	50%
TP	37%
TN	25%

References

CRC for Freshwater Ecology (1998), *Design Guidelines: Stormwater Pollution Control Ponds & wetlands*, by Ian Lawrence and Peter Breen.

CRC for Freshwater Ecology (2001), *Pond & Wetland Models: Description and Quality Assurance Report*, by Ian Lawrence.

Ecorecycle Victoria (1998), *In-Line Litter Separator: Installation and Monitoring Project*, prepared by: Swinburne University of Technology.

Engineers Australia (2006), *Australian Runoff Quality, A Guide to Water Sensitive urban Design*, EA Books, Crows Nest.

ewater (2011) *MUSIC User Manual*, Version 5.

Swinburne University (2000), *HUMEGARD IN-LINE LITTER SEPARATOR SEDIMENT CAPTURE TESTING-Preliminary Report* by Bronwyn Chapman, School of Engineering and Science

PLACE
PLANNING
DESIGN
ENVIRONMENT

In-Line Litter Separator: Installation and Monitoring Project

August 1998

Swinburne University
Of Technology

ecorecycle
VICTORIA

Level 4, 478 Albert Street, East Melbourne, VIC, 3002
Telephone: 03 9639 3322 Facsimile: 03 9639 3077
Email: mailbox@ecorecycle.vic.gov.au

10. INDICATIVE CAPTURE EFFICIENCIES

The indicative capture efficiencies given below were assessed from model tests and pilot prototype observation and analysis. The testing program in progress on installed prototypes suggests that these are generally conservative.

The capture efficiency of other devices is limited to the through-flow capacity of the device, with overflow or bypass events ignored. For the ILLS, this is equivalent to boom-down storm events when the potential capture efficiency is virtually 100%, as all entrained materials are diverted with the flow to the holding compartment.

Overflow or bypass events in other devices are equivalent to the boom lift situation with the ILLS. While these devices pass the surplus flow together with all floating materials, the ILLS continues to remove buoyant material. This feature is reflected in the indicative capture efficiencies given below.

As plastic sheet type litter is just buoyant, it is the most difficult to retain after initial capture. The comb of vertical wires suspended below the baffle to a depth of 1.2m prevents most of this material escaping.

Table 10.1 Indicative capture efficiencies for targeted litter items

Material	Indicative Capture Efficiency
Polystyrene	>95%
Plastic bags/sheets	>80%
Plastic bottles	>90%
Plastic wrappers	>90%
Metal cans	>90%
Cellulose paper	>90%
Vegetative matter	>90%
Granular material (>100micron)	>90%

HUMEGARD IN-LINE LITTER SEPARATOR SEDIMENT CAPTURE TESTING
Preliminary Report
Bronwyn Chapman, School of Engineering and Science
Swinburne University
August 2000

1. Introduction

Testing was conducted in July 2000 at Swinburne University to determine the capture rate of the Humegard using a specified sand. The capture rate was determined by capture of sediment at the outlet of the Humegard and expressing this as a percentage of the known sand mass fed into the Humegard.
The testing was conducted on a scale model of the Humegard. The model dimensions are related to the inlet pipe diameter. Compared with typical field installation, this model is approximately a one-quarter model.

2. Testing Brief

The testing brief from Humes was as follows

- use a screened sand with a median particle size of 200 micron with some down to 150 micron and some up to 300 and a specific gravity of 2.65
- test will be run on the scale model at Swinburne at a maximum treatment flow rate ie prior to boom floating (1in3 month flow)
- introduce sand at the inflow to provide a dry weight of sand per litre of water added of 210 mg/litre (over a 25 minute period)
- take 0.5 to 1.0 litre samples at the outlet at 1 minute intervals during the test. These samples may be composited or tested independently to the relevant standard to determine residual sediment levels and subsequent percentage removal rates.
- following the sediment rate capture test it is proposed to add sand to the storage/treatment chamber representing half of the available storage capacity. The unit to be left for one hour to alow finer particles to settle. Flow should then be increased to full design flow with boom floating. Without addition of any sand into the inflow, further samples should be taken over a period of 25 minutes at one minute intervals to determine the retention rate of the sediment during high flow conditions.
- headloss teasting shall provide a measurement of hydraulic losses through the Humegard at design storm flow.

3. Modifications to the Testing Brief

The collection method used at the outlet was modified. A woven nylon filter bag rated to capture 150 micron sand was used. The capture efficiency of the bag was checked in low flow tests by passing the outlet water through a 75 micron sieve. Flow rate was measured using a V notch weir, converted to flow by a weir flow formulae and an accepted weir coefficient. It was not possible to accurately achieve the specified sand flow rate of 210 mg/l due to limitations in accurately metering the sand inflow and metering the pipe flow rate. The sand flow rate was calculated from measurements during each test, and was generally about 200 mg/l. Details of each test are provided in this report.

4. Testing Method

Two types of test were conducted:

- sand capture test, where a given mass of graded sand was introduced upstream of the Humegard inlet, and a capture rate was determined using the mass of the sand from the outlet
- sand disturbance test, where a sand layer on the base of the Humegard was disturbed by flow, and the mass of the sand from the outlet was measured. A measure of outlet mass flow (mg/l) was derived from the test, as well as a capture rate.

5. Sand Capture Test

5.1 Flow Rate
The tests were conducted at a flowrate of 0.68l/s. This was measured using a V-notch weir. This flowrate was the flow that 'just lifted' the boom of the Humegard, corresponding to the treatment flow rate. The boom on the model does not lift evenly, so water can pass underneath part of the boom at this stage. Tests were conducted at the same flow rate at the theoretical 'just lift' condition, both allowing the boom to rise slightly, and with it seated on the platform. It is not known what behaviour the boom in a full scale Humegard will exhibit.

5.2 Sand sample

Diameter passing	% passing (by mass)	~ median sample size	SG
300 micron	100%		
225 micron	66%	200 micron	2.62
150 micron	33%		

The sand sample was dried and weighed before the test. The sand was metered into the upstream pipe through a tube at the pipe obvert that had been previously tested to give the required flow rate. The metering tube was located 160 mm upstream of the entry to the Humegard.

5.3 Determination of Results
The Humegard outlet was a short bend discharging to a tank (see fig 1). Any sand from the outlet was collected in a woven nylon filter bag rated to capture 150 micron sand. This was checked in low flow tests by passing the outlet water through a 75 micron sieve. Negligible sand was collected in the sieve.
Sand that was deposited in the bag and in the Humegard was collected and dried prior to weighing.
The capture rate is calculated using the sand that is exiting from the Humegard.

5.4 Results

54..2 Sand Capture Test 1 - Boom slightly lifted above platform

A 230gm sample was metered into the inlet pipe of the Humegard in 28min, giving a sand flow rate of 201 mg/l. The flowrate was 0.68l/s.

Most sand was deposited on the Humegard platform just upstream of the boom. Some was deposited on the platform just downstream of the boom. It appeared this passed under the boom, as no sand was observed to pass over the weir in the Humegard. Some sand was deposited in the Humegard chamber.

Sand inlet to Humegard	230.0 g
Sand upstream of boom	183.3 g
Sand downstream of boom	7.7 g
Sand from outlet	3.5 g

(Remainder of sand approx 30g presumed to deposit in Humegard chamber)
Capture rate 98%

54..2 Sand Capture Test 2 - Boom seated on platform

A 222gm sample was metered into the inlet pipe of the Humegard in 27min, giving a sand flow rate of 202 mg/l. The water flowrate was 0.68l/s

Most sand was deposited on the Humegard platform just upstream of the boom, and in the Humegard chamber. No sand was observed to pass over the weir in the Humegard, or deposited downstream of the boom. A small amount was captured from the outlet.

Sand inlet to Humegard 222.0 g
Sand upstream of boom 165.3 g
Sand in the Humegard chamber 37.4 g
Sand from outlet 0.5 g
Capture rate 99%
(It appears a small amount of sand remained in the Humegard from the previous test)

The sand in the Humegard was dried before collection. Of the sand in the chamber, 31.2g was deposited on the floor upstream of the comb, and 6.2g was on the floor downstream of the comb.

54..2 Sand Capture Test No. 3 - Boom seated on pad

A further test was conducted after installation of a pad of 5mm height, directly under the boom (see figure 2). This installation better diverted flow into the Humegard chamber, as could be seen by the curved pattern of sand on the platform upstream of the boom.
A 230 gm sample was metered into the inlet pipe of the Humegard in 18 min, giving a sand flow rate of 332 mg/l. The water flow rate was 0.64 l/s. Due to a problem with the metering device a faster sand flow occurred. After the sand was introduced, and most settled upstream of the boom, the flow rate was increased to the minimum that washed the sand into the chamber of the Humegard. A flow rate of 2.2 l/s was maintained for 30 minutes. Most of the sand was washed into the Humegard chamber. The boom lifted during this higher flow, but the pad prevented most sand washing past the boom. This test was conducted as field observations of two Humegard installations at Roxsborough Park showed most sand is deposited inside the chamber and not on the platform.

Sand inlet to Humegard 230.0 g
Sand upstream of boom 8.5g
Sand in the Humegard chamber 218.4 g
Sand downstream of the boom 1.0 g
Sand from outlet 0.8 g
Capture rate 99%

6. Sand Disturbance Test

A layer of sand was laid on the base of the sand, to a level corresponding to half full in the field. The Humegard was then run at full flow rate with the boom lifted. Due to the amount of sand required, a commercially available sand was used, but sieved to remove the fraction >300 micron.

Sample grading

Diameter passing	% passing (by mass)	~ median sample size	SG
300 micron	100%		
225 micron	33%	200 micron	2.62
150 micron			
	66%		

Since the chamber in the model is not as deep as field installations, the sand was laid to a level that was about the half full line in a full size chamber (see fig 3).
A full flow rate of 12.35 l/s was maintained for 25 minutes (total flow 18535l). During the test the sand swirled about in the chamber. The water downstream of the weir was noticeably clearer than in the Humegard chamber, indicating that sand was remaining in the chamber.

Sand Disturbance Test - Results
Sand collected from outlet 8.5 g
Concentration of sand in outlet water 0.0005 g/l

Since the chamber depth is not to scale, the model chamber was filled to the level that would correspond to half full in the field Humegard. The depth of sand in the model chamber was 7 cm. If the model chamber was a scale depth, the sand depth would be 35cm. The sand weight for a 35cm depth was estimated (from volume and SG) to be 520kg. Hence capture rate is greater than 99%. Since only the surface of the sand was mobilised, entrainment is negligible.

HUMEGARD IN-LINE LITTER HEADLOSS TESTING
Preliminary Report
Bronwyn Chapman, School of Engineering and Science
Swinburne University
August 2000

1. Introduction

Testing was conducted in August 2000 at Swinburne University to determine the headloss across the Humegard. The tests were conducted on a scale model of the Humegard. The model dimensions are related to the inlet pipe diameter. Compared with typical field installation, this model is approximately a one-quarter model.

7. Testing Method

The setup for the test is shown in figure 1, showing manometers installed upstream and downstream of the Humegard. Manometer readings were taken for a flowrate that is measured using a V notch weir. The HGL was projected to the centre of the Humegard from both the upstream and downstream measurements to determine the headloss across the Humegard. The shock loss coefficient K was calculated using the velocity in the upstream pipe, flowing full. All tests were conducted with the upstream pipe flowing between 0.8D and full, resulting in an upstream velocity of approximately V_{full} in all tests.

Tests were conducted at a range of flows, for pipe depths from 0.8D in the upstream pipe, to a full pipe under head. In each test a series of readings was taken, and an average headloss was calculated. For higher flows, when the upstream pipe was just full or greater, the boom lifted to the obvert of the pipe or higher. At lower flow rates, with the upstream pipe part full, the boom position was below the top of pipe.

8. Results

The headloss was different for following two flow conditions.

8.1 Pipe Full Flow Condition

The Humegard was tested for the uspstream and downstream pipes being
'just full' (Q= 24.7l/s) and under head (Q = 26.2l/s). Once the boom position is above top of pipe (see fig 2), the headloss results are similar.
Headloss in these tests was negligible, but given the effect of fluctuation in the manometer levels a figure of K is assumed K=0.1
The value of K=0.2 that is recommended for use would be conservative for the 'pipe full' flow condition that is used for drainage design.

8.2 Part Full Flow Condition

Once the boom position is below top of pipe, the headloss increases significantly. Tests were conducted with the following results.

U/S pipe	D/S pipe	Position of boom above invert	Q (l/s)	K (average)
~0.95D	~0.9D	0.7D	24.1	0.4
~0.9D	~0.7D	0.5D	22.6	1.6
~0.8D	~0.7D	0.4D	22.3	1.2

It is important to note that in both cases, although the K value is high, the upstream pipe was still not flowing full. The purpose of the use of K values in design using the HGL is to check for 'heading up' and possible overflow in upstream pits. Hence the part full condition is not the critical condition, despite the higher K value.

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Technical Report

1. Hydrofilter® Pollutant removal Capabilities

The system uses a combination of processes including vortex motion, sedimentation, up-flow pressure, physical filtration, adsorption and chemical precipitation, to remove pollutants from the stormwater inflows (refer to Figure 2). It incorporates a hydrodynamic separator with a sediment storage zone, a porous media filter and a bypass pipe to deliver high efficiency treatment.

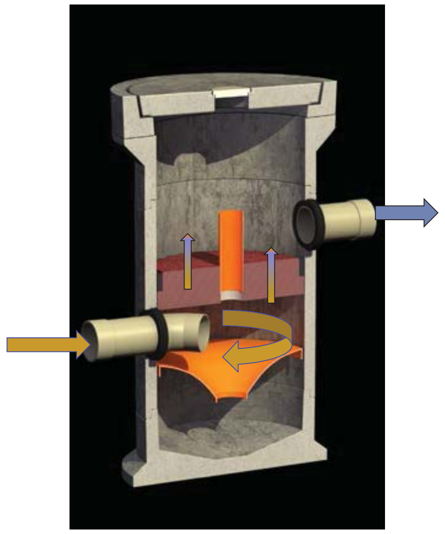

Figure (2), the Hydrofilter® systems

Stormwater enters the system into the lower chamber between the hydrodynamic separator and the filter. From there it is directed around the perimeter of the system, where a vortex motion is formed encouraging sediment to move towards the centre of the unit. The curve of the separator facilitates the settlement of coarse particles down into the sediment storage zone. Quiescent conditions in the sediment storage zone minimise re-suspension of captured pollutants. The vortex motion against the lower surface of the filter scours away biofilm and sediment build-up.

A head pressure in the lower chamber is created through a 250 mm water level change from upstream to downstream. This pressure drives flow up through the porous media filter where dissolved pollutants pass into the media pores, and suspended solids >10 microns are caught by the filter. Once the storm flow ceases, treated water filters back through the media dislodging captured particles, settling them into the sediment storage zone.

The particles and pollutants entering the media filter are subjected to adsorption and chemical precipitation. Dissolved pollutants, particularly heavy metals, have an affinity for the media and bond to it as the water passes through the filter.

The filter is manufactured with a patented formula to control the porosity and chemical composition such that entrained particles are captured and removed from solution. The transformed precipitate then settles out with the back flushing action, or is bound within the media. The design of the system ensures the filter is fully immersed at all times to prevent the formation of a dry, clogging layer.

The HydroFilter® system has demonstrated a high level of treatment in the testing that has been undertaken in Australia, Europe and the USA. The system has demonstrated to trap all particulates greater than 20 microns.

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2. Calculations

Nutrients, including nitrogen and phosphorous, are known to exist in a variety of forms and can be identified in two main groups based upon their state. These are; dissolved and particulate-bound/ organic forms. In this regard, we can make the following assumptions:

- (90-95)% of total phosphorus (TP) is in particulate form susceptible to sedimentation (ARQ 2006).
- Nitrites (NO2), nitrates (N03) and Ammonium (NH4) are dissolved pollutants in stormwater runoff. These contribute about 40% of total nitrogen (TN) (*CRCFE 2001*).

Based on analysing a range of particulates to determine what percentage of the pollutants is adsorbed across the particle size grading for a range of soils and pollutants, the following correlations have been established (*CRCFE 1998*):

- TP (μg/gm of suspended particulate material) = $0.7\ d^{-02}$
- TN (μg/gm of suspended particulate material) = $11\ d^{-02}$

Where d is the particulate material dia in μm

The following table shows calculations of particulate-bound TP and TN that are associated with total suspended solids (TSS) based on particle size distribution for urban runoff derived from Australian Runoff Quality as shown in Figure 3 below (*Engineers Australia 2006*).

Particle size (μm)	TSS individual retention%	TSS cumulative retention%	TP adsorption μg/g TSS	TP individual retention%	TP cumulative retention%	TN adsorption μg/g TSS	TN individual retention%	TN cumulative retention%
1	0.1	100%	0.70	0%	100%	11.00	0%	100%
2	1.9	99.9%	0.61	4%	100%	9.58	4%	100%
4	1	98%	0.53	2%	96%	8.34	2%	96%
8	2	97%	0.46	3%	94%	7.26	3%	94%
16	5	95%	0.40	7%	91%	6.32	7%	91%
32	10	90%	0.35	12%	84%	5.50	12%	84%
64	25	80%	0.30	26%	72%	4.79	26%	72%
128	32	55%	0.27	29%	46%	4.17	29%	46%
256	18	23%	0.23	14%	18%	3.63	14%	18%
500	5	5%	0.20	3%	3%	3.17	3%	3%

Table (1), calculations of TSS and particulate-bound TP and TN

The Humegard® /Hydrofilter® pollutant reduction performance in relation to TSS, TP and TN is determined as follows:

- TSS removal is based on 100% removal of TSS > 20 microns (from Table 1) = 90%
- TP removal is based on 100% removal of TP > 20 microns x 0.9 (90% of TP is particulate-bound)
  = 84% (from Table 1) x 0.9 = 75%
- TN removal is based on 100% removal of TN > 20 microns x 0.6 (60% of TN is particulate-bound)
  = 84% (from Table 1) x 0.6 = 50.4%

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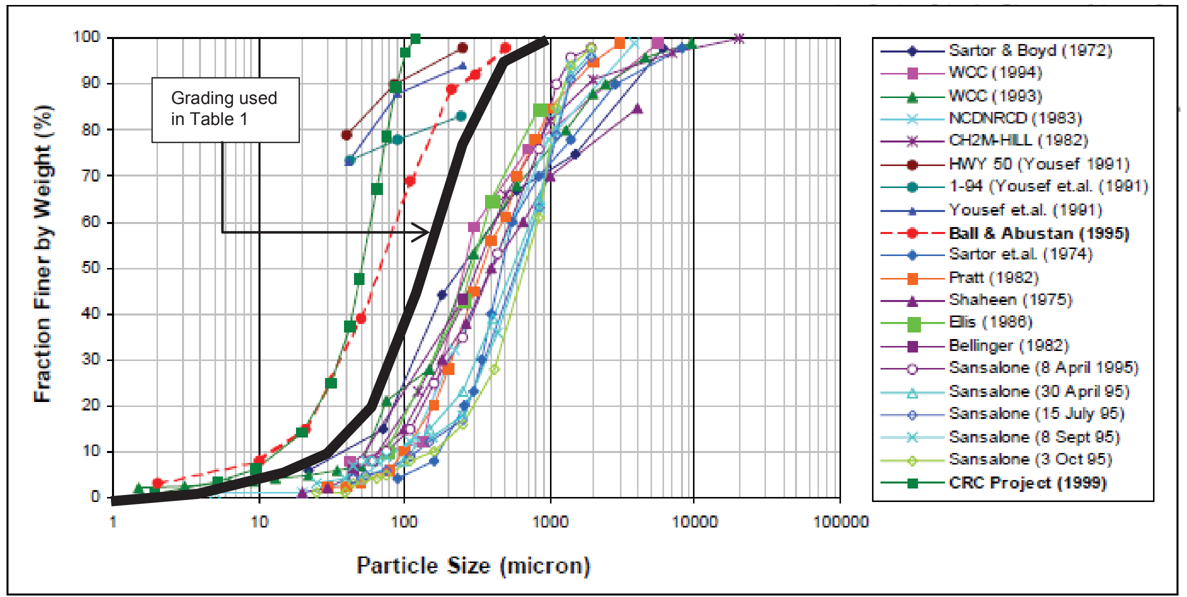

Figure 3, particle size grading used in this technical note compared to the compilation of observed particle size grading of sediment transported in urban stormwater as presented in ARQ (*Engineers Australia 2006*)

3. *Modelling (MUSIC) pollutant removal efficiency*

For the design treatable flow, the treatment train of Humeceptor® and of Hydrofilter® can achieve the following performance:

Pollutant	Removal efficiency
Gross Pollutants	95%
TSS	90%
TP	75%
TN	50%

4. *References*

CRC for Freshwater Ecology (1998), *Design Guidelines: Stormwater Pollution Control Ponds & wetlands*, by Ian Lawrence and Peter Breen.

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Ecorecycle Victoria (1998), *In-Line Litter Separator: Installation and Monitoring Project*, prepared by: Swinburne University of Technology.

Engineers Australia (2006), *Australian Runoff Quality, A Guide to Water Sensitive urban Design*, EA Books, Crows Nest.

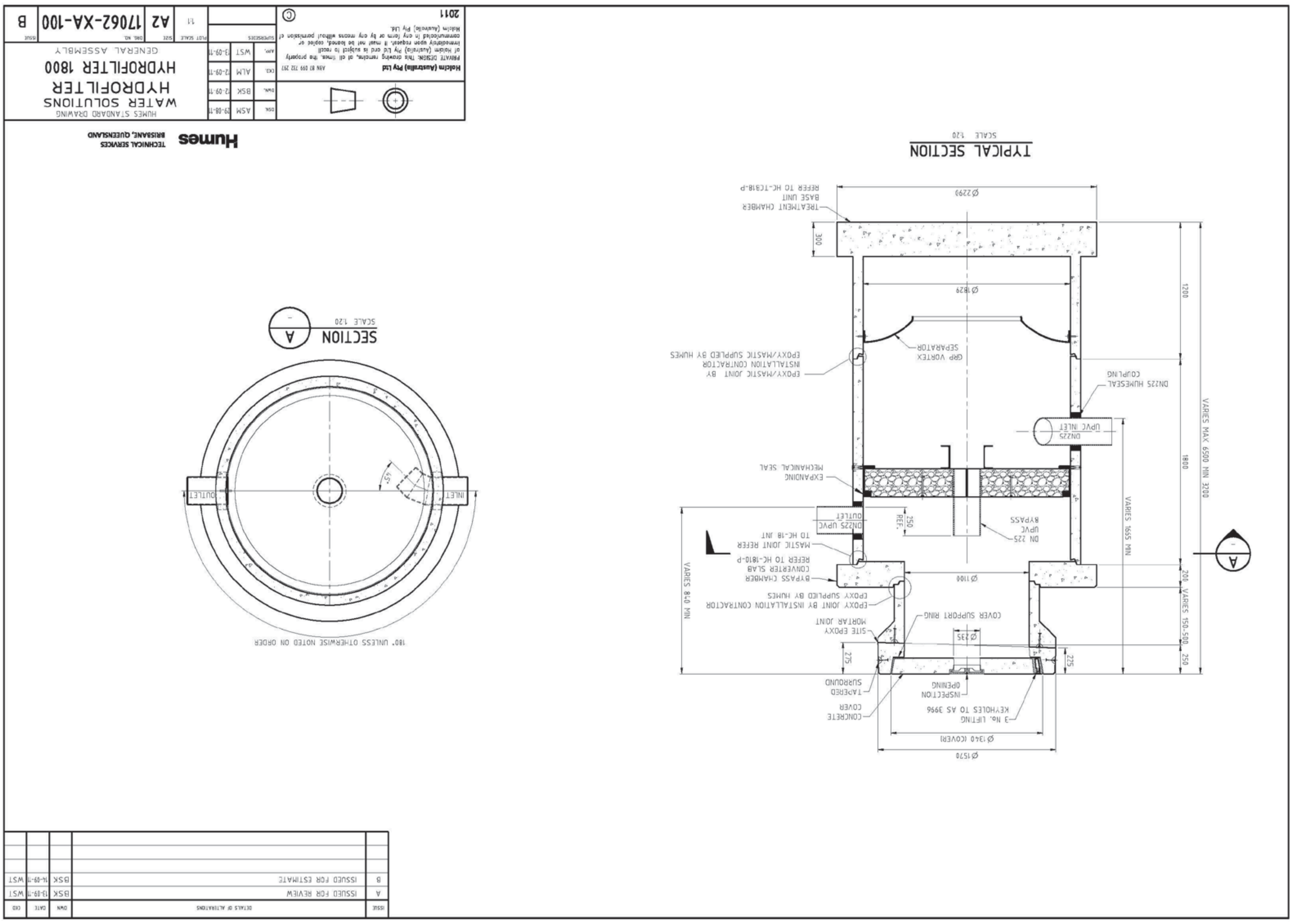
Humes Water Solutions, Humegard® technical manual, Issue 1

Humes Water Solutions, Hydrofilter® technical manual, Issue 1

Swinburne University (2000), *HUMEGARD IN-LINE LITTER SEPARATOR SEDIMENT CAPTURE TESTING-Preliminary Report* by Bronwyn Chapman, School of Engineering and Science

Table 2 – HydroFilter® model range and details

HydroFilter® models	Inlet pipe diameters (mm)	Treatment flow rates (L/s)	Structure diameter (mm)	Depth to outlet invert D (mm)		Total structure height H (mm)	
				Min	Max	Min	Max
HF1000 - A	100 - 225	4 - 10	1,570	840	1,190	3,000	3,350
HF1000 - B				1,190	1,540	3,350	3,700
HF1000 - C				1,540	1,890	3,700	4,050
HF1000 - D				1,890	2,240	4,050	4,400
HF1000 - E				2,240	2,590	4,400	4,750
HF1000 - F				2,590	2,940	4,750	5,100
HF1000 - G				2,940	3,290	5,100	5,450
HF1000 - H				3,290	3,640	5,450	5,800
HF1000 - I				3,640	3,990	5,800	6,150
HF1000 - J				3,990	4,340	6,150	6,500
HF1800 - A		10 - 26	2,290	840	1,190	3,000	3,350
HF1800 - B				1,190	1,540	3,350	3,700
HF1800 - C				1,540	1,890	3,700	4,050
HF1800 - D				1,890	2,240	4,050	4,400
HF1800 - E				2,240	2,590	4,400	4,750
HF1800 - F				2,590	2,940	4,750	5,100
HF1800 - G				2,940	3,290	5,100	5,450
HF1800 - H				3,290	3,640	5,450	5,800
HF1800 - I				3,640	3,990	5,800	6,150
HF1800 - J				3,990	4,340	6,150	6,500
HF2400 - A		19 - 47	2,850	840	1,190	3,000	3,350
HF2400 - B				1,190	1,540	3,350	3,700
HF2400 - C				1,540	1,890	3,700	4,050
HF2400 - D				1,890	2,240	4,050	4,400
HF2400 - E				2,240	2,590	4,400	4,750
HF2400 - F				2,590	2,940	4,750	5,100
HF2400 - G				2,940	3,290	5,100	5,450
HF2400 - H				3,290	3,640	5,450	5,800
HF2400 - I				3,640	3,990	5,800	6,150
HF2400 - J				3,990	4,340	6,150	6,500
HF3000 - A	100 - 300	29 - 73	3,490	840	1,190	3,000	3,350
HF3000 - B				1,190	1,540	3,350	3,700
HF3000 - C				1,540	1,890	3,700	4,050
HF3000 - D				1,890	2,240	4,050	4,400
HF3000 - E				2,240	2,590	4,400	4,750
HF3000 - F				2,590	2,940	4,750	5,100
HF3000 - G				2,940	3,290	5,100	5,450
HF3000 - H				3,290	3,640	5,450	5,800
HF3000 - I				3,640	3,990	5,800	6,150
HF3000 - J				3,990	4,340	6,150	6,500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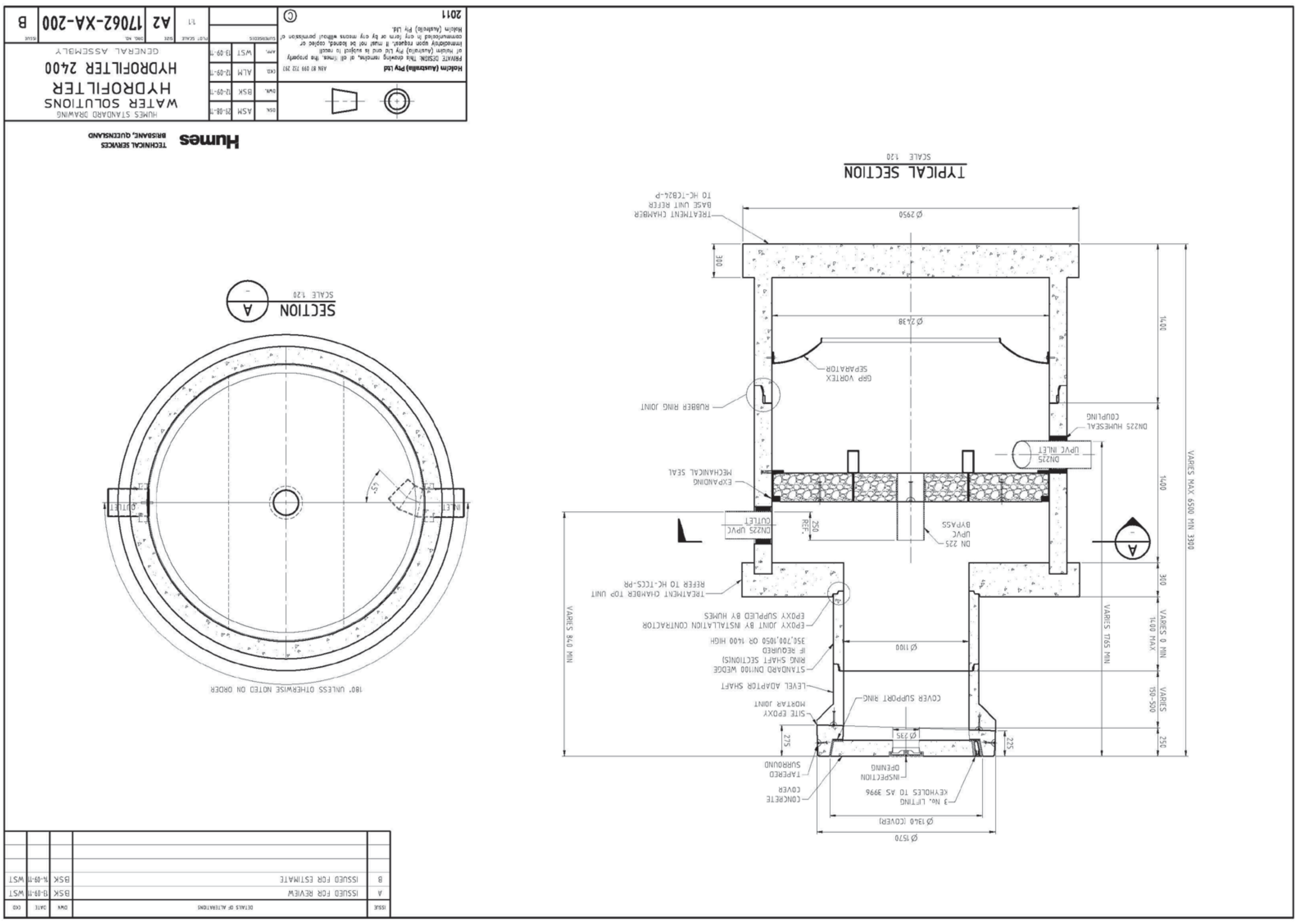
VARIES MAX 6500 MIN 3200
DN225 HUMESEAL COUPLING
DN225 UPVC INLET
DN 225 UPVC BYPASS
DN225 UPVC OUTLET
GRP VORTEX SEPARATOR
EXPANDING MECHANICAL SEAL
EPOXY/MASTIC JOINT BY INSTALLATION CONTRACTOR EPOXY/MASTIC SUPPLIED BY HUMES
TREATMENT CHAMBER BASE UNIT REFER TO HC-TC818-P
BYPASS CHAMBER CONVERTER SLAB REFER TO HC-1810-P
MASTIC JOINT REFER TO HC-18 JNT
EPOXY JOINT BY INSTALLATION CONTRACTOR EPOXY SUPPLIED BY HUMES
SITE EPOXY MORTAR JOINT
COVER SUPPORT RING
TAPERED SURROUND
CONCRETE COVER
INSPECTION OPENING
3 No. LIFTING KEYHOLES TO AS 3996
Ø1570
Ø1340 (COVER)
Ø2290
Ø1829
Ø1100
VARIES 840 MIN
Humes TECHNICAL SERVICES BRISBANE, QUEENSLAND
HUMES STANDARD DRAWING
WATER SOLUTIONS
HYDROFILTER
HYDROFILTER 1800
GENERAL ASSEMBLY
A2 17062-XA-100 B
Holcim (Australia) Pty Ltd
2011
A ISSUED FOR REVIEW
B ISSUED FOR ESTIMATE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VARIES MAX 6500 MIN 3300
DN225 HUMESEAL COUPLING
DN225 UPVC INLET
DN 225 UPVC BYPASS
DN225 UPVC OUTLET
GRP VORTEX SEPARATOR
RUBBER RING JOINT
EXPANDING MECHANICAL SEAL
TREATMENT CHAMBER BASE UNIT REFER TO HC-TC824-P
TREATMENT CHAMBER TOP UNIT REFER TO HC-TC(S-PR
EPOXY JOINT BY INSTALLATION CONTRACTOR EPOXY SUPPLIED BY HUMES
STANDARD DN1100 WEDGE RING SHAFT SECTION(S) IF REQUIRED 350,700,1050 OR 1400 HIGH
LEVEL ADAPTOR SHAFT
SITE EPOXY MORTAR JOINT
COVER SUPPORT RING
TAPERED SURROUND
CONCRETE COVER
INSPECTION OPENING
3 No. LIFTING KEYHOLES TO AS 3996
Ø1570
Ø1340 (COVER)
Ø2950
Ø2438
Ø1100
VARIES 840 MIN
Humes TECHNICAL SERVICES BRISBANE, QUEENSLAND
HUMES STANDARD DRAWING
WATER SOLUTIONS
HYDROFILTER
HYDROFILTER 2400
GENERAL ASSEMBLY
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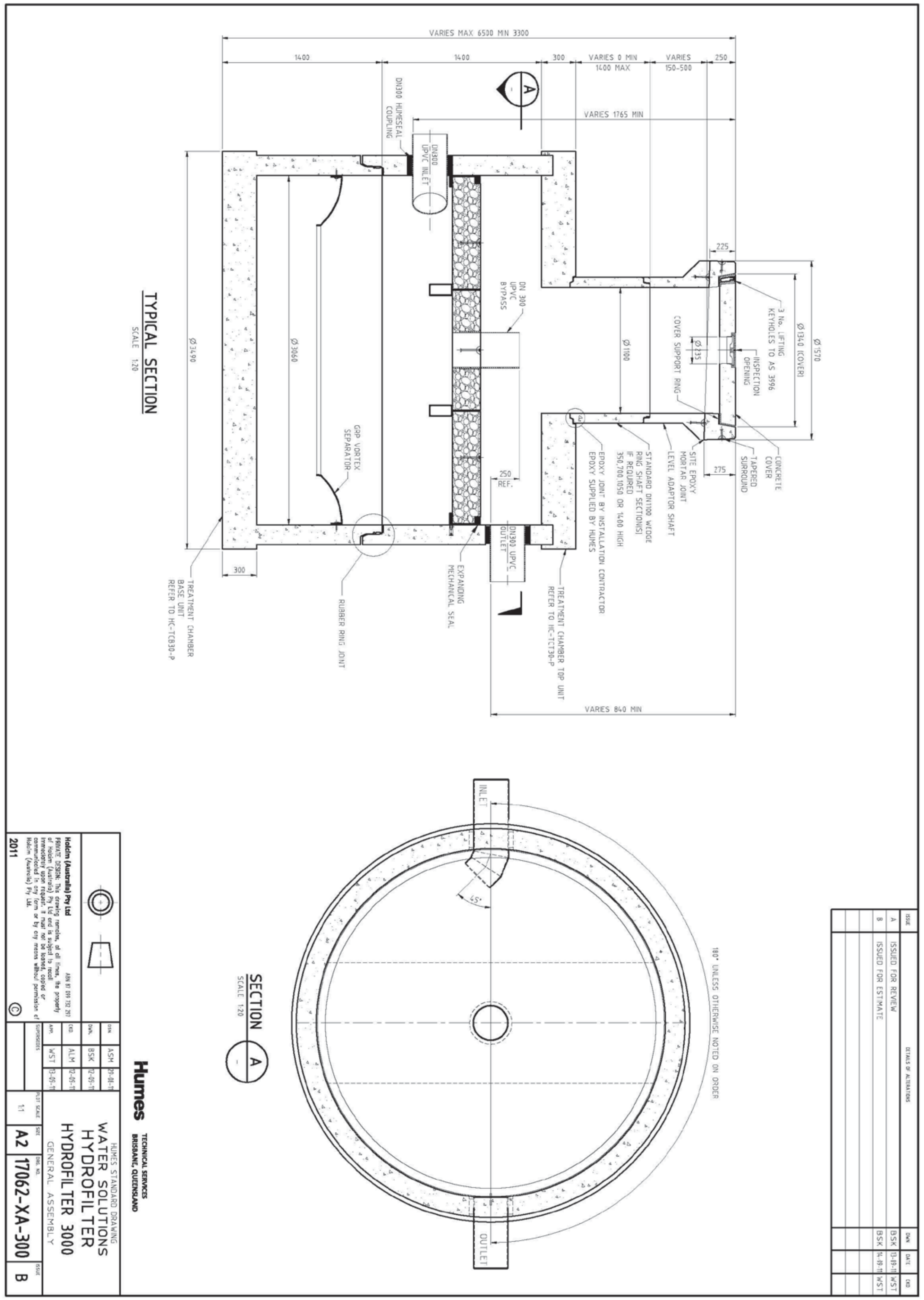
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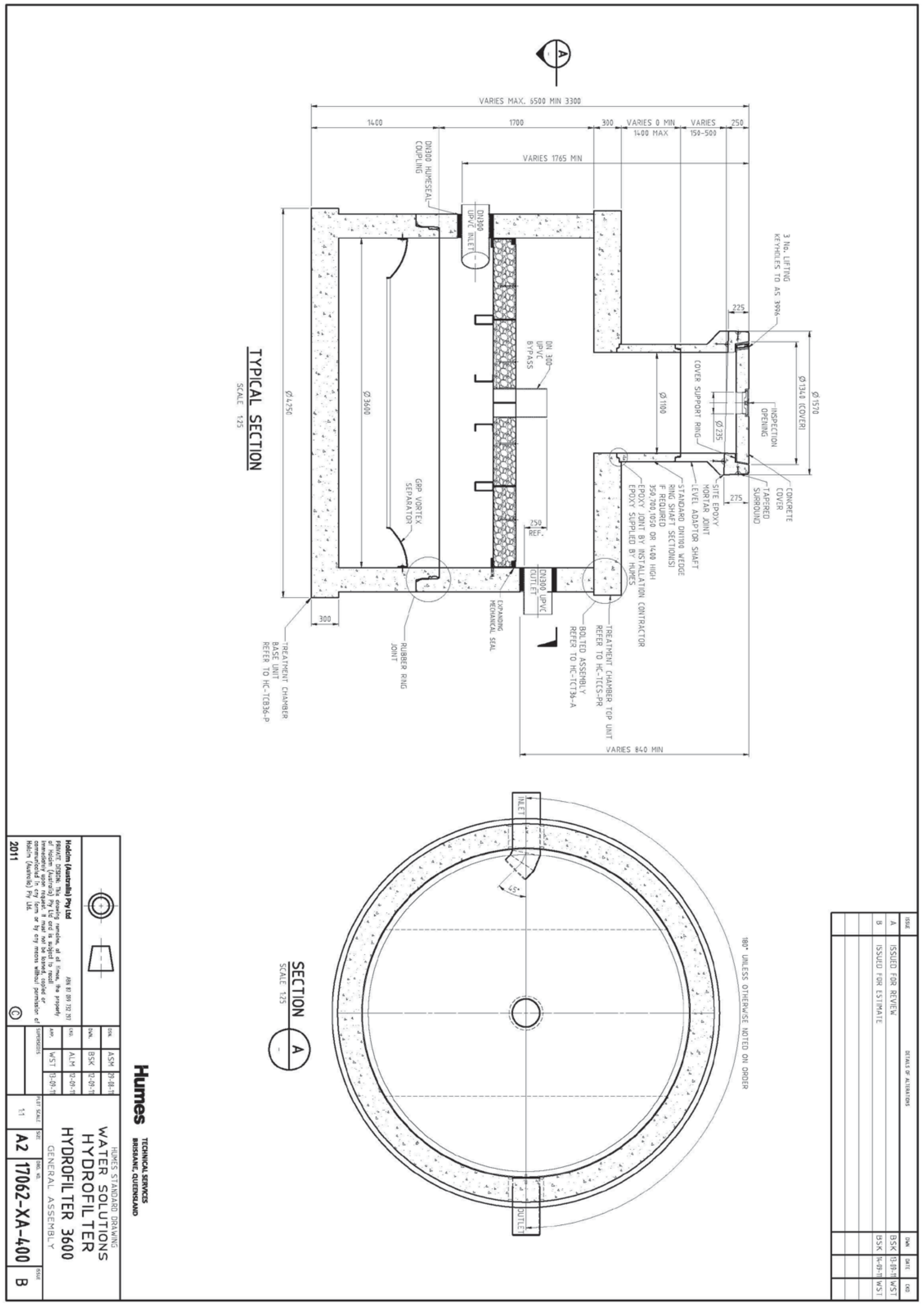
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Shepherds Bay Urban Renewal

APPENDIX C
MUSIC MODELLING PARAMETERS

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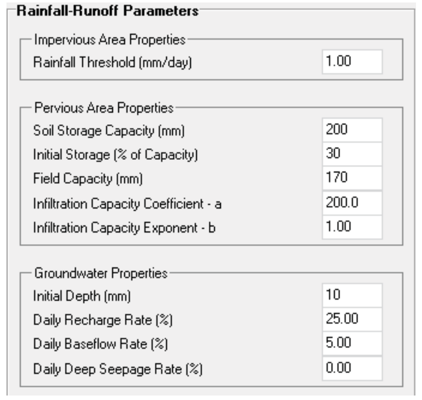
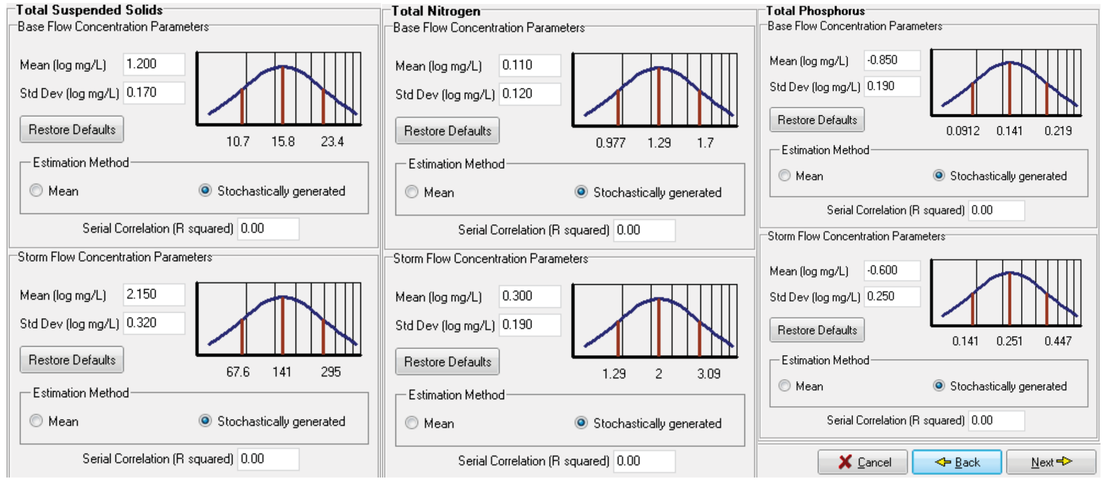
Shaping the Future

Sydney Rainfall-Runoff MUSIC Parameters

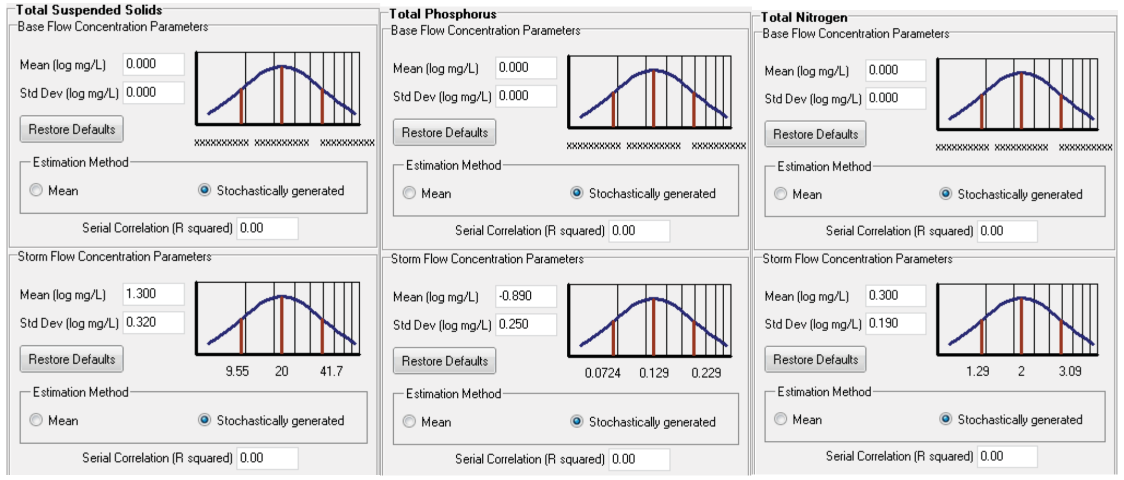


Rainfall-Runoff Parameters	
Impervious Area Properties	
Rainfall Threshold (mm/day)	1.00
Pervious Area Properties	
Soil Storage Capacity (mm)	200
Initial Storage (% of Capacity)	30
Field Capacity (mm)	170
Infiltration Capacity Coefficient - a	200.0
Infiltration Capacity Exponent - b	1.00
Groundwater Properties	
Initial Depth (mm)	10
Daily Recharge Rate (%)	25.00
Daily Baseflow Rate (%)	5.00
Daily Deep Seepage Rate (%)	0.00

MUSIC Source Node Parameters Land Use (Residential, Commercial or Industrial)
(Source Draft MUSIC modelling guidelines for NSW, reference: R.B17048.001.01)



MUSIC Source Node Parameters Roofs (Residential, Commercial or Industrial)
(Source Draft MUSIC modelling guidelines for NSW, reference: R.B17048.001.01)



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