STORMWATER MANAGEMENT PLAN

FOR

SYDNEY ADVENTIST HOSPITAL REDEVELOPMENT

REPORT NO. R00385-SMP

REVISION B

JULY 2010

C&M Consulting Engineers Pty Ltd
241-245 Pennant Hills Road, Carlingford, NSW, 2118
P8209 3846 F9687 9393

PROJECT DETAILS

Property Address: Sydney Adventist Hospital
185 Fox Valley Road, Wahroonga

Development Proposal: Redevelopment

REPORT CERTIFICATION

Report prepared by:

ANTHONY MANCONE
Civil Engineer - Director
B.E.(Civil),Hons., MIEAust, CPEng,
NPER (Civil), NPER (Building Services)

Report reviewed by:

EDWARD SHIN
Civil Engineer - Director
B.E.(Civil), MIEAust, CPEng,
RPEQ (Civil), NPER (Civil)

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DOCUMENT CONTROL

REVISION	ISSUE DATE	ISSUED TO	ISSUED FOR
A	12 July 2010	Sydney Adventist Hospital	Information
		Morris Bray Architects	Information
		Urbis	Information
B	14 July 2010	Sydney Adventist Hospital	Information
		Morris Bray Architects	Information
		Urbis	Information

EXECUTIVE SUMMARY

This report has been prepared to supplement the proposed Part 3A Application for the Sydney Adventist Hospital redevelopment.

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 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 and to not overload existing drainage infrastructure;

3. Bio-retention 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 Humeceptor Device(s) to provide water quality treatment to runoff from road and car park areas by removing sediment, oils and hydrocarbons.

    - EnviroPods installed in pits in car parking areas to capture gross pollutants at source;

5. Rainwater harvesting and retention system to allow rainwater reuse while at the same time providing improvement to the quality and volume of stormwater runoff from the site;

6. Vegetated swales to convey storm flows while providing water quality treatment via filtration;

7. 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 report has been prepared to supplement the proposed Part 3A Application for the Sydney Adventist Hospital redevelopment.

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:

- Redevelopment Drawings prepared by Morris Bray Architects;
- “Water Management Development Control Plan – DCP 47”, Ku-ring-gai Council;
- “Wahroonga Estate Flooding and Stormwater Master Plan”, Hyder Consulting Pty Ltd (February 2009);
- “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 tend 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 will be described as follows.

The site is located at 185 Fox Valley Road at Wahroonga (refer Figure 1).

Figure 1 - Site Location

The site is bounded by Fox Valley Road to the east, Coups Creek to the north and The Comenarra Parkway to the south and west.

The site is generally located at one of the higher points of the local drainage catchment, with the main hospital buildings generally being located at the highest points of the site. The majority of the site falls towards the north and west towards Coups Creek (refer Figure 2).

Drainage infrastructure is available throughout the developed components of the hospital site. As the project is generally a redevelopment of existing areas, existing drainage infrastructure will be utilised wherever possible and/or diverted or extended as necessary to drain the work proposed as part of the redevelopment.

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:

Water Quantity

Standard: “Water Management Development Control Plan – DCP 47”, Ku-ring-gai Council;

Ku-ring-gai Council generally requires On Site Stormwater Detention (OSD) to be provided for developments and redevelopments to limit the quantity of stormwater draining from a particular site to the same quantity or less than what could have occurred prior to the development or redevelopment. Generally, this is done by controlling the rate of runoff or limiting peak flows from the development and holding the excess stormwater for a short period of time in storage areas or tanks.

Under Ku-ring-gai Council’s DCP 47, the hospital site is designated as a Type C Property, i.e. draining directly to bushland without passing through another property. For this property type, Ku-ring-gai Council does not require OSD as the primary aim is to ensure minimal adverse impact to the natural environment downstream.

For the hospital redevelopment, (although not required by Council) OSD will be provided to maintain the current peak flows from the existing site. OSD is intended to be incorporated into the redevelopment works for the following reasons:

1. To maintain the status quo of current peak storm flows so that existing drainage infrastructure at the hospital site can be utilised as part of the redevelopment works without the need for unnecessary upgrade of existing drainage infrastructure;

2. To minimise the impact on the downstream natural environment by maintaining peak storm flows to that of the existing site;

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

- Equivalent minimum OSD storage volume of 325m^3/ha of redevelopment area;

- 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 creek system. This approach is in keeping with the proposed Biodiversity Management Plan (BMP) for the area;

- Permissible Site Discharge (PSD) of 132L/s/ha of redevelopment area for storm events greater than a 1 in 2 year ARI up to and including a 1 in 100 year ARI event.

In addition to OSD as a method of controlling stormwater quantity, rainwater harvesting, retention and reuse will be provided. Rainwater retention and reuse will be an effective measure in reducing the frequency and volume of storm water runoff post development and is consistent with the objectives of the proposed Biodiversity Management Plan for the area. 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 creek system.

Water Quality

Guidelines: "Water Management Development Control Plan – DCP 47", Ku-ring-gai Council;

Ku-ring-gai Council requires that the stormwater quality targets outlined in their DCP 47 and summarised in Table 1 of this report, are met for all new developments and redevelopments.

Table 1 - Water Quality Reduction Targets

PARAMETERS	CRITERIA
Gross Pollutants	70% 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.

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 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.

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

- Treatment measures shall be provided within the stormwater drainage systems for the redevelopment areas to ensure that the reduction targets in Table 1 are achieved;

- Due to the significant areas of car parking proposed as part of the redevelopment, in addition to the aforementioned reduction targets, we have included an additional requirement to remove oils and hydrocarbons (which are typical pollutants for car park areas).

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.

It should be noted that for this property type (i.e. draining directly to bushland without passing through another property), Ku-ring-gai Council does not require OSD. However, we have opted to provide OSD for the redevelopment areas for the following reasons:

1. To maintain the status quo of current peak storm flows so that existing drainage infrastructure at the hospital site can be utilised as part of the redevelopment works without the need for unnecessary upgrade of existing drainage infrastructure;

2. To minimise the impact on the downstream natural environment by maintaining peak storm flows to that of the existing 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 to comply with the requirements of Ku-ring-gai Council:

- Permissible Site Discharge (PSD) of 132 l/s/ha of redevelopment area for storm events up to and including a 1 in 100 year Average Recurrence Interval (ARI) event;

- Equivalent minimum OSD storage volume of 325m^3/ha of redevelopment area.

In keeping with the proposed Biodiversity Management Plan (BMP) for the area, inclusion of an additional flow control measure for storm events up to a 1 in 2 year ARI will be provided as follows:

- 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 additional 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 creek system.

The detention requirements for the proposed redevelopment areas are summarised in Table 4 below.

Table 4 - Summary of OSD Requirements

REDEVELOPMENT AREA	AREA (HA)	PSD Up to 2 YR ARI (L/S)	PSD Up to 100 YR ARI (L/S)	MINIMUM STORAGE (M3)
Area 1	0.398	37	53	130
Area 2	2.195	147	290	714
Area 3	1.070	72	141	348
Area 4	0.560	52	74	182

3.2.3 RAINWATER RETENTION REQUIREMENTS

Rainwater retention and reuse for this project is proposed and will be an effective measure in reducing the frequency and volume of storm water runoff post development. This is consistent with the objectives of the proposed Biodiversity Management Plan for the area.

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 creek system.

A water balance model was prepared using MUSIC (also refer to the Water Quality section of this report). The modelling indicates that a total rainwater storage of approximately 200kL and a daily usage of up to 7,500L on site will provide an effective water balance.

We expect that the daily usage can be achieved via a number of various uses such as irrigation of lawns and other landscape areas, hosing in wash down areas and for toilet flushing in selected areas.

The appropriate uses of rainwater will be determined during the detailed design phase of the project in conjunction with the Hospital to achieve the water quantity objectives for the project.

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 Coups Creek.

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 0.50m and the filter media depth of 0.35m.
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 5m top 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 Humeceptor. ▪ The device has been chosen for its ability to remove fine sediment, oils and hydrocarbons.
Rainwater Retention Tank	▪ Rainwater retention tanks are effective in the removal of pollutant loads at source. The pollutant removal process is by harvesting runoff for reuse, thereby limiting the nutrients discharging to the waterways. ▪ Rainwater retention tanks also reduce stormwater runoff quantity.
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 the Wahroonga Reservoir for a period of 5 years from 1966 to 1970 (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 derived by calibrating the EMC against parameters set by Ku-ring-gai Council in their DCP 47. 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
Roofs **Roads** **Carparks**	12.6	0.151	2.09	141	0.316	2.29

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
Area 1		
Roof Area	0.160	100
Road and Carpark Area	0.238	100
Area 2		
Roof Area	0.920	100
Road and Carpark Area	1.275	90
Area 3		
Road and Carpark Area	1.070	100
Area 4		
Road and Carpark Area	0.560	80

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

STORMWATER TREATMENT MEASURE AND/OR STORMWATER QUALITY IMPROVEMENT DEVICE (SQID)	QUANTITY
Area 1	
• Rainwater Tank	50kL
• Bio-retention Basin	2 x $30m^2$
• Vegetated Swale	100m
Area 2	
• Hydrodynamic Separator (Humeceptor)	1
• Bio-retention Basin	$100m^2$
• Rainwater Tank	150kL
Area 3	
• Bio-retention Basin	$80m^2$
Area 4	
• Bio-retention Basin	$100m^2$
• Vegetated Swale	70m

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
Area 1					
GP	70	97.4	0.0	100	Yes
TSS	80	563	35.9	93.6	Yes
TP	45	1.26	0.404	68.0	Yes
TN	45	9.19	3.15	65.7	Yes
Area 2					
GP	70	533	0.0	100	Yes
TSS	80	3070	594	80.7	Yes
TP	45	6.90	3.49	49.5	Yes
TN	45	50.2	18.4	63.4	Yes
Area 3					
GP	70	267	0.0	100	Yes
TSS	80	1570	272	82.7	Yes
TP	45	3.53	1.61	54.2	Yes
TN	45	25.5	12.8	49.8	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 at one of the higher points of the local drainage catchment, with the main hospital buildings generally being located at the highest points of the site. The site generally falls towards Coups Creek to the north. The northern extent of the hospital site is generally defined by a steep “drop-off” that falls down into the Coups Creek valley approximately 30m below the lowest point of the hospital site.

As the creek is retained by deep, well defined valleys that are significantly lower than the hospital site, the site is not considered to be flood affected.

Ku-ring-gai Council’s on-site stormwater detention (OSD) policy has been adopted for the project (refer to Section 4 of this report). By adopting OSD for this project, the rate of stormwater runoff and peak storm flows being discharged from the hospital site will be controlled to ensure that the proposed development has no affect on flooding within the Coups Creek system.

5.1 POTENTIAL AFFECTS OF CLIMATE CHANGE ON FLOODING

Potential Sea-level Rise

The NSW State Governments policy on potential sea-level rise due to climate change has been considered. The policy projects a sea level rise relative to the 1990 mean sea level of 0.4m by 2050 and 0.9m by the year 2100.

Due to the location of Coups Creek (adjacent to the hospital site) in relation to the nearest downstream receiving water that may be effected by sea level rise and the height difference between the creek and the hospital site, there is no additional risk of flooding to the proposed development from potential sea level rise.

Potential Increase in Rainfall Intensity

Whilst it is possible that an increase in rainfall intensity could potentially increase flooding within Coups Creek, we do not expect that any increase in flooding would be significant enough to pose any flooding problems at the hospital site due to the relative level difference between the creek and the hospital.

Locally within the hospital site itself, good drainage practice by incorporating defined overland flow paths generally along the hospitals road network will protect the hospital from any local flooding that may occur in future from increased rainfall intensities.

6. CONCLUSIONS

Redevelopment 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 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 and to not overload existing drainage infrastructure;

3. Bio-retention 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 Humeceptor Device(s) to provide water quality treatment to runoff from road and car park areas by removing sediment, oils and hydrocarbons.

   - EnviroPods installed in pits in car parking areas to capture gross pollutants at source;

5. Rainwater harvesting and retention system to allow rainwater reuse while at the same time providing improvement to the quality and volume of stormwater runoff from the site;

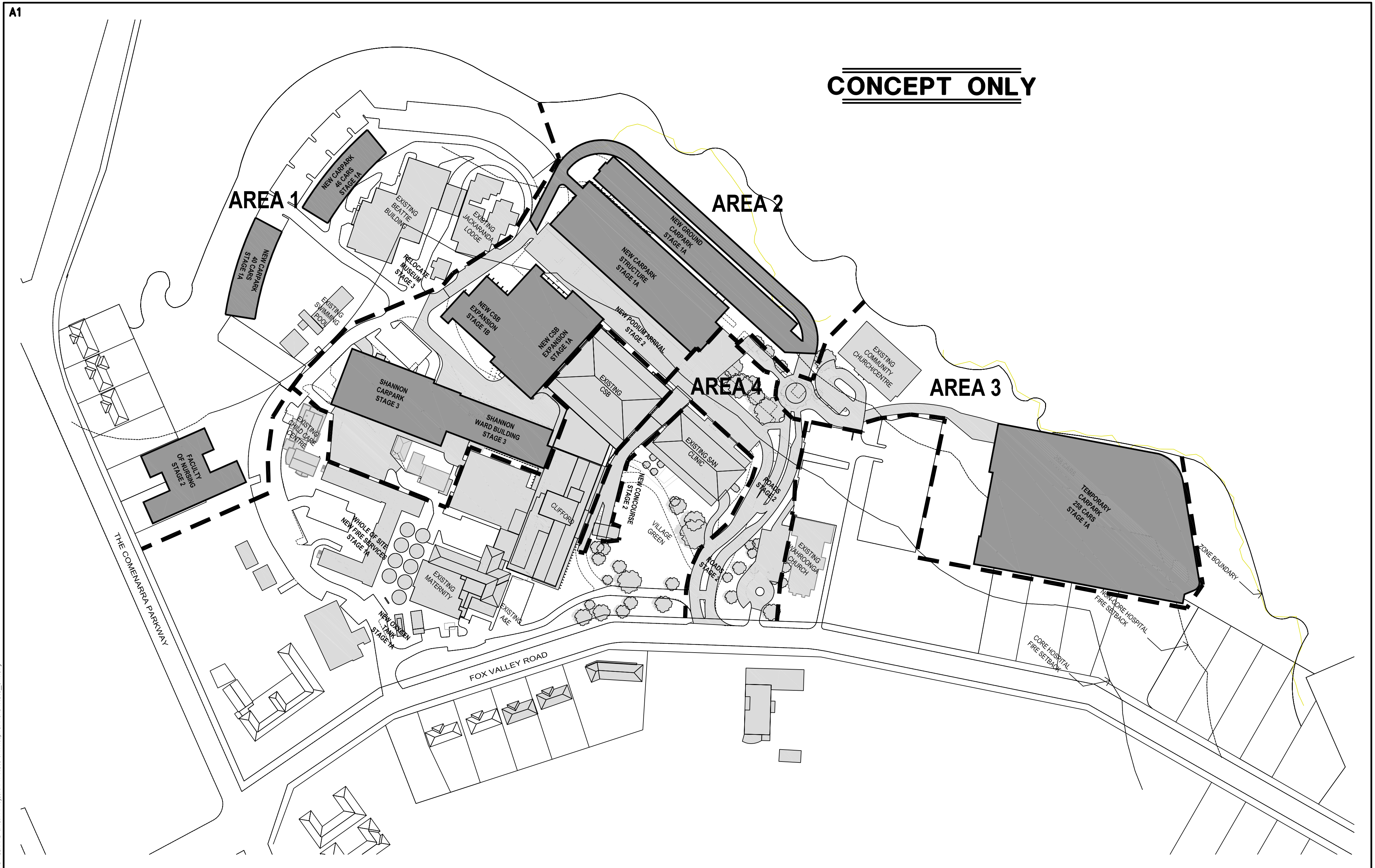
6. Vegetated swales to convey storm flows while providing water quality treatment via filtration;

7. 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



REV.	DES.	DATE	VER.	DATE	DESCRIPTION
02	W.M.	14/07/10	A.M.	14/07/10	ISSUE FOR PART 3A APPLICATION
01	W.M.	12/07/10	A.M.	12/07/10	PRELIMINARY ISSUE

C&M CONSULTING ENGINEERS

CIVIL AND HYDRAULIC ENGINEERING DESIGN AND PROJECT MANAGEMENT
SUITE 2
241-245 PENNANT HILLS ROAD
CARLINGFORD NSW 2118
PHONE: (02) 8209 3846
FAX: (02) 9687 9393
ABN 21 118 134 240

DESIGNED	W.M.	DATE	28/06/10
VERIFIED	A.M.	DATE	28/06/10
DRAWN	W.M.	SCALE @ A1	N/A

SYDNEY ADVENTIST HOSPITAL, WAHROONGA

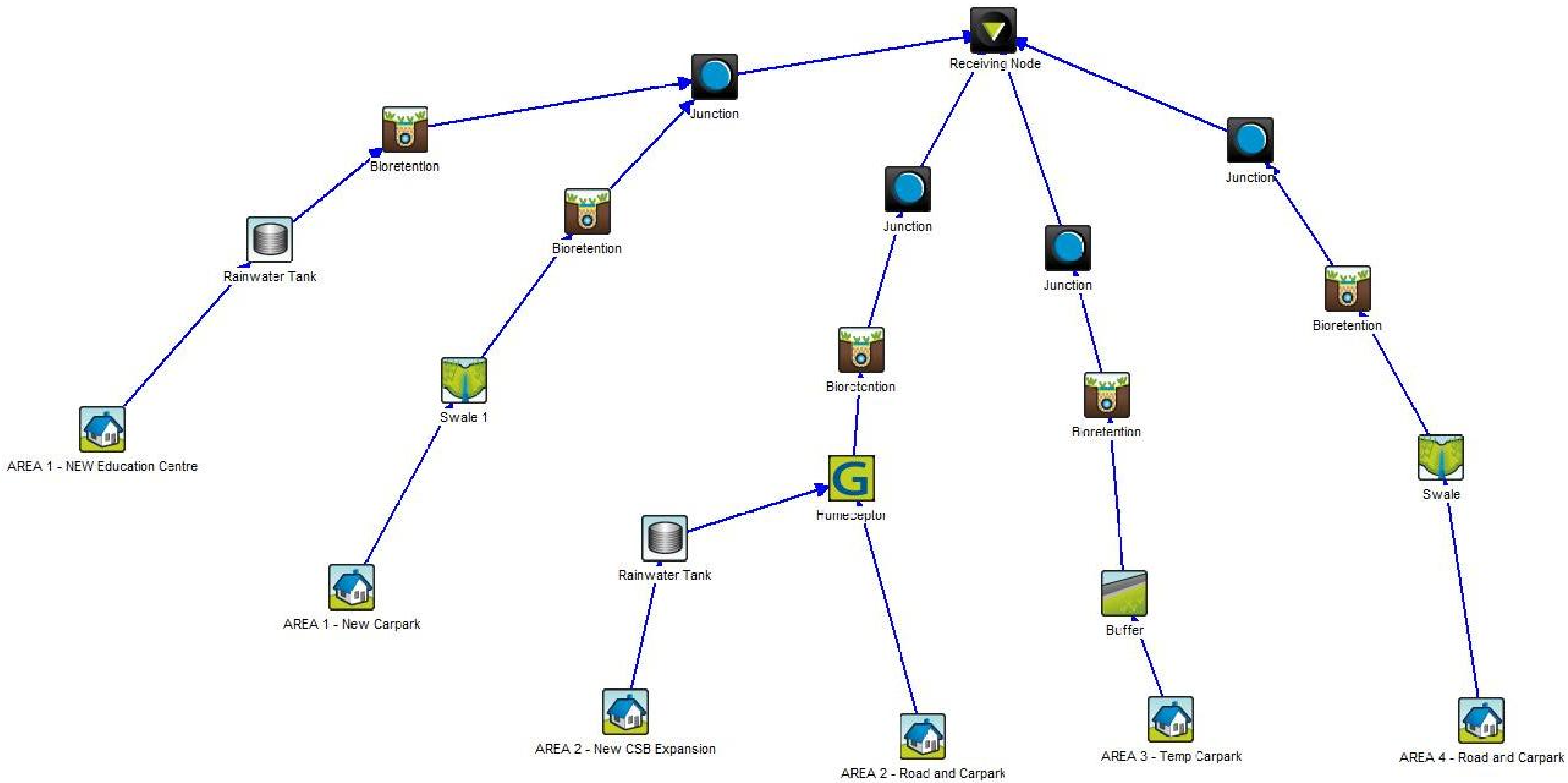
AREA PLAN

STATUS: CONCEPT ONLY | DRAWING No. C110 | REVISION 02

CAD FILENAME: Q:\C&M\Projects\PN-00385 SAH Hospital\ACAD\00385_C110.dwg

APPENDIX B

MUSIC MODEL RESULTS


Receiving Node
Junction
Bioretention
Rainwater Tank
AREA 1 - NEW Education Centre
Bioretention
Swale 1
AREA 1 - New Carpark
Junction
Bioretention
Humeceptor
Rainwater Tank
AREA 2 - New CSB Expansion
AREA 2 - Road and Carpark
Junction
Bioretention
Buffer
AREA 3 - Temp Carpark
Junction
Bioretention
Swale
AREA 4 - Road and Carpark

MUSIC Output

```
Source nodes
Location,AREA 1 - New Carpark,AREA 2 - Road and Carpark,AREA 3 - Temp Carpark,AREA 2 - New CSB Expansion,AREA 4 - Road and Carpark,AREA 1 - NEW Education Centre
ID,1,2,3,12,14,18
Node Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Total Area (ha),0.19,1.275,1.07,0.92,0.56,0.21
Area Impervious (ha),0.19,1.1445231277533,1.07,0.92,0.447876651982379,0.188509691629956
Area Pervious (ha),0,0.130476872246696,0,0,0.112123348017621,0.0214903083700441
Field Capacity (mm),80,80,80,80,80,80
Pervious Area Infiltration Capacity coefficient - a,200,200,200,200,200,200
Pervious Area Infiltration Capacity exponent - b,1,1,1,1,1,1
Impervious Area Rainfall Threshold (mm/day),1,1,1,1,1,1
Pervious Area Soil Storage Capacity (mm),120,120,120,120,120,120
Pervious Area Soil Initial Storage (% of Capacity),30,30,30,30,30,30
Groundwater Initial Depth (mm),10,10,10,10,10,10
Groundwater Daily Recharge Rate (%),25,25,25,25,25,25
Groundwater Daily Baseflow Rate (%),5,5,5,5,5,5
Groundwater Daily Deep Seepage Rate (%),0,0,0,0,0,0
Stormflow Total Suspended Solids Mean (log mg/L),2.15,2.15,2.15,2.15,2.15,2.15
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.32,0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean
Stormflow Total Suspended Solids Serial Correlation,0.95,0.95,0.95,0.95,0.95,0.95
Stormflow Total Phosphorus Mean (log mg/L),-0.5,-0.5,-0.5,-0.5,-0.5,-0.5
Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.25,0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean
Stormflow Total Phosphorus Serial Correlation,0.95,0.95,0.95,0.95,0.95,0.95
Stormflow Total Nitrogen Mean (log mg/L),0.36,0.36,0.36,0.36,0.36,0.36
Stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean
Stormflow Total Nitrogen Serial Correlation,0.95,0.95,0.95,0.95,0.95,0.95
Baseflow Total Suspended Solids Mean (log mg/L),1.1,1.1,1.1,1.1,1.1,1.1
Baseflow Total Suspended Solids Standard Deviation (log mg/L),0.17,0.17,0.17,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean
Baseflow Total Suspended Solids Serial Correlation,0.94,0.94,0.94,0.94,0.94,0.94
Baseflow Total Phosphorus Mean (log mg/L),-0.82,-0.82,-0.82,-0.82,-0.82,-0.82
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean
Baseflow Total Phosphorus Serial Correlation,0.94,0.94,0.94,0.94,0.94,0.94
Baseflow Total Nitrogen Mean (log mg/L),0.32,0.32,0.32,0.32,0.32,0.32
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation Method,Mean,Mean,Mean,Mean,Mean,Mean
Baseflow Total Nitrogen Serial Correlation,0.94,0.94,0.94,0.94,0.94,0.94
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OUT - Mean Annual Flow (ML/yr),1.98,12.3,11.1,9.58,5.01,2.03
OUT - TSS Mean Annual Load (kg/yr),280,1.72E3,1.57E3,1.35E3,686,283
OUT - TP Mean Annual Load (kg/yr),0.626,3.87,3.53,3.03,1.56,0.638
OUT - TN Mean Annual Load (kg/yr),4.53,28.2,25.5,22.0,11.4,4.65
OUT - Gross Pollutant Mean Annual Load (kg/yr),47.4,304,267,230,126,50.0
Rain In (ML/yr),2.14611,14.4015,12.086,10.3917,6.32536,2.37201
ET Loss (ML/yr),0.166672,2.04073,0.938627,0.807046,1.30139,0.336119
Deep Seepage Loss (ML/yr),0,0,0,0,0,0
Baseflow Out (ML/yr),0,0.19338,0,0,0.169871,0.0318508
Imp. Stormflow Out (ML/yr),1.97944,11.9548,11.1473,9.58464,4.6673,1.96902
Perv. Stormflow Out  (ML/yr),0,0.200199,0,0,0.175861,0.0329738
Total Stormflow Out (ML/yr),1.97944,12.1549,11.1473,9.58464,4.84316,2.00199
Total Outflow (ML/yr),1.97944,12.3483,11.1473,9.58464,5.01303,2.03384
Change in Soil Storage (ML/yr),0,0.012458,0,0,0.0109436,0.002052
TSS Baseflow Out (ML/yr),0,2.43452,0,0,2.13855,0.400979
TSS Total Stormflow Out (ML/yr),279.603,1716.93,1574.6,1353.87,684.115,282.789
TSS Total Outflow (ML/yr),279.603,1719.37,1574.6,1353.87,686.254,283.19
TP Baseflow Out (ML/yr),0,0.0292692,0,0,0.025711,0.0048208
TP Total Stormflow Out (ML/yr),0.625953,3.84373,3.5251,3.03093,1.53154,0.633085
TP Total Outflow (ML/yr),0.625953,3.873,3.5251,3.03093,1.55725,0.637906
TN Baseflow Out (ML/yr),0,0.404029,0,0,0.354911,0.0665458
TN Total Stormflow Out (ML/yr),4.53463,27.8454,25.5371,21.9571,11.095,4.5863
TN Total Outflow (ML/yr),4.53463,28.2494,25.5371,21.9571,11.4499,4.65284
GP Total Outflow (ML/yr),47.4042,303.55,266.961,229.536,126.31,49.9965

No Imported Data Source nodes

USTM treatment nodes
Location,Swale 1,Bioretention,Bioretention,Rainwater Tank,Swale,Bioretention,Bioretention,Bioretention,Rainwater
Tank,Buffer
ID,4,7,11,13,15,16,19,20,21,22
Node
Type,SwaleNode,BioRetentionNodeV4,BioRetentionNodeV4,RainWaterTankNode,SwaleNode,BioRetentionNodeV4,BioRetentionNodeV4,Bi
oRetentionNodeV4,RainWaterTankNode,BufferNode
Lo-flow bypass rate (cum/sec),0,0,0,0,0,0,0,0,0,
Hi-flow bypass rate (cum/sec), ,100,100,100, ,100,100,100,100,
Inlet pond volume, , , ,0, , , , ,0,
Area (sqm), ,140,110,15, ,120,40,40,15,535
Extended detention depth (m),0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5,0.5,
Permanent pool volume (cum), , , ,150, , , , ,50,
Proportion vegetated, , , ,0, , , , ,0,
Equivalent pipe diameter (mm), , , ,300, , , , ,300,
Overflow weir width (m),50,2,2,10,50,2,2,2,10,
Notional Detention Time (hrs), , , ,14.0E-3, , , , ,14.0E-3,
Orifice discharge coefficient, , , ,0.6, , , , ,0.6,
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Weir coefficient, ,1.7,1.7,1.7, ,1.7,1.7,1.7,1.7,
Number of CSTR cells,10,3,3,2,10,3,3,3,2,
Total Suspended Solids k (m/yr),8000,8000,8000,400,8000,8000,8000,8000,400,
Total Suspended Solids C* (mg/L),20,20,20,12,20,20,20,20,12,
Total Suspended Solids C** (mg/L),14, , ,12,14, , , ,12,
Total Phosphorus  k (m/yr),6000,6000,6000,300,6000,6000,6000,6000,300,
Total Phosphorus C* (mg/L),0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,
Total Phosphorus C** (mg/L),0.13, , ,0.13,0.13, , , ,0.13,
Total Nitrogen k (m/yr),500,500,500,40,500,500,500,500,40,
Total Nitrogen C* (mg/L),1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,
Total Nitrogen C** (mg/L),1.4, , ,1.4,1.4, , , ,1.4,
Threshold hydraulic loading for C** (m/yr),3500, , ,3500,3500, , , ,3500,
Horizontal Flow Coefficient, ,3,3, , ,3,3,3, ,
Extraction for Re-use,Off,Off,Off,On,Off,Off,Off,Off,On,Off
Annual Re-use Demand - scaled by daily PET (ML), , , ,0, , , , ,0,
Annual Re-use Demand - scaled by daily PET - Rain (ML), , , ,0, , , , ,0,
Constant Daily Re-use Demand (kL), , , ,6, , , , ,1.5,
User-defined Annual Re-use Demand (ML), , , ,0, , , , ,0,
Percentage of User-defined Annual Re-use Demand Jan, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand Feb, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand Mar, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand Apr, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand May, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand Jun, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand Jul, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand Aug, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand Sep, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand Oct, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand Nov, , , ,8.33333333333333, , , , ,8.33333333333333,
Percentage of User-defined Annual Re-use Demand Dec, , , , , , ,8.33333333333333, , , , , , , , , ,8.33333333333333, , ,
User-defined Re-use File, , , , , , , , , ,
Filter area (sqm), ,100,80, , ,100,30,30, ,
Filter perimeter (m), ,40,40, , ,50,20,20, ,
Filter depth (m), ,0.35,0.35, , ,0.35,0.35,0.35, ,
Filter median particle diameter (mm), , , , , , , , , ,
Saturated hydraulic conductivity (mm/hr), ,100,100, , ,50,100,100, ,
Infiltration Media Porosity, ,0.35,0.35, , ,0.35,0.35,0.35, ,
Length (m),100, , , ,70, , , , ,
Bed slope,0.01, , , ,0.03, , , , ,
Base Width (m),1, , , ,1, , , , ,
Top width (m),5, , , ,5, , , , ,
Vegetation height (m),0.25, , , ,0.25, , , , ,
Vegetation Type, ,Vegetated with Effective Nutrient Removal Plants,Vegetated with Effective Nutrient Removal Plants, ,
,Vegetated with Effective Nutrient Removal Plants,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, , ,800,800,800, ,
Proportion of Organic Material in Filter (%), ,<5,<5, , ,<5,<5,<5, ,
Orthophosphate Content in Filter (mg/kg), ,<55,<55, , ,<55,<55,<55, ,
Is Base Lined?, ,No,No, , ,No,No,No, ,
Is Underdrain Present?, ,Yes,Yes, , ,Yes,Yes,Yes, ,
Is Submerged Zone Present?, ,Yes,Yes, , ,Yes,Yes,Yes, ,
Submerged Zone Depth (m), ,0.3,0.3,-9999, ,0.3,0.3,0.3,-9999,
B for Media Soil Texture,-9999,13,13, ,-9999,13,13,13, ,-9999
Proportion of upstream impervious area treated, , , ,0, , , , ,0,0.4
Exfiltration Rate (mm/hr),0,7,7,0,0,7,7,7,0,0
Evap Loss as proportion of PET, , , , , , , , , ,
Depth in metres below the drain pipe, , , , , ,0,0,0, ,
TSS A Coefficient, , , , , , , , , ,
TSS B Coefficient, , , , , , , , , ,
TP A Coefficient, , , , , , , , , ,
TP B Coefficient, , , , , , , , , ,
TN A Coefficient, , , , , , , , , ,
TN B Coefficient, , , , , , , , , ,
Sfc, ,0.61,0.61, , ,0.61,0.61,0.61, ,
S*, ,0.37,0.37, , ,0.37,0.37,0.37, ,
Sw, ,0.11,0.11, , ,0.11,0.11,0.11, ,
Sh, ,0.05,0.05, , ,0.05,0.05,0.05, ,
Emax (m/day), ,0.008,0.008, , ,0.008,0.008,0.008, ,
Ew (m/day), ,0.001,0.001,9.58, ,0.001,0.001,0.001,2.03,
IN - Mean Annual Flow (ML/yr),1.98,19.9,11.1,1.35E3,5.01,5.01,1.52,1.98,283,11.1
IN - TSS Mean Annual Load (kg/yr),280,1.70E3,1.12E3,3.03,686,111,146,29.1,0.638,1.57E3
IN - TP Mean Annual Load (kg/yr),0.626,6.09,2.86,22.0,1.56,0.731,0.391,0.261,4.65,3.53
IN - TN Mean Annual Load (kg/yr),4.53,25.0,22.8,230,11.4,9.63,3.33,3.31,50.0,25.5
IN - Gross Pollutant Mean Annual Load (kg/yr),47.4,0.00,267,7.57,126,0.00,0.00,0.00,1.52,267
OUT - Mean Annual Flow (ML/yr),1.98,17.6,9.38,926,5.01,3.20,1.15,1.40,146,11.1
OUT - TSS Mean Annual Load (kg/yr),29.1,594,272,2.22,111,37.2,23.9,12.0,0.391,1.12E3
OUT - TP Mean Annual Load (kg/yr),0.261,3.49,1.61,17.2,0.731,0.488,0.194,0.210,3.33,2.86
OUT - TN Mean Annual Load (kg/yr),3.31,18.4,12.8,0.00,9.63,4.94,1.38,1.77,0.00,22.8
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,9.5845,0.00,0.00,0.00,0.00,2.03226,267
Flow In (ML/yr),1.97945,19.9046,11.147,0,5.0102,5.01063,1.51741,1.9818,0,11.147
ET Loss (ML/yr),0,0.24538,0.170368,0,0,0.245325,0.0380788,0.0636856,0,0
Infiltration Loss (ML/yr),0,2.03094,1.59628,0,0,1.56404,0.324289,0.514449,0,0
Low Flow Bypass Out (ML/yr),0,0,0,0,0,0,0,0,0,0
High Flow Bypass Out (ML/yr),0,0,0,7.47755,0,0,0,0,1.51741,6.68852
Orifice / Filter Out (ML/yr),1.9818,5.07998,3.74177,0.0912552,5.01062,1.84833,0.642934,0.882408,0,4.459
Weir Out (ML/yr),0,12.5597,5.6381,0,0,1.35444,0.511881,0.521306,0,0
Transfer Function Out (ML/yr),0,0,0,2.00935,0,0,0,0,0.514653,0
Reuse Supplied (ML/yr),0,0,0,2.18054,0,0,0,0,0.545134,0
Reuse Requested (ML/yr),0,0,0,92.1491,0,0,0,0,94.4085,0
% Reuse Demand Met,0,0,0,21.0308,0,0,0,0,25.3338,0
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% Load Reduction,-0.118912,11.3792,15.8531,1353.88,-0.00842281,36.0804,23.8959,29.1697,282.953,-0.00442809
TSS Flow In (kg/yr),279.619,1701.06,1124.72,0,685.396,111.32,145.655,29.0884,0,1574.64
TSS ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0
TSS Infiltration Loss (kg/yr),0,15.4736,12.4773,0,0,7.1411,2.3719,2.52204,0,0
TSS Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0
TSS High Flow Bypass Out (kg/yr),0,0,0,915.46,0,0,0,0,145.655,944.749
TSS Orifice / Filter Out (kg/yr),29.0883,10.16,7.48355,10.8293,111.32,3.69666,1.28587,1.76482,0,179.948
TSS Weir Out (kg/yr),0,584.281,264.361,0,0,33.4584,22.6322,10.2131,0,0
TSS Transfer Function Out (kg/yr),0,0,0,120.739,0,0,0,0,14.6989,0
TSS Reuse Supplied (kg/yr),0,0,0,0,0,0,0,0,0,0
TSS Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0
TSS % Reuse Demand Met,0,0,0,31.5824,0,0,0,0,48.5231,0
TSS % Load Reduction,89.5972,65.0547,75.8301,3.03106,83.7584,66.623,83.579,58.8223,0.637296,28.5744
TP Flow In (kg/yr),0.625939,6.08776,2.8581,0,1.55613,0.73066,0.390558,0.261234,0,3.52504
TP ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0
TP Infiltration Loss (kg/yr),0,0.324077,0.250892,0,0,0.243703,0.0509836,0.0796798,0,0
TP Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0
TP High Flow Bypass Out (kg/yr),0,0,0,2.19419,0,0,0,0,0.390558,2.11505
TP Orifice / Filter Out (kg/yr),0.261233,0.812797,0.598683,0.0262928,0.730667,0.295734,0.102869,0.141186,0,0.743064
TP Weir Out (kg/yr),0,2.67672,1.01487,0,0,0.192557,0.0909044,0.068873,0,0
TP Transfer Function Out (kg/yr),0,0,0,0.426155,0,0,0,0,0.0827908,0
TP Reuse Supplied (kg/yr),0,0,0,0,0,0,0,0,0,0
TP Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0
TP % Reuse Demand Met,0,0,0,26.7421,0,0,0,0,38.7164,0
TP % Load Reduction,58.2654,42.6798,43.5444,21.9561,53.0459,33.1713,50.3855,19.5897,4.64854,18.9196
TN Flow In (kg/yr),4.53459,24.9631,22.8137,0,11.4444,9.62293,3.3306,3.31431,0,25.5371
TN ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0
TN Infiltration Loss (kg/yr),0,1.3163,1.21943,0,0,1.99122,0.250059,0.54384,0,0
TN Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0
TN High Flow Bypass Out (kg/yr),0,0,0,16.9631,0,0,0,0,3.33059,15.3223
TN Orifice / Filter Out (kg/yr),3.31431,2.3876,1.76514,0.206419,9.62291,2.30323,0.313611,0.84,0,7.49138
TN Weir Out (kg/yr),0,15.9672,11.0495,0,0,2.635,1.07015,0.92561,0,0
TN Transfer Function Out (kg/yr),0,0,0,4.3327,0,0,0,0,0.992996,0
TN Reuse Supplied (kg/yr),0,0,0,0,0,0,0,0,0,0
TN Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0
TN % Reuse Demand Met,0,0,0,21.8006,0,0,0,0,28.3518,0
TN % Load Reduction,26.9106,26.4721,43.8293,229.535,15.9162,48.6826,58.4532,46.7276,49.9965,10.6644
GP Flow In (kg/yr),47.4044,0,266.962,0,126.31,0,0,0,0,266.962
GP ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0
GP Infiltration Loss (kg/yr),0,0,0,0,0,0,0,0,0,0
GP Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0
GP High Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,160.178
GP Orifice / Filter Out (kg/yr),0,0,0,0,0,0,0,0,0,0
GP Weir Out (kg/yr),0,0,0,0,0,0,0,0,0,0
GP Transfer Function Out (kg/yr),0,0,0,0,0,0,0,0,0,0
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GP Reuse Supplied (kg/yr),0,0,0,0,0,0,0,0,0,0
GP Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0
GP % Reuse Demand Met,0,0,0,100,0,0,0,0,100,0
GP % Load Reduction,100,100,100,100,100,100,100,39.9998

Generic treatment nodes
Location,Humeceptor
ID,5
Node Type,GenericNode
Lo-flow bypass rate (cum/sec),0
Hi-flow bypass rate (cum/sec),100
Flow Transfer Function
Input (cum/sec),0
Output (cum/sec),0
Input (cum/sec),1000
Output (cum/sec),1000
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
Output (kg/ML),0
Input (kg/ML),1000
Output (kg/ML),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),

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Input (kg/ML),
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
Output (mg/L),0
Input (mg/L),1000
Output (mg/L),550
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
Output (mg/L),0
Input (mg/L),0.5
Output (mg/L),0.5
Input (mg/L),40
Output (mg/L),24
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 Suspended Solids Transfer Function
Input (mg/L),0
Output (mg/L),0
Input (mg/L),75
Output (mg/L),75
Input (mg/L),1000
Output (mg/L),250
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),
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IN - TSS Mean Annual Load (kg/yr),2.65E3
IN - TP Mean Annual Load (kg/yr),6.09
IN - TN Mean Annual Load (kg/yr),45.4
IN - Gross Pollutant Mean Annual Load (kg/yr),304
OUT - Mean Annual Flow (ML/yr),19.9
OUT - TSS Mean Annual Load (kg/yr),1.70E3
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OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00
Flow In (ML/yr),19.9046
ET Loss (ML/yr),0
Infiltration Loss (ML/yr),0
Low Flow Bypass Out (ML/yr),0
High Flow Bypass Out (ML/yr),0
Orifice / Filter Out (ML/yr),0
Weir Out (ML/yr),0
Transfer Function Out (ML/yr),19.9046
Reuse Supplied (ML/yr),0

Reuse Requested (ML/yr),0
% Reuse Demand Met,0
% Load Reduction,0
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TSS ET Loss (kg/yr),0
TSS Infiltration Loss (kg/yr),0
TSS Low Flow Bypass Out (kg/yr),0
TSS High Flow Bypass Out (kg/yr),0
TSS Orifice / Filter Out (kg/yr),0
TSS Weir Out (kg/yr),0
TSS Transfer Function Out (kg/yr),1701.06
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TSS % Load Reduction,35.6623
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TP Weir Out (kg/yr),0
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TN ET Loss (kg/yr),0
TN Infiltration Loss (kg/yr),0
TN Low Flow Bypass Out (kg/yr),0
TN High Flow Bypass Out (kg/yr),0
TN Orifice / Filter Out (kg/yr),0
TN Weir Out (kg/yr),0
TN Transfer Function Out (kg/yr),24.9636
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GP High Flow Bypass Out (kg/yr),0
GP Orifice / Filter Out (kg/yr),0

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

Other nodes
Location,Junction,Junction,Junction,Receiving Node,Junction
ID,6,8,9,10,17
Node Type,JunctionNode,JunctionNode,JunctionNode,ReceivingNode,JunctionNode
IN - Mean Annual Flow (ML/yr),2.56,17.6,9.38,32.8,3.20
IN - TSS Mean Annual Load (kg/yr),35.9,594,272,939,37.2
IN - TP Mean Annual Load (kg/yr),0.404,3.49,1.61,6.00,0.488
IN - TN Mean Annual Load (kg/yr),3.15,18.4,12.8,39.3,4.94
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00
OUT - Mean Annual Flow (ML/yr),2.56,17.6,9.38,0.00,3.20
OUT - TSS Mean Annual Load (kg/yr),35.9,594,272,0.00,37.2
OUT - TP Mean Annual Load (kg/yr),0.404,3.49,1.61,0.00,0.488
OUT - TN Mean Annual Load (kg/yr),3.15,18.4,12.8,0.00,4.94
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00

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,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
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Target node ID,5,7,8,10,10,10,13,15,16,17,10,6,20,6,4,5,21,19,22,11,9
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,Not Routed,Not Routed,Not Routed,Not
Routed,Not Routed
Muskingum K, , , , , , , , , , , , , , , , , , , , ,
Muskingum theta, , , , , , , , , , , , , , , , , , , , ,
IN - Mean Annual Flow
(ML/yr),12.3,19.9,17.6,2.56,17.6,9.38,9.58,5.01,5.01,3.20,3.20,1.15,1.98,1.40,1.98,7.57,2.03,1.52,11.1,11.1,9.38
IN - TSS Mean Annual Load
(kg/yr),1.72E3,1.70E3,594,35.9,594,272,1.35E3,686,111,37.2,37.2,23.9,29.1,12.0,280,926,283,146,1.57E3,1.12E3,272
IN - TP Mean Annual Load
(kg/yr),3.87,6.09,3.49,0.404,3.49,1.61,3.03,1.56,0.731,0.488,0.488,0.194,0.261,0.210,0.626,2.22,0.638,0.391,3.53,2.86,1.6
1
IN - TN Mean Annual Load
(kg/yr),28.2,25.0,18.4,3.15,18.4,12.8,22.0,11.4,9.63,4.94,4.94,1.38,3.31,1.77,4.53,17.2,4.65,3.33,25.5,22.8,12.8
IN - Gross Pollutant Mean Annual Load
(kg/yr),304,0.00,0.00,0.00,0.00,0.00,230,126,0.00,0.00,0.00,0.00,0.00,0.00,47.4,0.00,50.0,0.00,267,267,0.00
```

OUT - Mean Annual Flow
(ML/yr),12.3,19.9,17.6,2.56,17.6,9.38,9.58,5.01,5.01,3.20,3.20,1.15,1.98,1.40,1.98,7.57,2.03,1.52,11.1,11.1,9.38
OUT - TSS Mean Annual Load
(kg/yr),1.72E3,1.70E3,594,35.9,594,272,1.35E3,686,111,37.2,37.2,23.9,29.1,12.0,280,926,283,146,1.57E3,1.12E3,272
OUT - TP Mean Annual Load
(kg/yr),3.87,6.09,3.49,0.404,3.49,1.61,3.03,1.56,0.731,0.488,0.488,0.194,0.261,0.210,0.626,2.22,0.638,0.391,3.53,2.86,1.6
1
OUT - TN Mean Annual Load
(kg/yr),28.2,25.0,18.4,3.15,18.4,12.8,22.0,11.4,9.63,4.94,4.94,1.38,3.31,1.77,4.53,17.2,4.65,3.33,25.5,22.8,12.8
OUT - Gross Pollutant Mean Annual Load
(kg/yr),304,0.00,0.00,0.00,0.00,0.00,230,126,0.00,0.00,0.00,0.00,0.00,0.00,47.4,0.00,50.0,0.00,267,267,0.00

APPENDIX C

HUMECEPTOR TECHNICAL DATA

Humeceptor ™

Hydrocarbon and Fine Sediment
Hydrodynamic Separator

Technical Manual

Australian Patent No. 693164
New Zealand Patent No. 314646
Australian Patent Application 63621/98

Part of the Humes Water Solutions Treatment Train

ABN 90 000 001 276
www.humes.com.au

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1. Summary

Hume*ceptor* ™ is manufactured under licence to Imbrium Systems Inc. **Hume***ceptor* ™ is a patented stormwater quality improvement device (SQID) that operates as an Hydrodynamic Separator in a stormwater drainage system. **Hume***ceptor* ™ removes hydrocarbons and suspended solids from stormwater, preventing spills and minimising non-point source pollution entering downstream waterways.

A summary of the key benefits related to the implementation of a **Hume***ceptor* ™ is as follows :

- Capable of removing up to 80% of the total sediment load when properly applied as a source control for small areas
- Removes up to 98% of free oil from stormwater
- Will not scour or re-suspend trapped pollutants even during peak flows
- Can be implemented as part of a treatment train (e.g. prevents groundwater contamination in recharge measures, extends the maintenance period for other stormwater quality measures)
- Excellent spill control device for commercial and industrial developments
- Simple to design and specify
- Cost Effective compared to other stormwater quality measures
- Easy to install in new or retrofit situations
- Easy to maintain (vacuum truck)
- Can be used as a junction
- Pre-engineered for traffic loading
- Does not require a large drop in storm drain elevation for implementation (25 mm)
- **Hume***ceptor* ™ clearly marked on the cover (Excluding the STC2 Inlet model)

Although the Humeceptor ™ is extremely versatile, users of this document should keep in mind several key constraints :

- The STC2 "Inlet" **Hume***ceptor* ™ and the **Multi***ceptor*™ units can be used as a storm drain inlet
- Treatment is dependent on head differential between the Inlet and Outlet of the treatment chamber, therefore, care should be taken when designing in tidal zones
- The difference between the inlet pipe invert elevation and the outlet pipe elevation must be 25 mm
- The invert level difference between the inlet and outlet on the STC2 Unit and **Multi***ceptor*™ units is 75mm.
- The largest standard inlet/outlet size that can be accommodated without customisation is 1050 mm RCP (STC18-60 models) and 450 mm RCP (STC2 Inlet model)
- **Hume***ceptor*™ can accommodate several inlet pipes, but they must be considered in the overall context of the unit diameter and structural integrity.

2. Overview

Hume*ceptor* ™ is a pollution prevention device that efficiently removes hydrocarbons and sediment from stormwater. **Hume***ceptor* ™ is compatible with standard infrastructure components. The key advantage of **Hume***ceptor* ™ compared to other stormwater quality controls is the patented bypass which prevents the re-suspension and scour of settled material during subsequent storm events. Accordingly, **Hume***ceptor* ™ will not release pollutants between servicing, even during infrequent events (i.e. 5 year or 10 year storm).

Hume*ceptor* ™ follows the philosophy of treating pollution at its source. Treating pollution at the source is the preferred methodology for water quality control since the dilution of pollutants in stormwater becomes problematic in terms of effective treatment as the drainage area increases. A study by Bannerman et al., (1993) indicated that the application of stormwater quality controls to 14% of the residential land and 40% of the industrial lands could reduce a region's total contaminant loading by 75%, indicating that cost-effective water quality control can be implemented by targeting certain "hot spots". In this study, streets were critical in all land uses, and parking lots were critical for industrial and commercial land uses.

3. Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) is a framework for, or way of thinking about, the planning and design of urban environments that takes into account the many demands and opportunities for water and environmental protection (ARQ, 2006). The four main objectives of WSUD include;

- Reducing potable water demand
- Minimising wastewater generation and reusing treated wastewater
- Treating urban stormwater to meet water quality objectives
- Preserving the natural hydrology of catchments

To achieve the treatment of urban stormwater objective, it is necessary to implement a "treatment train" of measures that can address the variety of pollutants and their wide range of particle sizes (ARQ, 2006). It is widely acknowledged that there is no single device whether natural, constructed or manufactured that can achieve all of the water quality objectives desired for urban stormwater.

The **Hume***ceptor* ™ solution is designed to be an integral part of the WSUD Treatment Train for improving urban stormwater quality, specifically in the fine sediment (5,000 μm – 10μm) and hydrocarbon areas. Figure 1 is adapted from ARQ (2006) to demonstrate the treatment range for the **Hume***ceptor* ™ device.

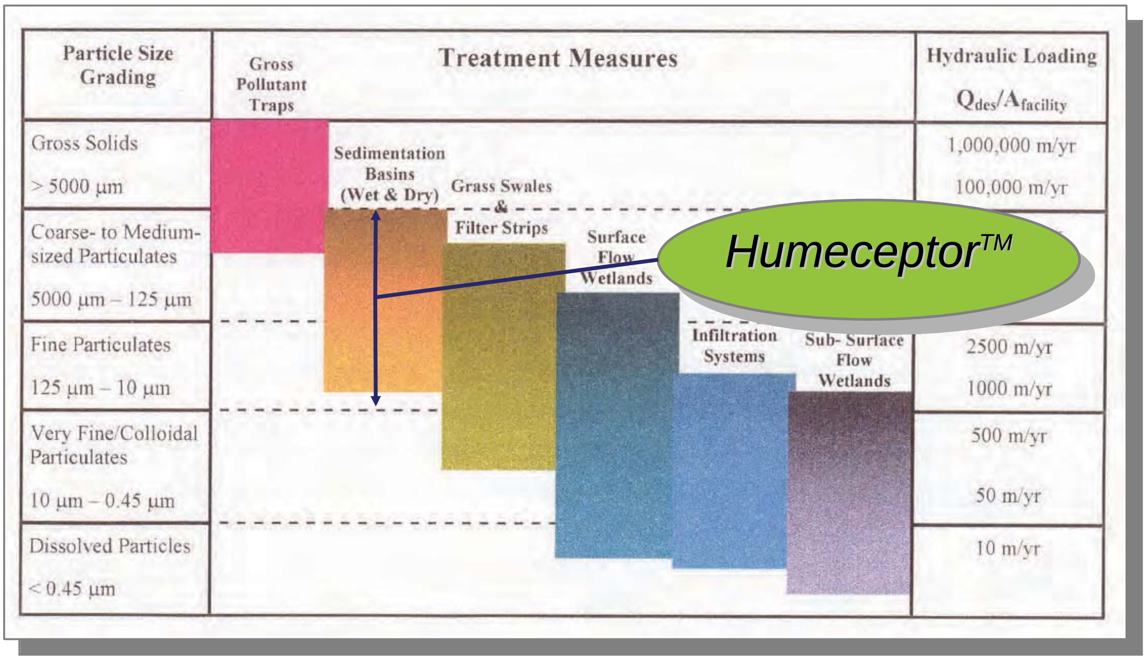

Figure 1. Pollutant Range & Hume*ceptor* ™ treatment

4. Applications

Hume*ceptor* **™** is applicable in a variety of development situations including :

- stormwater quality retrofits for existing development
- industrial and commercial parking lots
- automobile service stations
- airports
- areas susceptible to spills of hydrocarbons (bus depots, transfer stations, etc.)
- new residential developments (as part of a treatment train)
- re-development in urban areas.

4.1 Existing Development Retrofits

Existing development can comprise up to 80% of a watershed's tributary drainage area. These areas are often overlooked since the large area of uncontrolled runoff is overwhelming. By targeting "hot spot" areas however, cost-effective water quality control can be implemented for existing developed areas.

Existing developed areas generally provide numerous constraints to the implementation of water quality enhancement. Surrounding properties define the grading of the development (or else bunds and expensive retaining walls are required) and existing stormwater inverts and locations define the minor system drainage route. These constraints generally limit the number and type of options available to the stormwater management professional with respect to water quality enhancement. In these situations, **Hume***ceptor* **™** is an attractive solution due to its low cost, ease of installation and maintenance, and compatibility with the existing drainage system.

4.2 Emergency Spill Areas

Parking lots, highways, motorways, and industrial areas where transfer of deleterious materials occur, are potential spill areas. Generally, the area of land draining to the stormwater in these instances is small. **Hume***ceptor* ™ is recommended for these types of land use regardless of whether other water quality control techniques are proposed. The spills protection provided by **Hume***ceptor* ™ prevents creeks from damaging spills which have toxic effects on the instream aquatic resources. Additional “Emergency Spill Storage” tanks can be connected with **Hume***ceptor* ™ units to increase the capture volume.

4.3 Redevelopment

Redevelopment can be classified as new construction on an existing developed area. This can be an addition to an existing development, or the replacement of the entire development with a similar or new type of land use. In these situations, natural, surface treatment techniques are generally not feasible, meaning that any treatment system must conform to the existing stormwater network. The implementation of large underground systems (such as tanks, underground sand filters, etc.) is also generally problematic due to the proximity of other underground utilities, the configuration of the existing stormwater system, and long term maintenance.

Most redevelopment situations typically occupy relatively small areas. Surface stormwater quality techniques for these areas would result in a loss of developable land which could jeopardise the economic feasibility of small high density development areas. In these situations **Hume***ceptor*™ is sometimes the only feasible solution.

4.4 New Residential Subdivisions

Hume*ceptor*™ is not intended to replace natural, constructed, stormwater management system solutions (bioretention, wetlands) for large residential subdivisions. **Hume***ceptor*™ can be used, however, as part of the treatment train approach in these subdivisions. For small subdivisions, in which ponds or wetlands are not feasible (i.e. < 2 ha), and for large developments (> 10 ha) that would result in numerous small ponds within a tributary area, the use of **Hume***ceptor*™ as part of the treatment train approach (i.e. numerous **Hume***ceptor*™ units in conjunction with a Gross Pollutant Trap, eg. **Hume***gard*™) is a cost-effective solution which will lessen the maintenance burden of municipalities who will have the ultimate responsibility for stormwater quality systems. A **Hume***ceptor* ™ upstream of a bioretention area (rain garden) will also extend the lifespan through minimising the amount of sediment trapped on the bioretention media and thereby maximise the duration before clogging occurs.

The use of **Hume***ceptor*™ for street drainage helps to mitigate long term maintenance costs by centralising the capture and retention of sediment in the unit instead of being distributed across the entire treatment area of the receiving wetlands or bioretention basin.

5. Hume*ceptor*™ Design and Operation

Hume*ceptor***™** can be divided into two components:

- treatment chamber
- bypass chamber

Stormwater flows into the inlet weir area of the bypass chamber. Design flows are diverted into the treatment chamber by a weir and drop pipe arrangement (Figure 2). The drop pipe is configured to discharge water tangentially along the treatment chamber wall. Water flows through the treatment chamber to the decant pipe which is submerged similar to the drop inlet pipe. Water flows up through the decant pipe based on the head differential at the inlet weir, and is discharged back into the bypass chamber downstream of the weir. The downstream section of the bypass chamber is connected to the outlet stormwater pipe.

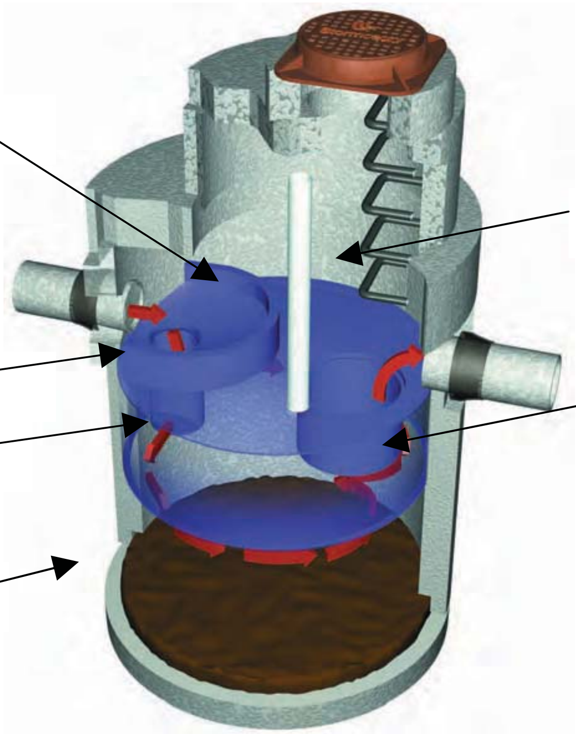

Figure 2. Hume*ceptor***™ Operation During Design Flow Conditions**

Hydrocarbons and other entrained substances with a specific gravity less than water (e.g. cigarette butts) will rise in the treatment chamber and become trapped beneath the fibreglass insert since the decant pipe is submerged. Sediment will settle to the bottom of the chamber by gravity forces. The circular design of the treatment chamber assists in preventing turbulent eddy currents and promoting settling.

During high flow conditions, stormwater in the bypass chamber will overtop the weir and be conveyed to the stormwater outlet directly (Figure 3). Water which overflows the weir creates a backwater effect on the outlet pipe (head stabilisation between the inlet drop pipe and outlet decant pipe) ensuring that excessive flow will not be forced into the treatment chamber which could scour or re-suspend the settled material. The bypass is an integral part of the **Hume***ceptor*™ since other oil/grit separators have been noted to scour during high flow conditions (Schueler and Shepp, 1993).

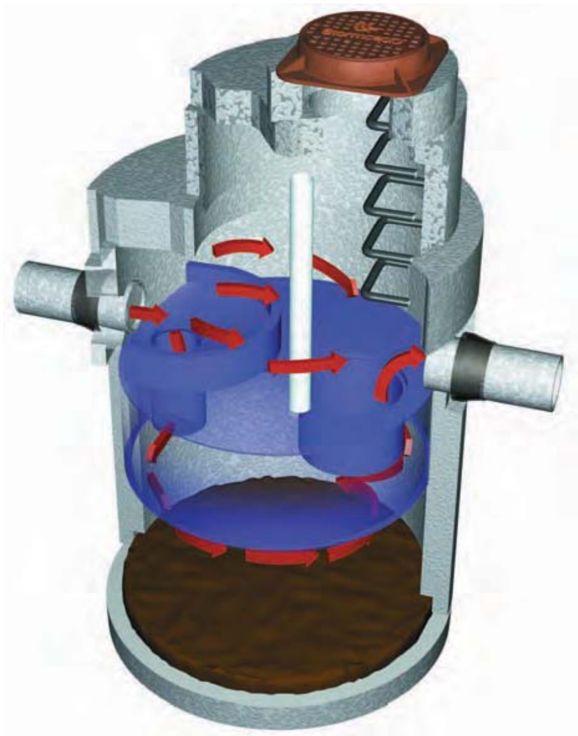

Figure 3. Hume*ceptor* ™ Operation During High Flow Conditions

Hume*ceptor*™ comes "ready-to-assemble" to the job site with its own frame and cover (grate for the STC2). The cover has the name **Hume***ceptor*™ clearly embossed on it to allow easy identification of the unit in the field for maintenance. The inlet and outlet openings are clearly marked and can have Kor-n-seal Boots to facilitate easy connection to the stormwater pipes.

6. Product Range

Depending upon the catchment characteristics and the desired WQOs a wide range of potential **Hume***ceptor* ™ sizes are available. Table 1 presents the standard units and their Sediment Capacity, Oil Storage Volume and the Total Storage Volume. As noted earlier, the Oil Storage Capacity can be expanded through the addition of "Emergency Spill Storage" tanks upon request.

Table 1. Hume*ceptor*™ Product Range

Humeceptor™ Model	*Sediment Capacity (m^3)*	*Oil Capacity (l)*	*Total Holding Capacity (l)*
STC 2 (Inlet)	*1*	*350*	*1,740*
STC 3	*2*	*1,020*	*3,410*
STC 5	*3*		*4,550*
STC 7	*5*		*6,820*
STC 9	*6*	*1,900*	*9,090*
STC 14	*10*	*2,980*	*13,640*
STC 18	*14*		*18,180*
STC 23	*18*		*22,730*
STC 27	*20*	*4,290*	*27,270*

7. Variants

A number of additional innovations have been made to the **Hume***ceptor*™ units to facilitate their effective operation in a wider range of applications;

- **Aqua***ceptor*™ has been designed to operate under submerged or high tailwater conditions
- **Duo***ceptor*™ has been designed to treat stormwater runoff from catchments ~2Ha or greater
- **Multi***ceptor*™ has been designed to incorporate multiple inlet pipes into the unit for treatment and thereby replace junction pits

7.1 Aquaceptor™

The **Aqua***ceptor*™ has been designed with a weir extension to increase the level at which flows bypass the treatment chamber and accommodate downstream tailwater levels or periodic inundation (eg. Tidal situations). **This weir extension is provided in standard heights of 100mm intervals up to a maximum of 500mm**.

To maintain the hydrocarbon capture capabilities, an additional “high level” inlet pipe is also fitted. This facilitates the formation of the surface vortex from the bypass chamber into the treatment chamber and draws floating hydrocarbons into the unit.

Selection of the appropriate weir extension height is undertaken in conjunction with the downstream engineering design and/or tidal range charts for the specific location. Figure 4 displays the **Aqua***ceptor*™ unit. The **Aqua***ceptor*™ units are available in the same range of sizes as the standard **Hume***ceptor*™ units (refer Table 1 above).

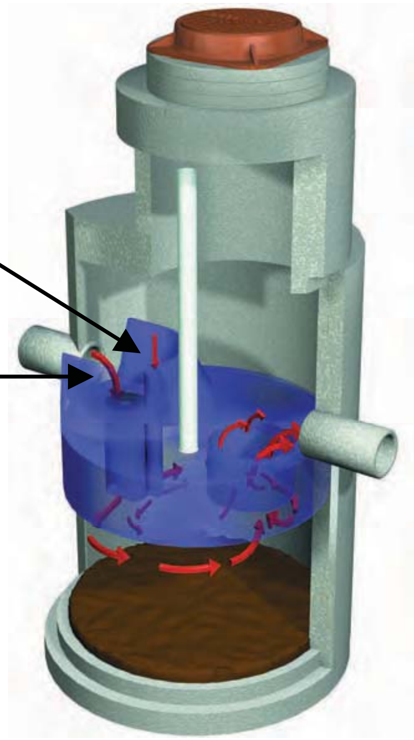

Figure 4. Aqua*ceptor*™ treatment device

7.2 Duoceptor™

The **Duo***ceptor*™ unit has been developed to treat larger catchment (>2Ha) as some developments are optimally treated with a single large device instead of several smaller devices. Figure 5 displays the **Duo***ceptor*™ unit and Table 2 details the range of capacities available. The unit operates by splitting the flow and treating half of the design flowrate through the first chamber. The untreated half of the design flow bypassed from the first chamber then passes through the split connection pipe into the second chamber for treatment. Treated flow from the first chamber exits and flows through the other half of the split connection pipe and bypasses the second chamber to join the treated flow from the second chamber at the outlet of the **Duo***ceptor*™.

Table 2. Duo*ceptor*™ capacities

Duoceptor ™ Model	Sediment Capacity (m^3)	Oil Capacity (l)	Total Holding Capacity (l)
STC40	27	10,585	42,370
STC50	35	10,585	50,525
STC60	42	11,560	60,255

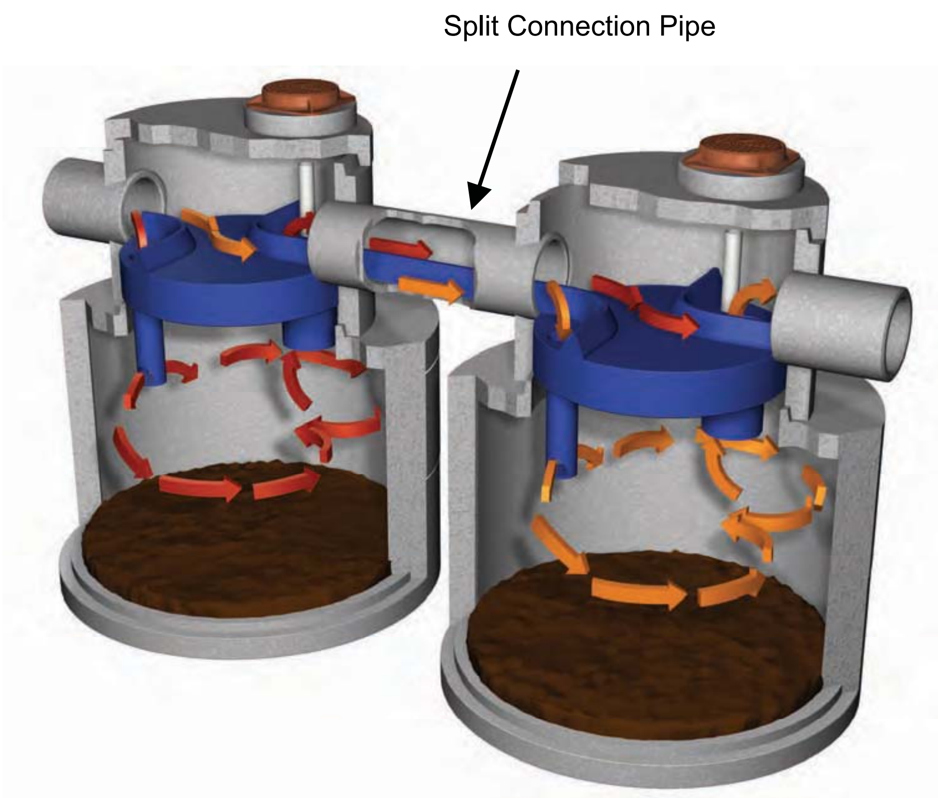

Figure 5. Duo*ceptor*™ Unit

7.3 Multiceptor™

The **Multi***ceptor*™ has been developed to facilitate the replacement of junction pits as well as providing the treatment abilities of the traditional **Hume***ceptor* ™ device. These units reverse the weir structure to allow for;

- Change of pipe direction
- Multiple inlet pipes
- Differing invert levels of multiple inlet pipes
- Grated Inlets

Multi*ceptor*™ units are available in the same capacities as the standard **Hume***ceptor* ™ units (refer Table 1). The potential inlet locations are demonstrated in Figure 6.

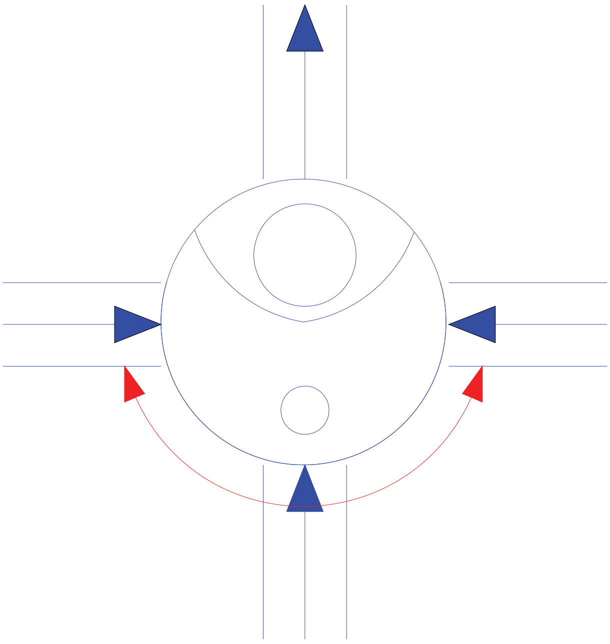

Figure 6. Potential inlet locations for the Multi*ceptor*™ range

8. Construction Materials

- **Hume***ceptor*™ is manufactured in precast concrete.
- The weir inserts are manufactured in fibreglass.
- The Oil Inspection pipe is PVC.
- **Hume***ceptor*™ is designed to be fully structural and withstand highway loading.
- It has a design life of 50 years and is manufactured according to the Rinker Group ISO9001 Quality Assurance System.

9. Research & Testing

Extensive studies have been conducted on the **Hume***ceptor*™ system including:-

- The National Water Research Institute (1993, 1994) and University of Coventry (1996) laboratory testing.
- Marshall Macklin Monaghan Limited (1994) - computer modelling of the **Hume***ceptor*™.
- Stormceptor Canada Inc. - sediment monitoring of 21 installed units in the Greater Toronto Area (GTA).
- Field monitoring in Edmonton, Alberta; Westwood, Massachusetts; Como Park; Minnesota; and Madison, Wisconsin. Detailed reports from these studies are available from Humes Water Solutions.
- City of Indianapolis – full scale testing
- New Jersey TARP Program – full scale testing

The major findings of these studies can be summarised as follows:

- The site monitoring indicated that 50% of the sediment collected by the **Hume***ceptor*™ was smaller than 10 μm in size.
- The National Water Research Institute, Canada laboratory testing proved the non-scouring design of the **Hume***ceptor*™ units under high flow conditions.
- Conventry Unveristy, UK – 97% removal of oil, 83% removal of sand and 73% removal of peat
- New Jersey TARP Program – full scale testing of an STC3 demonstrating 75% TSS removal of particles from 1 to 1000 microns. Scour testing completed demonstrated that the system does not scour. The only technology to follow the NJDEP protocol.
- City of Indianapolis – full scale testing of an STC3 demonstrating over 80% TSS removal of particles from 50 microns to 300 microns at 130% of the unit's operating rate. Scour testing completed demonstrated that the system does not scour
- Full size tests to European Standards showed free oil removal rate of 97.8% at full treatment flow.
- For high inflows, the risk of washing out the treatment chamber is reduced since the flowrate through the unit reduces (up to 20%).
- The headloss through the **Hume***ceptor*™ unit is approximately the same as a 60° bend at a pit (loss coefficient K ~1.3).
- The TSS removal rate for the unit monitored in Edmonton (1996) was consistent with the sizing guidelines (52%)
- 400 litres of oil was captured in an Edmonton **Hume***ceptor*™
- The TSS removal rate for the unit in Westwood, Massachusetts (1997) was consistent with the sizing guidelines (82%)
- **Hume***ceptor*™ removed 18% of the Total Phosphorus and dissolved Phosphorus in Madison, Wisconsin
- 450 litres of oil was captured in the Madison, Wisconsin **Hume***ceptor*™ after 1 year of operation
- A review of **Hume***ceptor*™ laboratory testing and field monitoring (Massachusetts's STEP Program) concluded that **Hume***ceptor*™ can provide TSS removal rates consistent with the sizing guidelines.
- The laboratory testing (with synthetic sand) indicated that 90% removal would be achieved at a flowrate of ~6 L/s.
- The theoretical modelling indicated that an annual cleanout would be sufficient based on the estimated annual sediment removal rates.
- The site monitoring indicated a strong relationship between upstream drainage area, **Hume***ceptor*™ storage volume and treatment efficiency.

Graph of the test results are presented in Figures 7 to 12 following.

The performance of the **Hume***ceptor* ™ device has been certified under the Canada ETV and US NJCAT verification programs.

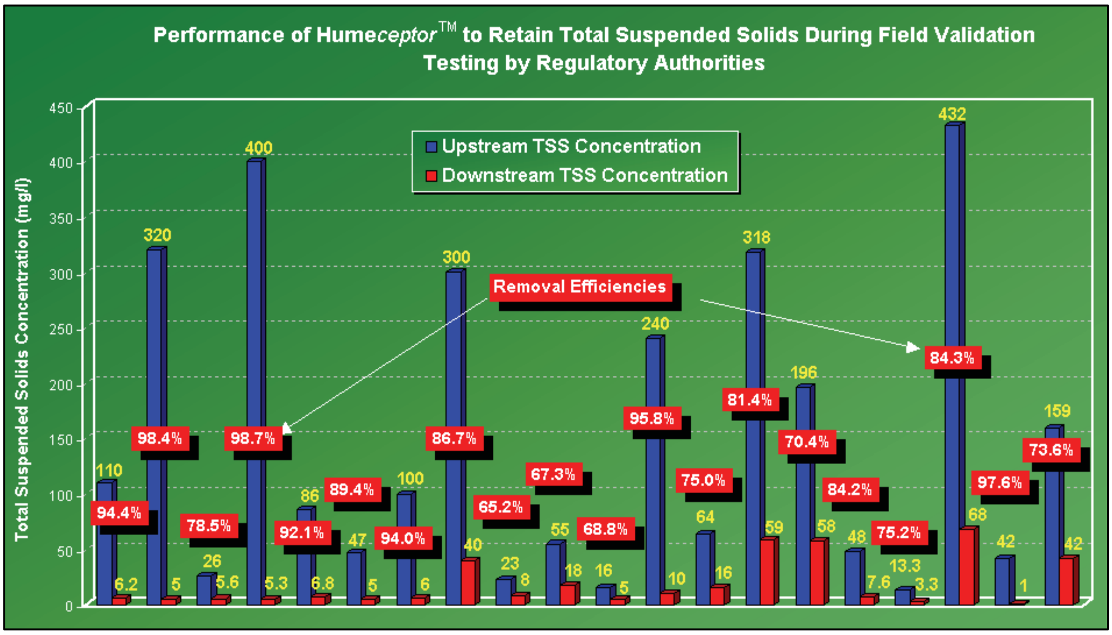

Figure 7. Humeceptor™ Field Performance Results for TSS Removal

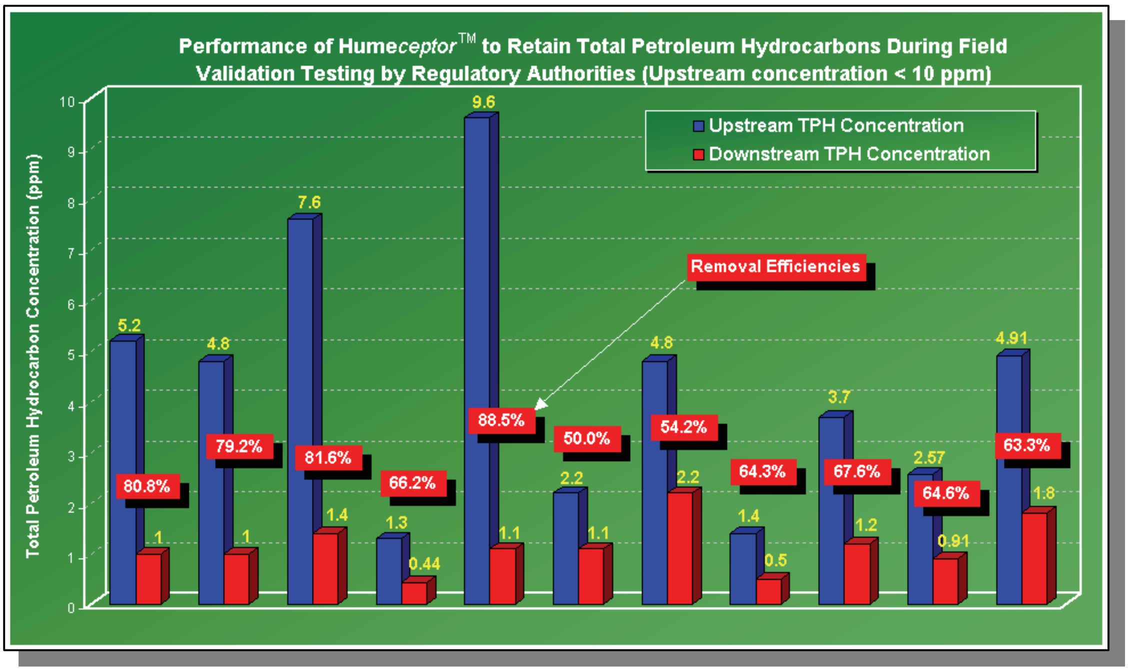

Figure 8. Humeceptor™ Field Performance for TPH Removal for Influent Concentration <10ppm

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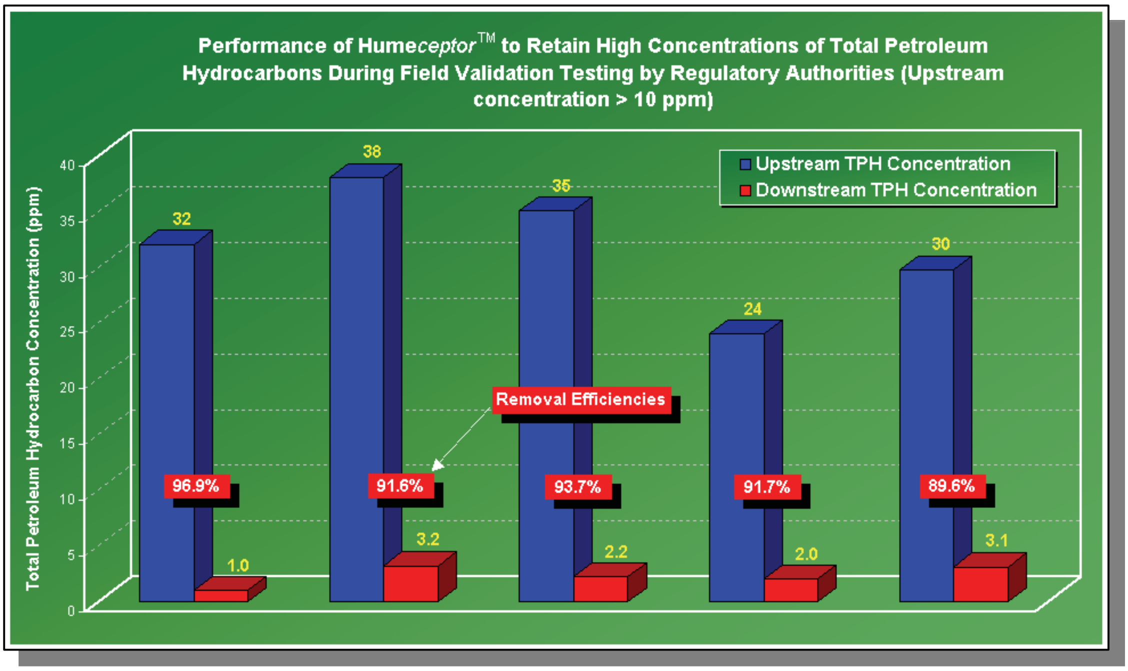


Figure 9. Hume*ceptor* ™ Field Performance for TPH Removal for Influent Concentration >10ppm

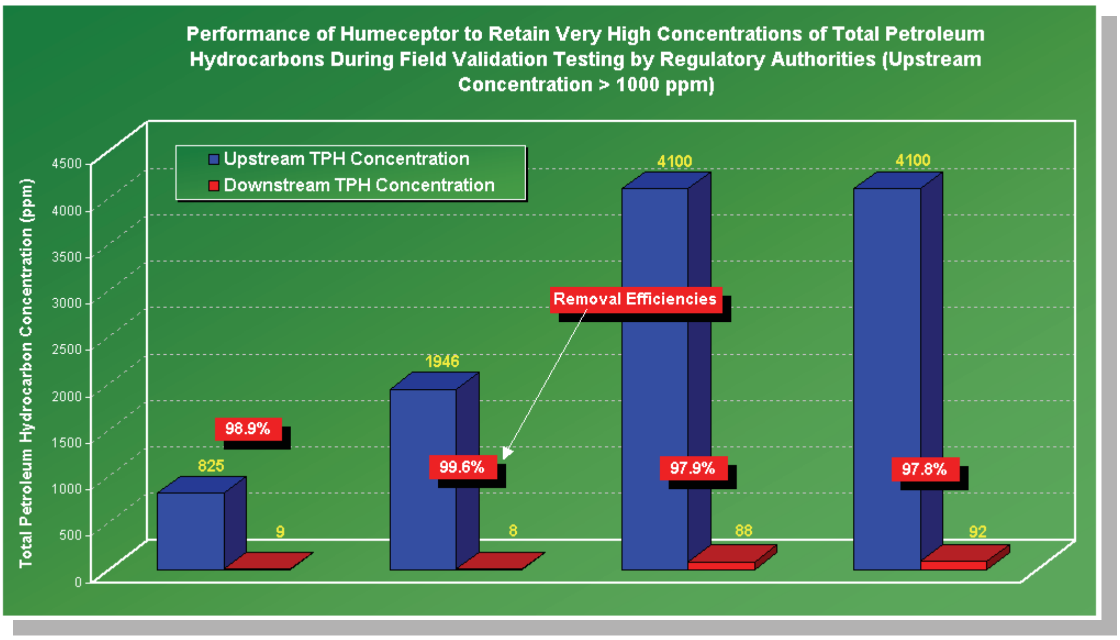


Figure 10. Hume*ceptor* ™ Field Performance for TPH Removal for Influent Concentration >1000ppm

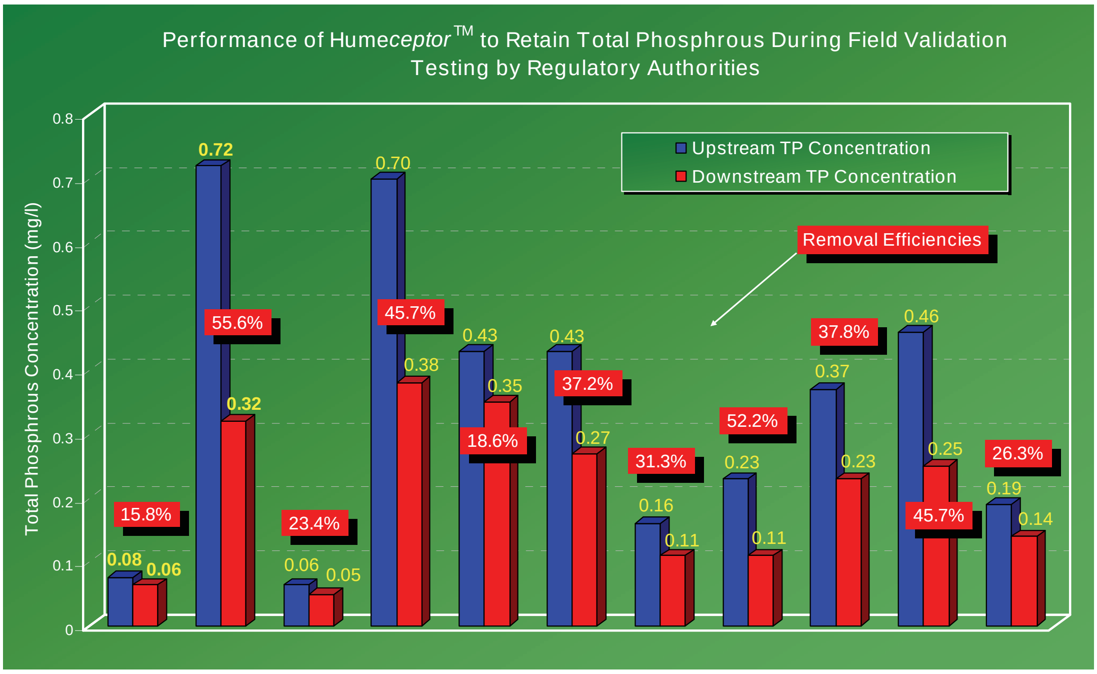


Figure 11. Hume*ceptor*™ Field Performance for TP Removal

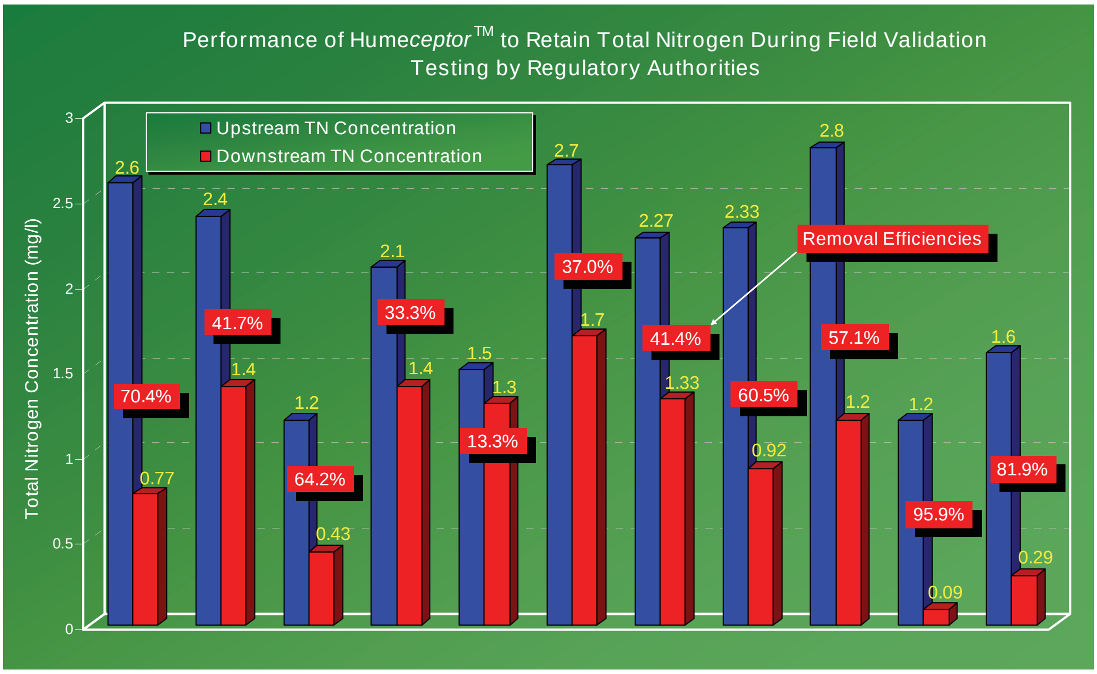


Figure 12. Hume*ceptor*™ Field Performance for TN Removal

10. MUSIC Inputs for Hume*ceptor*™

Whilst Field Testing can produce a wide variety of results, as indicated in the previous figures, on average, the performance against the Total Annual Pollutant Load can be modelled in MUSIC using the following input parameters.

Table 3. MUSIC Removal Efficiencies for Hume*ceptor* ™

Parameter	Removal Efficiency
TSS	80%
TN	30%
TP	30%

11. Design Information

The design of **Hume***ceptor*™ involves reviewing the configuration of the stormwater system, the location and purpose of other stormwater management controls for the proposed development, and the impervious area of the proposed development.

11.1 Configuration of the Stormwater System

The configuration of the stormwater system is important since **Hume***ceptor*™ works most efficiently for small drainage areas.

11.1.1 Inlet Configuration (STC2 & Multi*ceptor*™ Units)

The **Hume***ceptor*™ unit is designed to replace a conventional inlet pit or access chamber, depending upon the size of the chosen unit. The smallest STC2 unit and **Multi***ceptor*™ units can be configured to have a grated inlet at the surface (Figure 13). All other sizes from STC3 through to STC27 are designed with a horizontal inlet pipe.

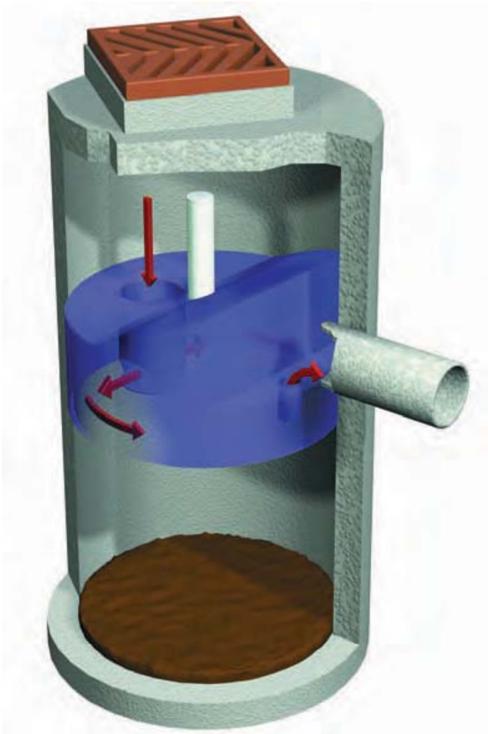


Figure 13. Grated Inlet Configuration of an STC2 Unit

11.1.2 Bypass Chamber

The bypass chamber is 1.2 m diameter for the STC2 Inlet model and 1.8 m diameter for the other models. The largest pipe that can currently be accommodated in the 1800 mm ϕ **Hume***ceptor*™ insert is a 1050 mm diameter reinforced concrete pipe.

Whilst this diameter pipe can physically fit into the **Hume***ceptor*™, it is considerably larger than the pipe sizes which are recommended by the sizing software. Pipes greater than 1050 mm ϕ require customisation of the **Hume***ceptor*™ insert. In these cases, seek assistance from Humes Water Solutions.

11.1.3 Location in the Stormwater System

Hume*ceptor*™ is designed to accommodate 80% of the Annual Runoff Volume and remove 80% Total Suspended Solids (TSS). The frequency of the magnitude of a flowrate is dependent on the upstream drainage area and the level of imperviousness of that drainage area, therefore the selection of a 3mth ARI, for example, may not be necessary to achieve the desired WQOs.

Accordingly, the recommended design approach is that the **Hume***ceptor*™ be implemented at or close to the source on local or lateral drains rather than trunk drainage for new development application. Humes Water Solutions are available to work closely with stormwater designers to select the appropriate location for **Hume***ceptor*™**.**

The implementation of a **Hume***ceptor*™ in retrofit and redevelopment applications is important, however, since they can provide significant enhancement (i.e. to remove stormwater bedload) at a small cost in situations where there are few economical options for treatment.

11.2 Sizing the **Hume***ceptor™ System*

The **Hume***ceptor* ™ System is a versatile product that can be used for many different aspects of water quality improvement. While addressing these needs, there are conditions that the designer needs to be aware of in order to size the **Hume***ceptor*™ model to meet the challenges in an efficient and cost-effective manner.

PCSWMM for **Hume***ceptor*™ is the decision support tool used for identifying the appropriate **Hume***ceptor*™ model. In order to size a unit, it is recommended that the user follow the 7 design steps in the software. The steps are as follows:

11.2.1 STEP 1 – Project Details & WQOs

Enter the Project Details in the appropriate cells. The next step prior to sizing the **Hume***ceptor*™ System is to clearly identify the water quality objective for the development. It is recommended that a level of annual sediment (TSS) removal be identified and defined by a particle size distribution. In most Australian situations, this WQO is for 80% TSS Removal, but a Particle Size Distribution (PSD) is not defined. This can be determined from relevant research data or from site monitoring.

11.2.2 STEP 2 – Site Details

Identify the site development by the drainage area and the level of imperviousness. It is recommended that imperviousness be calculated based on the actual area of imperviousness based on paved surfaces, sidewalks and rooftops.

11.2.3 STEP 3 – Upstream Detention/Retention

The **Hume***ceptor*™ System is designed as a water quality device and is sometimes used in conjunction with onsite water quantity control such as ponds or underground detention systems. When possible, a greater benefit is typically achieved when installing a **Hume***ceptor*™ unit upstream of a detention facility. By placing the **Hume***ceptor*™ unit upstream of a detention structure, the sediment load is reduced and the maintenance interval between cleaning is maximised.

In some installations, the **Hume***ceptor* ™ is installed downstream of detention structures which alter the hydrology of the catchment and will therefore also influence the size of the **Hume***ceptor* ™ selected by the software.

11.2.4 STEP 4 – Particle size distribution

It is critical that the PSD be defined as part of the WQOs. PSD is critical for the design of treatment system for a unit process of gravity settling and governs the size of a treatment system. A range of particle sizes has been provided and it is recommended that clays and silt-sized particles be considered in addition to sand and gravel-sized particles. Options and sample PSDs are provided in PCSWMM for **Hume**_ceptor_™. The default particle size distribution is the Fine Distribution (Table 4);

Table 4. Default PSD (Fine)

Particle Size (microns)	Distribution	Specific Gravity
20	20%	1.3
60	20%	1.8
150	20%	2.2
400	20%	2.65
2000	20%	2.65

If the objective is for the long term removal of 80% of the total suspended solids on a given site, the PSD should be representative of the expected sediment on the site. For example, a system designed to remove 80% of coarse particles (greater than 75 microns) would provide relatively poor removal efficiency of finer particles that may be naturally prevalent in runoff from the site. Since the small particle fraction contributes a disproportionately large amount of the total available particle surface area for pollutant adsorption, a system designed primarily for coarse particle capture will compromise water quality objectives.

11.2.5 STEP 5 – Rainfall Records

Local historical rainfall has been acquired from the Bureau of Meteorology. The rainfall data provided with PCSMM for **Hume**_ceptor_™ provides an accurate estimation of storm hydrology by modelling actual historical storm events including duration, intensities and peaks.

11.2.6 STEP 6 – Summary

At this point, the software may be executed to predict the level of TSS removal from the site. Once the simulation has completed, a table shall be generated identifying the TSS removal of each **Hume**_ceptor_™ unit. Based on the water quality objective identified in Step 1, the recommended **Hume**_ceptor_™ System will be highlighted.

11.3 PCSWMM for **Hume***ceptor*™

The **Hume**_ceptor_™ System has been developed in conjunction with _PCSWMM for_ **Hume**_ceptor_™ as a technological solution to achieve water quality goals. Together, these two innovations model, simulate, predict and calculate the water quality objectives desired by a design engineer for TSS removal. _PCSWMM for_ **Hume**_ceptor_™ is a proprietary sizing program which uses site specific inputs to a computer model to simulate sediment accumulation, hydrology and long-term total suspended solids removal. The model has been calibrated to field monitoring results from **Hume***ceptor*^{TM} units that have been monitored. The sizing methodology can be described by three processes:

1. Determination of real time hydrology
2. Buildup and wash off of TSS from impervious land areas
3. TSS transport through the **Hume***ceptor*^{TM} (settling and discharge)

The use of a calibrated model is the preferred method for sizing stormwater quality structures for the following reasons:

1. the hydrology of the local area is properly and **accurately** incorporated in the sizing (distribution of flows, flow rate ranges and peaks, back to back storms, inter-event times)
2. the distribution of TSS with the hydrology is properly and **accurately** considered in the sizing
3. particle size distribution is properly considered in the sizing
4. the sizing can be optimized for TSS removal
5. the cost benefit of alternate TSS removal criteria can be easily assessed
6. the program assesses the performance of all **Hume***ceptor*^{TM} models. Sizing may be selected based on a specific water quality outcome or based on the Maximum Extent Practicable

For more information regarding *PCSWMM for* **Hume***ceptor*^{TM}, please contact your local **Hume***ceptor*^{TM} representative, or visit www.humes.com.au to download a free copy of the program.

11.3.1 Sediment Loading Characteristics

The way in which sediment is transferred to stormwater can have a considerable effect on which type of system is implemented. On typical impervious surfaces (e.g. parking lots) sediment will build over time, and wash off with the next rainfall. When rainfall patterns are taken into consideration, a short intense storm will have a higher concentration of sediment than a long slow drizzle. Together with rainfall data representing the site's typical rainfall patterns, sediment loading characteristics play a part in the correct sizing of a stormwater quality device. This Buildup/Washoff Algorithm unique to PCSWMM for **Hume***ceptor* ^{TM} more closely models natural storm events and pollutant generation than other Pollutant Export Models (eg. MUSIC) which do not model these algorithms.

11.3.2 Typical Sites

For standard site design of the **Hume***ceptor*^{TM} System, *PCSWMM for* **Hume***ceptor*^{TM} is utilised to accurately model the unit's performance. As an integral part of the products design, the program can be used to meet local requirements for total suspended solid removal. Typical installations of manufactured stormwater treatment devices would occur on areas such as paved parking lots or paved roads. These are considered "stable" surfaces which have non–erodible surfaces.

11.3.3 Unstable Sites

While standard sites consist of stable concrete or asphalt, sites such as gravel parking lots, or maintenance yards with stockpiles of sediment would be classified as "unstable". These types of sites do not exhibit first flush characteristics, are erodible, have different sediment loading characteristics and must therefore be modelled more carefully. Please contact you local **Hume***ceptor*™ representative for assistance in selecting the proper unit size.

11.4 Dimensions

Hume*ceptor*™ dimensions vary with the size of unit that is specified. Dimensions of the standard **Hume***ceptor*™ and **Duo***ceptor*™ units are provided in Table 5.

Table 5. Hume*ceptor*™ **Dimensions ***

Model	Treatment Chamber Diameter (mm)	Depth from Pipe Invert (m)
STC2	1200	1.7
STC3	1800	1.68
STC5	1800	2.13
STC7	1800	3.03
STC9	2440	2.69
STC14	2440	3.69
STC18	3060	3.44
STC23	3060	4.04
STC27	3060	3.84
STC40	3060	3.44
STC50	3060	4.04
STC60	3600	3.84

*** Depths are approximate**

11.5 Design Parameters

There are some standard design parameters that must be provided in any stormwater design with a **Hume***ceptor*™ installation.

11.5.1 Inlet Pipe Grade

Hume*ceptor*™ units should be located on a pipe system with a slope less than 10%, preferably less than 5%.

11.5.2 Inlet / Outlet Elevation Difference

- There is a **25 mm difference** in elevation between the inlet invert and the outlet invert in **Hume***ceptor*™, **Aqua***ceptor*™ and **Duo***ceptor*™ units from **STC3 to STC60**.
- There is a **75mm difference** in elevation between the inlet pipe invert and the outlet pipe invert in the **STC2 Hume***ceptor* ™ unit and **Multi***ceptor*™ units.
- Stormwater designs must accommodate this elevation difference.

11.5.3 Influent and Effluent Pipe

Epoxy grouting or Flexible rubber (Kor-n-Seal) boots can be utilised to facilitate the installation of the inlet/outlet pipes to the **Hume***ceptor*™.

11.5.4 Head Loss

The measured head loss through the **Hume***ceptor*™ is approximately the same as a 60° bend at a stormwater pit. An appropriate K value to use in calculating minor losses through the stormwater system for a **Hume***ceptor*™ unit would be 1.3 (Minor Loss = 1.3 $v^2/2g$).

11.5.5 Installation Depth

There is a minimum inlet obvert (inside top of pipe) to surface level depth required to physically implement the **Hume***ceptor*™ due to the modular construction of the structure. **Generally the minimum obvert to Surface Level elevation is 500 mm**. For situations where the minimum obvert to grade is less than 500 mm, contact Humes Water Solutions for advice.

The maximum installation depth for the **Hume***ceptor*™ is 10 metres. The dimensions (i.e. depth of treatment chambers) for various **Hume***ceptor*™ units are given in Table 3 (previous). **Hume***ceptor*™ installations at depths greater than those noted above will require custom manufacturing. Humes Water Solutions should be consulted for recommendations in these instances.

12. Installation Procedures

The installation of **Hume***ceptor*™ should conform in general to Local Authorities' Specification for the construction of stormwater pits. Detailed installation instructions are dispatched with each unit.

12.1 Construction Sequence

Hume*ceptor*™ is installed in sections in the following sequence:

1. geotextile
2. aggregate base
3. treatment chamber section with base slab
4. treatment chamber section(s) (if required)

5. transition slab (if required)
6. bypass chamber
7. fit inlet drop pipe and decant pipe (if required)
8. connect inlet and outlet pipes as required
9. transition slab
10. maintenance access chamber section (if required)
11. frame and access cover (grate for the STC2)

The treatment chamber with base slab should be placed level at the specified RL. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with Humes Water Solutions recommendations.

Adjustment of the **Hume***ceptor*™ can be performed by lifting the upper sections free of the excavated area, re-leveling the base treatment chamber. Damaged sections and gaskets should be repaired or replaced as necessary.

12.2 Fitting the Inlet Drop Pipe, Orifice Plates and Outlet Riser (Decant) Pipe

Once the bypass section has been attached to the treatment chamber, the inlet drop pipe, orifice plate and outlet riser (decant) pipe can be inserted. Models up to and including STC7 will have these fitted prior to delivery. Other models will have easy to follow instructions for installation of the components. Where these parts are required to be fitted on site, installation occurs from above the insert i.e. there is no requirement to enter the chamber below.

12.3 Inlet and Outlet Pipes

Inlet and outlet pipes should be securely set into the bypass chamber using Kor-n-Seal boots so that the structure is watertight. The Kor-n-Seal boots are typically installed at the Humes plant prior to transport. The boots are applicable for pipes up to and including 1050 mm SRCP with an outside diameter up to 1194 mm. Installation of the flexible rubber connectors should follow the manufacturer's recommendations. The following procedure should be followed to attach the inlet and outlet pipes:
1. Lubricate the outside of the pipe and/or inside of the boot if the pipe outside diameter is the same as the inside diameter of the boot
2. Insert the pipe, centering it in the boot opening
3. Position the pipe clamp in the groove of the boot with the screw at the top
4. Tighten the pipe clamp screw to 7 Newton metres
5. On minimum outside diameter installations lift the boot such that it contacts the bottom of the pipe while tightening the pipe clamp to ensure even contraction of the rubber.
6. Move the pipe horizontally and/or vertically to bring it to grade

Where Kor-n-Seal boots are not fitted, epoxy grout the inlet and outlet joints.

12.4 Frame and Cover Installation

Precast concrete adjustment units are used to set the frame and cover at the required elevation. Humes Water Solutions should be advised at the time of ordering if a precast surround is not required for the frame e.g. if asphalt is to be laid up to the frame edge.

13. Maintenance Procedures

Maintenance of the **Hume***ceptor*™ is performed using vacuum trucks. Normally no entry into the unit is required for maintenance. Costs to clean the **Hume***ceptor*™ vary based on the size of unit and transportation distances.

13.1 STC2 Units

The smaller STC2 units must be maintained through the inlet opening into the treatment chamber. This is achieved by removing the orifice plate and the drop tee using the PVC handle affixed to the drop tee. The eduction hose can then be inserted into the base of the treatment chamber to educt the captured sediment and hydrocarbons. Where sediment has accumulated and consolidated in the base due to infrequent maintenance, a water hose can be inserted into the decant pipe opening and used to jet the sediment towards the eduction hose.

13.2 STC3 to STC60 Units

The STC3 to STC60 units are maintained through the larger decant pipe openings. The eduction hose can be inserted into the base of the treatment chamber to educt the captured sediment and hydrocarbons. Where sediment has accumulated and consolidated in the base due to infrequent maintenance, a water hose can be inserted into the drop tee opening or the oil inspection pipe and used to jet the sediment towards the eduction hose.

13.3 Maintenance Costs

A typical cleaning cost (equipment and personnel) will vary based on unit location and size. Disposal costs will vary depending on land use and local government requirements. Economies of scale are expected where there are multiple units for a given location. The time taken to clean the **Hume***ceptor*™ is approximately 15 – 60 minutes, depending on the size of the unit, excluding transportation.

13.4 Maintenance Frequency

If the **Hume***ceptor*™ is sized based on the guidelines discussed in Section 10.2, annual maintenance is recommended, however, the frequency of maintenance may need to be increased or reduced based on local conditions (i.e. if the unit is filling up with sediment more quickly than projected, maintenance may be required biannually; conversely once the site has stabilised, maintenance may only be required once every two or three years).

13.5 Spills

Hume*ceptor*™ is often implemented in areas where the potential for spills is great. **Hume***ceptor*™ should be cleaned immediately after a spill occurs by a licensed liquid waste management company. The Regulatory Authority should also be notified in the event of a spill.

13.6 Disposal

Waste products collected in the **Hume***ceptor*™ should be removed by a licensed waste management company, similar to any other stormwater treatment device.

13.7 Inspection

Hume*ceptor*™ can be easily inspected from the surface by removing the maintenance cover. The presence of oil in the interceptor can be determined by inserting a dipstick in the 150 mm oil sample port. Similarly, the depth of sediment can be measured from the surface without entry into the **Hume***ceptor*™ via a sediment depth measurement device (Sludge Judge™). Maintenance should be performed once the sediment depth exceeds the guideline values provided in Table 4.

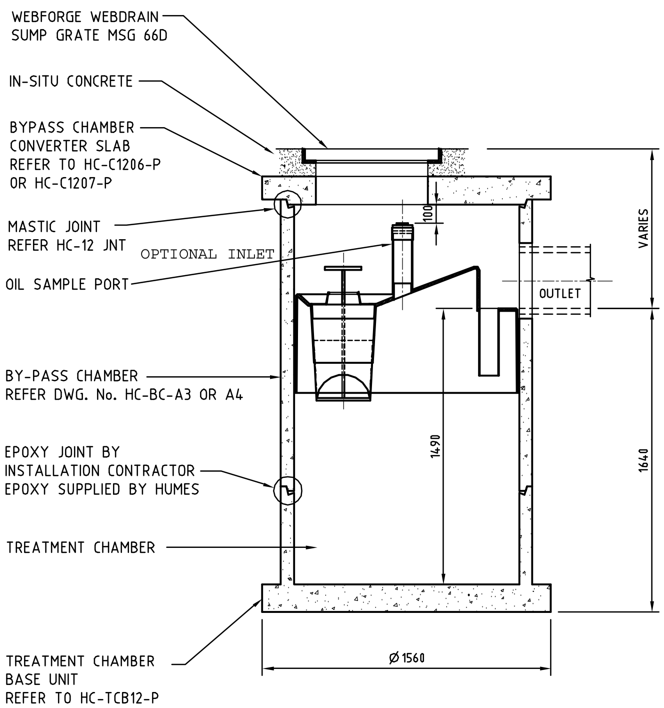
Any potential obstructions at the inlet can be observed from the surface. The insert has been designed as a platform for maintenance personnel in the event that obstructions need to be removed, stormwater flushing needs to be performed, or camera surveys are required.

Table 6. Sediment Depths Indicating Required Maintenance

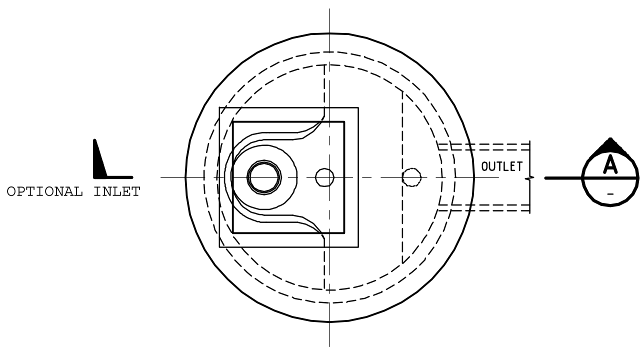
Model	Sediment Depth (mm)
STC2	200
STC3	200
STC5	225
STC7	300
STC9	300
STC14	375
STC18	300
STC23	450
STC27	375
STC40	300
STC50	450
STC60	375

Appendix 1
Hume*ceptor* TM Drawings

OCTOBER 2007



SECTION A
SCALE 1:20



PLAN
SCALE 1:20

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
0	UPDATED AND ISSUED FOR MANUFACTURE	M.Z.	23-01-03	DFW
1	GENERAL UPGRADE	RM	17-08-03	DFW

NOTES:

1. TYPICAL ASSEMBLY DETAIL ONLY - REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS
2. DIMENSIONS INCLUDED ARE STANDARD
3. STORAGE VOLUMES
   TOTAL = 1740 LITRES
   OIL STORAGE VOLUME = 350 LITRES
   SEDIMENT STORAGE VOLUME = 1.34 m3
4. COMPONENT MASSES
   TREATMENT CHAMBER BASE UNIT (INCL. SHAFT) = 1130 kg
   BYPASS CHAMBER = VARIES
   BYPASS CHAMBER CONVERTER SLAB = 575 kg
5. REFER TO BYPASS CHAMBER ASSEMBLY DRAWING FOR FIXING DETAILS FOR FIBREGLASS INSERT.
6. FOR OUTLET PIPE CONNECTION DETAILS REFER HC-BC-A3 OR A4 AND KOR-N-SEAL INSTALLATION INSTRUCTIONS
7. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS (REFER PRODUCT DRAWING)
8. JOINT SEALANT AS PER MANUFACTURERS RECOMMENDATIONS.

Humes TECHNICAL (DESIGN) SERVICES
BRISBANE, QUEENSLAND

DSN.	DFW	23-01-03
DWN.	M.Z.	23-01-03
CKD.	DFW	23-01-03
APP.	DFW	23-01-03
SUPERSEDES		

HUMECEPTOR™
STANDARD DRAWING
STC-2 HUMECEPTOR
ASSEMBLY DRAWING

PLOT SCALE	SIZE	DRG. NO.	ISSUE
1:20	A2	HC-STC2-A	1

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
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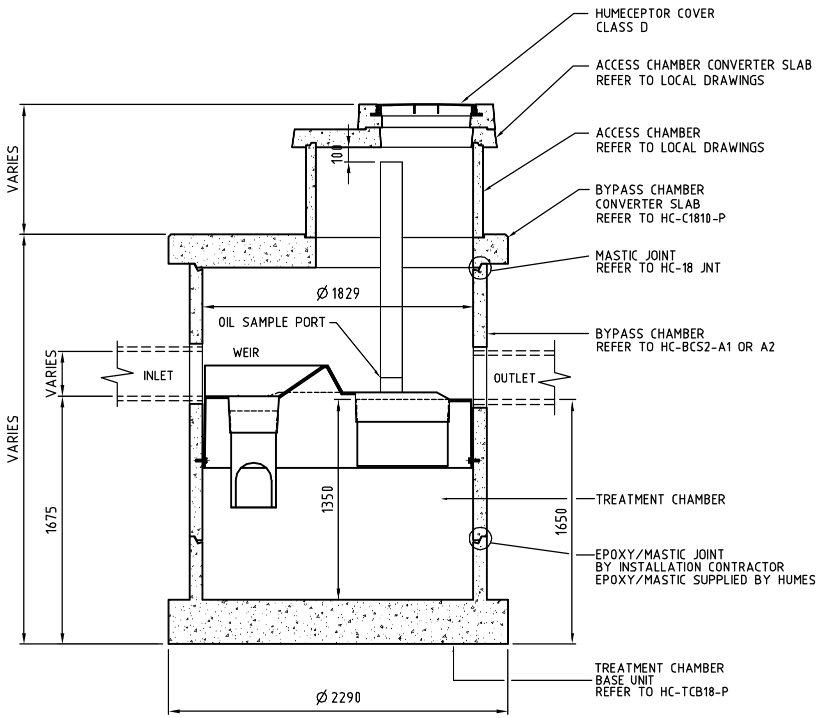
1	STORAGE VOLUMES REVISED	M.Z.	03-09-03	DFW



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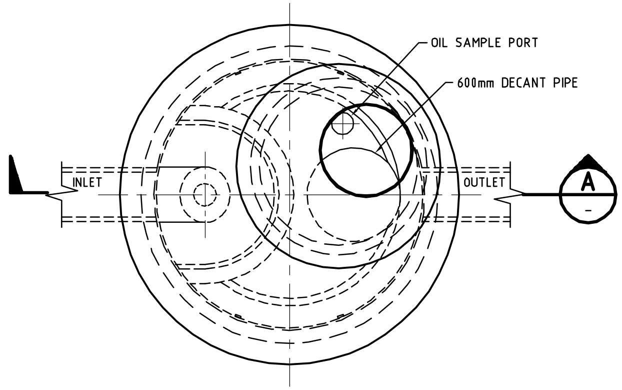
SCALE 1:25



PLAN
SCALE 1:25

NOTES:

1. TYPICAL ASSEMBLY DETAIL ONLY - REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS
2. DIMENSIONS INCLUDED ARE STANDARD
3. STORAGE VOLUMES (1)
   TOTAL = 3540 LITRES
   OIL STORAGE VOLUME = 1020 LITRES
   SEDIMENT STORAGE VOLUME = 2.20m3 (1)
4. COMPONENT MASSES
   TREATMENT CHAMBER BASE UNIT (INCL. SHAFT) = 3.9 TONNE
   BYPASS CHAMBER = VARIES
   BYPASS CHAMBER CONVERTER SLAB = 1.9 TONNE
5. REFER TO BYPASS CHAMBER ASSEMBLY DRAWING FOR FIXING DETAILS FOR FIBREGLASS INSERT.
6. BYPASS CHAMBER CONVERTER SLAB TO SUIT LOCAL ACCESS CHAMBER UNITS.
7. FOR INLET AND OUTLET PIPE CONNECTION DETAILS REFER HC-BCS2-A1 OR A2 AND KOR-N-SEAL INSTALLATION INSTRUCTIONS
8. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS (REFER PRODUCT DRAWING)
9. NOTE MARKINGS - INLET & OUTLET OVER EACH
10. JOINT SEALANT AS PER MANUFACTURERS RECOMMENDATIONS.
11. OIL SAMPLE PORT AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.

Humes
TECHNICAL (DESIGN) SERVICES
BRISBANE, QUEENSLAND

Readymix Holdings Pty Limited ABN 87 099 732 297

DSN.	DFW	28-01-03
DWN.	M.Z.	28-01-03
CKD.	DFW	07-08-03
APP.	DFW	07-08-03
SUPERSEDES		

H U M E C E P T O R™
STANDARD DRAWING
STC-3 HUMECEPTOR
ASSEMBLY DRAWING

PLOT SCALE	SIZE	DRG. NO.	ISSUE
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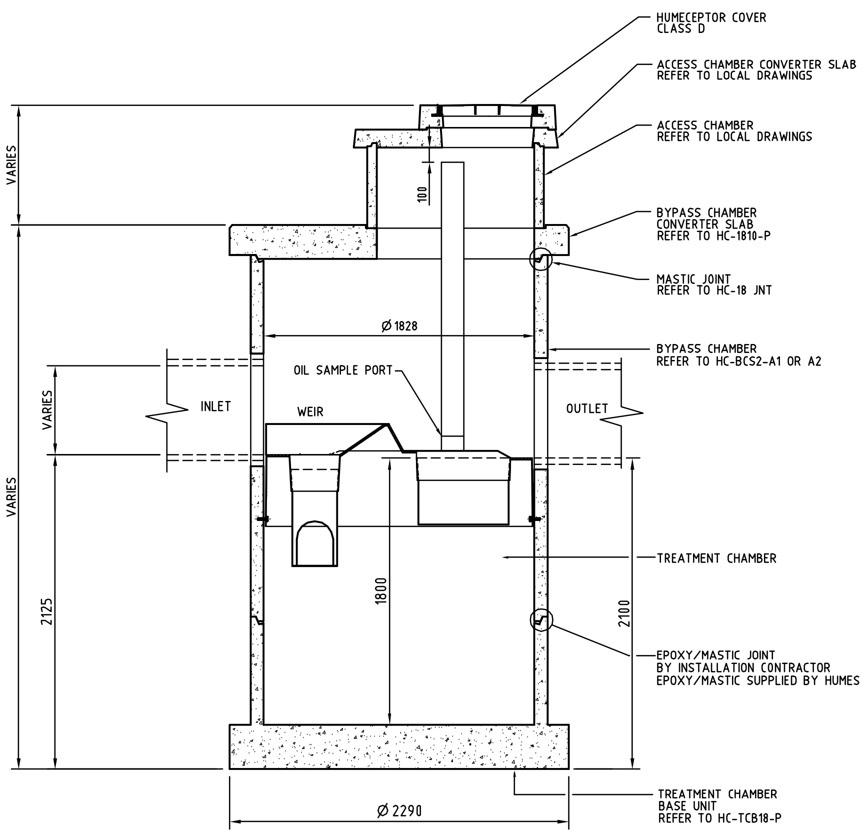

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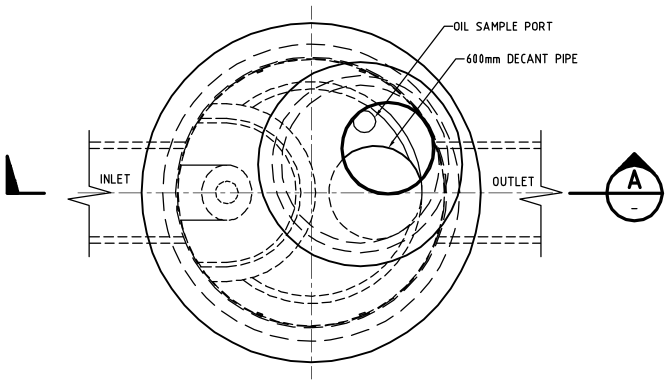
SCALE 1:25



PLAN
SCALE 1:25

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
0	UPDATED AND ISSUED FOR MANUFACTURE	M.Z.	03-09-03	DFW

NOTES:

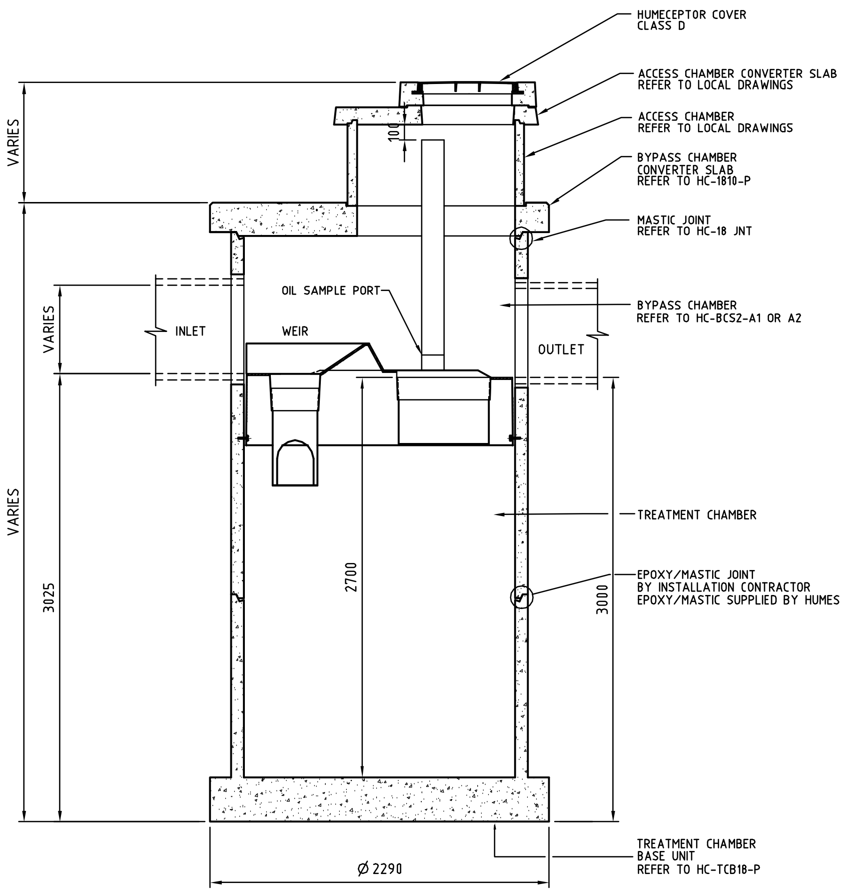
1. TYPICAL ASSEMBLY DETAIL ONLY - REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS
2. DIMENSIONS INCLUDED ARE STANDARD
3. STORAGE VOLUMES
   TOTAL = 4720 LITRES
   OIL STORAGE VOLUME = 1020 LITRES
   SEDIMENT STORAGE VOLUME = 3.38m3
4. COMPONENT MASSES
   TREATMENT CHAMBER BASE UNIT (INCL. SHAFT) = 4.4 TONNE
   BYPASS CHAMBER = VARIES
   BYPASS CHAMBER CONVERTER SLAB = 1.9 TONNE
5. REFER TO BYPASS CHAMBER ASSEMBLY DRAWING FOR FIXING DETAILS FOR FIBREGLASS INSERT.
6. BYPASS CHAMBER CONVERTER SLAB TO SUIT LOCAL ACCESS CHAMBER UNITS.
7. FOR INLET AND OUTLET PIPE CONNECTION DETAILS REFER HC-BCS2-A1 OR A2 AND KOR-N-SEAL INSTALLATION INSTRUCTIONS
8. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS (REFER PRODUCT DRAWING)
9. NOTE MARKINGS - INLET & OUTLET OVER EACH
10. JOINT SEALANT AS PER MANUFACTURERS RECOMMENDATIONS.
11. OIL SAMPLE PORT AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.

Humes TECHNICAL (DESIGN) SERVICES BRISBANE, QUEENSLAND

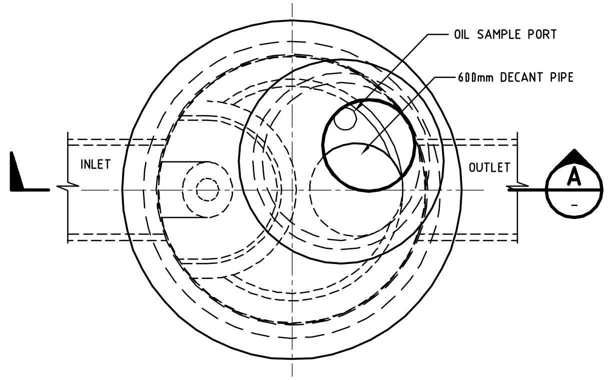
DSN.	DFW	28-01-03
DWN.	M.Z.	28-01-03
CKD.	DFW	03-09-03
APP.	DFW	03-09-03
SUPERSEDES		

HUMECEPTOR™
STANDARD DRAWING
STC-5 HUMECEPTOR
ASSEMBLY DRAWING

PLOT SCALE	SIZE	DRG. NO.	ISSUE
1:25	A2	HC-STC5-A	0



SECTION A
SCALE 1:25



PLAN
SCALE 1:25

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
0	UPDATED AND ISSUED FOR MANUFACTURE	M.Z.	03-09-03	DFW

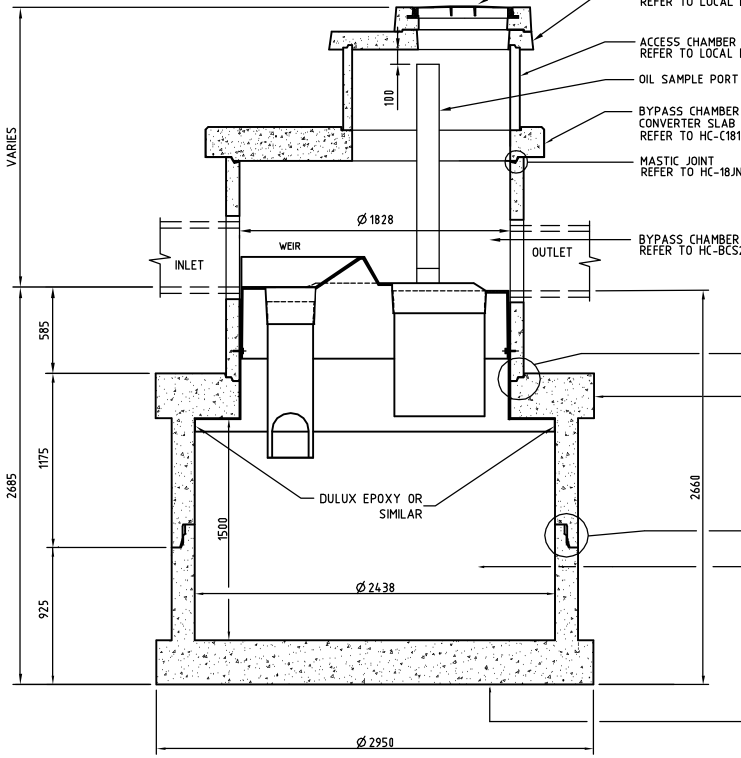
NOTES:

1. TYPICAL ASSEMBLY DETAIL ONLY - REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS
2. DIMENSIONS INCLUDED ARE STANDARD
3. STORAGE VOLUMES
   TOTAL = 7080 LITRES
   OIL STORAGE VOLUME = 1020 LITRES
   SEDIMENT STORAGE VOLUME = 5.74m3
4. COMPONENT MASSES
   TREATMENT CHAMBER BASE UNIT (INCL. SHAFT) = 5.1 TONNE
   BYPASS CHAMBER = VARIES
   BYPASS CHAMBER CONVERTER SLAB = 1.9 TONNE
5. REFER TO BYPASS CHAMBER ASSEMBLY DRAWING FOR FIXING DETAILS FOR FIBREGLASS INSERT.
6. BYPASS CHAMBER CONVERTER SLAB TO SUIT LOCAL ACCESS CHAMBER UNITS.
7. FOR INLET AND OUTLET PIPE CONNECTION DETAILS REFER HC-BCS2-A1 OR A2 AND KOR-N-SEAL INSTALLATION INSTRUCTIONS
8. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS (REFER PRODUCT DRAWING)
9. NOTE MARKINGS - INLET & OUTLET OVER EACH
10. JOINT SEALANT AS PER MANUFACTURERS RECOMMENDATIONS.
11. OIL SAMPLE PORT AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.

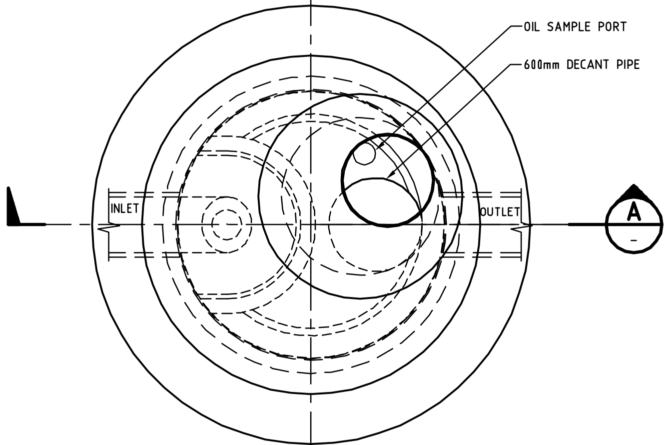
Humes™ TECHNICAL (DESIGN) SERVICES
BRISBANE, QUEENSLAND

DSN.	DFW	28-01-03	HUMECEPTOR™ STANDARD DRAWING
DWN.	M.Z.	28-01-03	**STC-7 HUMECEPTOR**
CKD.	DFW	03-09-03	ASSEMBLY DRAWING
APP.	DFW	03-09-03	
SUPERSEDES			PLOT SCALE 1:25 · SIZE A2 · DRG. NO. HC-STC7-A · ISSUE 0

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
0	UPDATED AND ISSUED FOR MANUFACTURE	M.Z.	03-09-03	DFW



SECTION A
SCALE 1:25



PLAN
SCALE 1:10

NOTES:

1. TYPICAL ASSEMBLY DETAIL ONLY - REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS
2. DIMENSIONS INCLUDED ARE STANDARD
3. STORAGE VOLUMES
   TOTAL = 9260 LITRES
   OIL STORAGE VOLUME = 1900 LITRES
   OIL SEDIMENT STORAGE VOLUME = 6.81 m3
4. COMPONENT MASSES
   TREATMENT CHAMBER BASE UNIT (INCL. SHAFT) = 7.7 TONNE
   TREATMENT CHAMBER TOP UNIT (CONV. SLAB + SHAFT) = 6.0 TONNE
   BYPASS CHAMBER = VARIES
5. REFER TO BYPASS CHAMBER ASSEMBLY DRAWING FOR FIXING DETAILS FOR FIBREGLASS INSERT.
6. BYPASS CHAMBER CONVERTER SLAB TO SUIT LOCAL ACCESS CHAMBER UNITS.
7. FOR INLET AND OUTLET PIPE CONNECTION DETAILS REFER HC-BCS2-A1 or A2 AND KOR-N-SEAL INSTALLATION INSTRUCTIONS.
8. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS. (REFER PRODUCT DRAWING)
9. NOTE MARKINGS - INLET AND OUTLET OVER EACH.
10. JOINT SEALANT AS PER MANUFACTURERS RECOMMENDATIONS.
11. OIL SAMPLE PORT AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.

RUBBER RING JOINT SPECIFICATION	
MATERIAL	: NITRILE
HARDNESS:	: 43 ± 3 IRHD (AS 1646)
PROFILE	: L25 (REFER Dwg. J1001-01)
ID	: 2225 ± 16mm

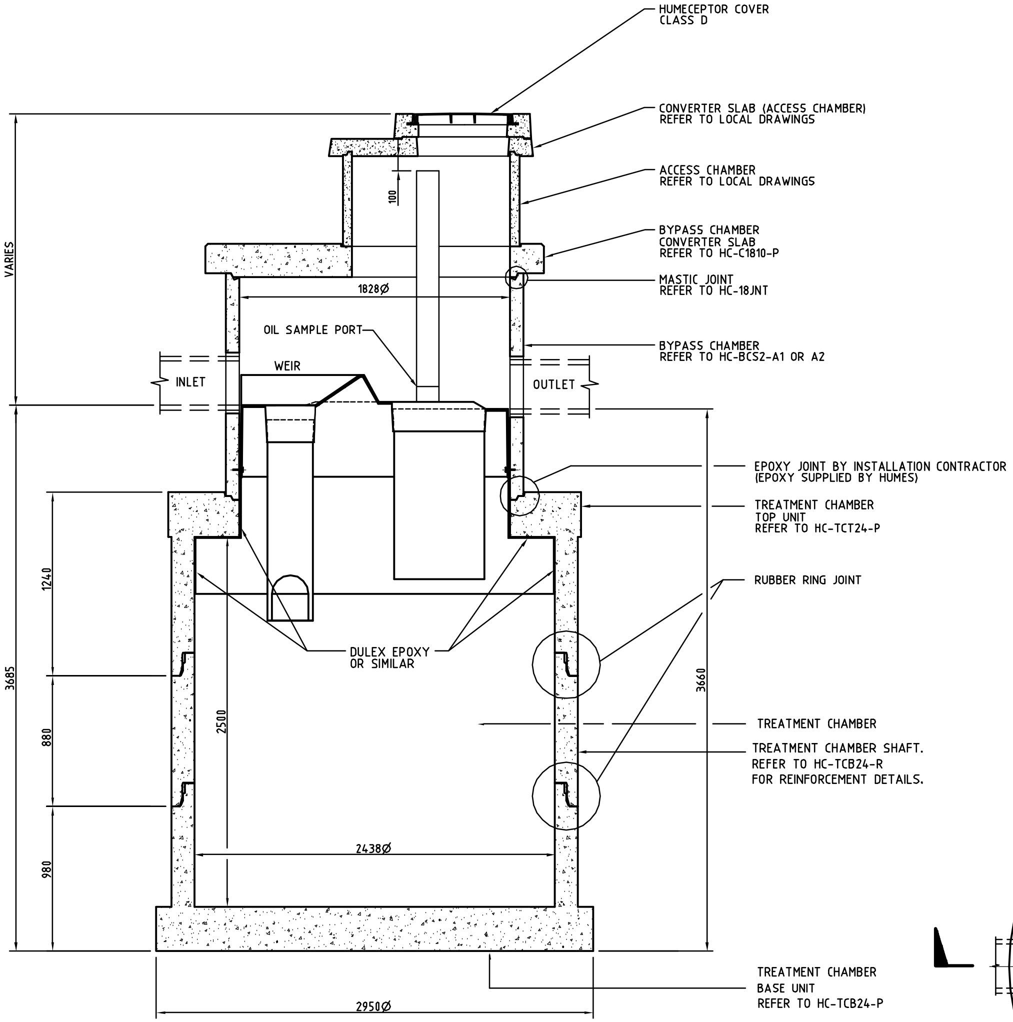
Humes TECHNICAL (DESIGN) SERVICES
BRISBANE, QUEENSLAND

DSN.	DFW	28-01-03
DWN.	M.Z.	28-01-03
CKD.	DFW	03-09-03
APP.	DFW	03-09-03
SUPERSEDES		

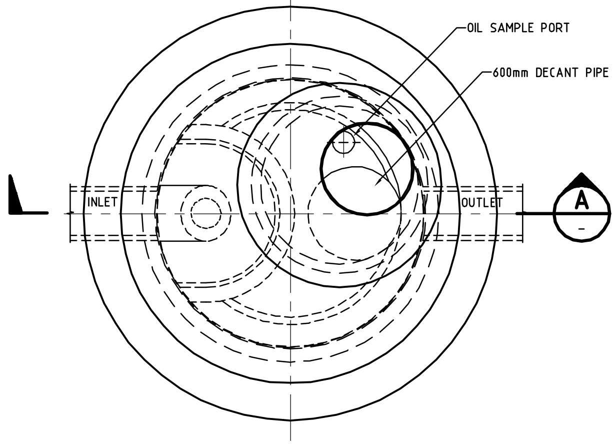
HUMECEPTOR™
STANDARD DRAWING
STC-9 HUMECEPTOR
ASSEMBLY DRAWING

PLOT SCALE	SIZE	DRG. NO.	ISSUE
1:25	A2	HC-STC-9-A	0

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
0	UPDATED AND ISSUED FOR MANUFACTURE	M.Z.	03-09-03	DFW



SECTION (A)
SCALE 1:25



PLAN
SCALE 1:25

NOTES:

1. TYPICAL ASSEMBLY DETAIL ONLY - REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS
2. DIMENSIONS INCLUDED ARE STANDARD
3. STORAGE VOLUMES
   TOTAL = 13920 LITRES
   OIL STORAGE VOLUME = 2980 LITRES
   SEDIMENT STORAGE VOLUME = 10.27 m3
4. COMPONENT MASSES
   TREATMENT CHAMBER BASE UNIT (INCL. SHAFT) = 7.9 TONNE
   TREATMENT CHAMBER TOP UNIT (CONV. SLAB + SHAFT) = 6.1 TONNE
   BYPASS CHAMBER = VARIES
   TREATMENT CHAMBER SHAFT = 2.8 TONNE
5. REFER TO BYPASS CHAMBER ASSEMBLY DRAWING FOR FIXING DETAILS FOR FIBREGLASS INSERT.
6. BYPASS CHAMBER CONVERTER SLAB TO SUIT LOCAL ACCESS CHAMBER UNITS.
7. FOR INLET AND OUTLET PIPE CONNECTION DETAILS REFER HC-BCS2-A1 OR A2 AND KOR-N-SEAL INSTALLATION INSTRUCTIONS
8. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS (REFER PRODUCT DRAWINGS)
9. NOTE MARKINGS - INLET AND OUTLET OVER EACH.
10. JOINT SEALANT AS PER MANUFACTURERS RECOMMENDATIONS.
11. OIL SAMPLE PORT AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.

RUBBER RING JOINT SPECIFICATION

MATERIAL : NITRILE
HARDNESS : 43 ± 3 IRHD (AS1646)
PROFILE : L25 (REFER Dwg. J1001-01)
ID : 2225 ± 16mm

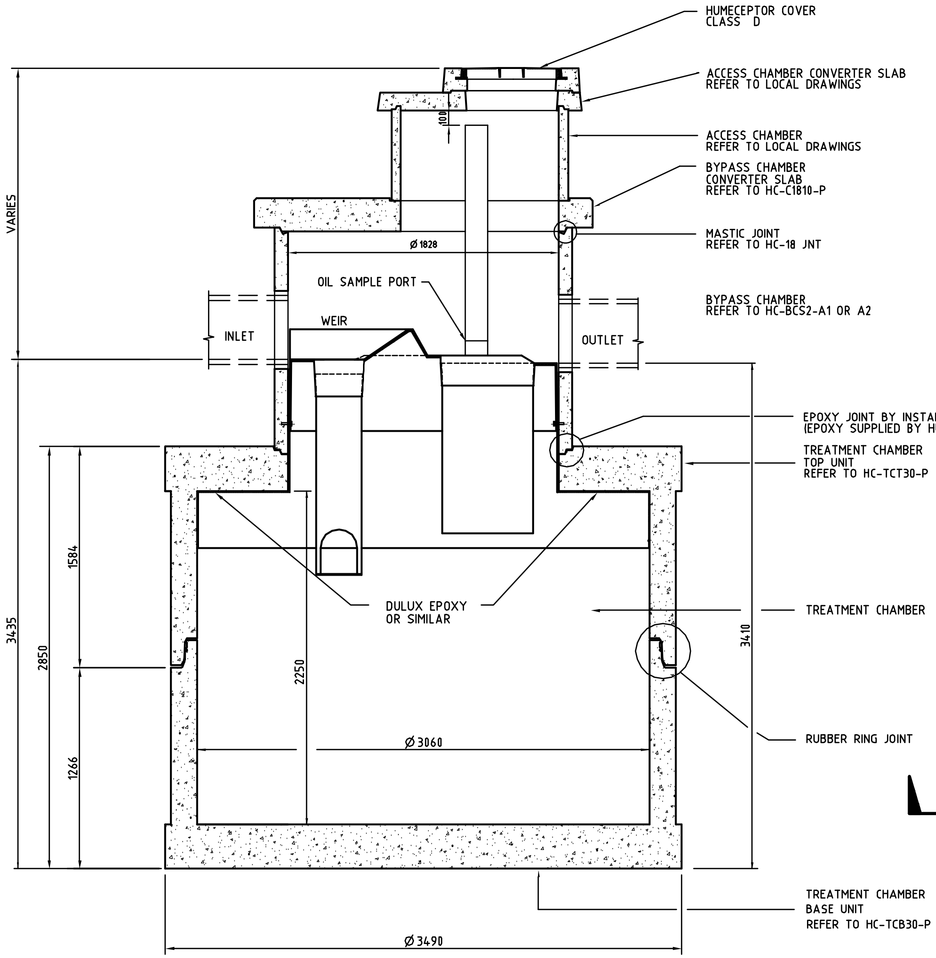
Humes TECHNICAL (DESIGN) SERVICES BRISBANE, QUEENSLAND

HUMECEPTOR™
STANDARD DRAWING
STC-14 HUMECEPTOR
ASSEMBLY DRAWING

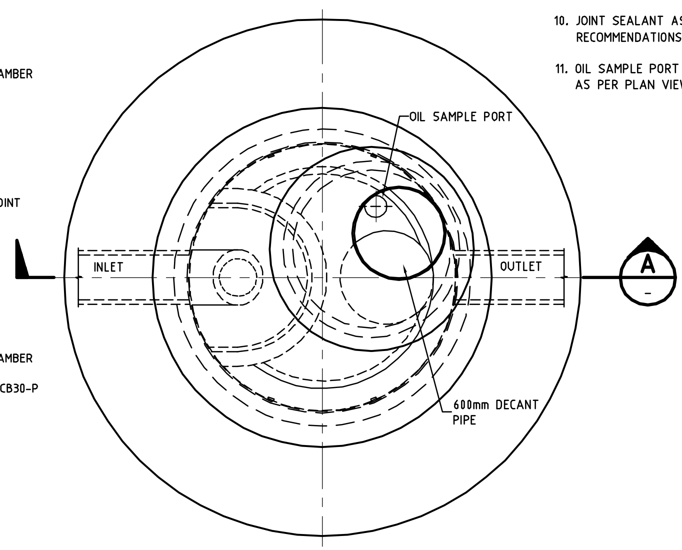
DSN.	DFW	28-01-03
DWN.	M.Z.	28-01-03
CKD.	DFW	03-09-03
APP.	DFW	03-09-03

SUPERSEDES	PLOT SCALE	SIZE	DRG. NO.	ISSUE
	1:25	A2	HC-STC14-A	0

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
0	UPDATED AND ISSUED FOR MANUFACTURE	M.Z.	03-09-03	DFW



SECTION (A)
SCALE 1:25



PLAN
SCALE 1:25

NOTES:

1. TYPICAL ASSEMBLY DETAIL ONLY - REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS
2. DIMENSIONS INCLUDED ARE STANDARD
3. STORAGE VOLUMES
   TOTAL = 18790 LITRES
   OIL STORAGE VOLUME = 2980 LITRES
   SEDIMENT STORAGE VOLUME = 14.04 m3
4. COMPONENT MASSES
   TREATMENT CHAMBER BASE UNIT (INCL.SHAFT) = 12.1 TONNE
   TREATMENT CHAMBER TOP UNIT (CONV. SLAB + SHAFT) = 11.2 TONNE
   BYPASS CHAMBER = VARIES
5. REFER TO BYPASS CHAMBER ASSEMBLY DRAWING FOR FIXING DETAILS FOR FIBREGLASS INSERT.
6. BYPASS CHAMBER CONVERTER SLAB TO SUIT LOCAL ACCESS CHAMBER UNITS.
7. FOR INLET AND OUTLET PIPE CONNECTION DETAILS REFER HC-BCS2-A1 OR A2 AND KOR-N-SEAL INSTALLATION INSTRUCTIONS
8. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS (REFER PRODUCT DRAWINGS)
9. NOTE MARKINGS - INLET AND OUTLET OVER EACH.
10. JOINT SEALANT AS PER MANUFACTURERS RECOMMENDATIONS.
11. OIL SAMPLE PORT AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.

RUBBER RING SPECIFICATION

MATERIAL	: NITRILE
HARDNESS	: 43 ± 3 IRHD (AS1646)
PROFILE	: L25 (REFER Dwg. J1001-01)
ID	: 2775 ± 16mm

Humes TECHNICAL (DESIGN) SERVICES BRISBANE, QUEENSLAND

DSN.	DFW	28-01-03
DWN.	M.Z.	28-01-03
CKD.	DFW	03-09-03
APP.	DFW	03-09-03

HUMECEPTOR™
STANDARD DRAWING
STC-18 HUMECEPTOR
ASSEMBLY DRAWING

SUPERSEDES	PLOT SCALE	SIZE	DRG. NO.	ISSUE
	1:25	A2	HC-STC18-A	0

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
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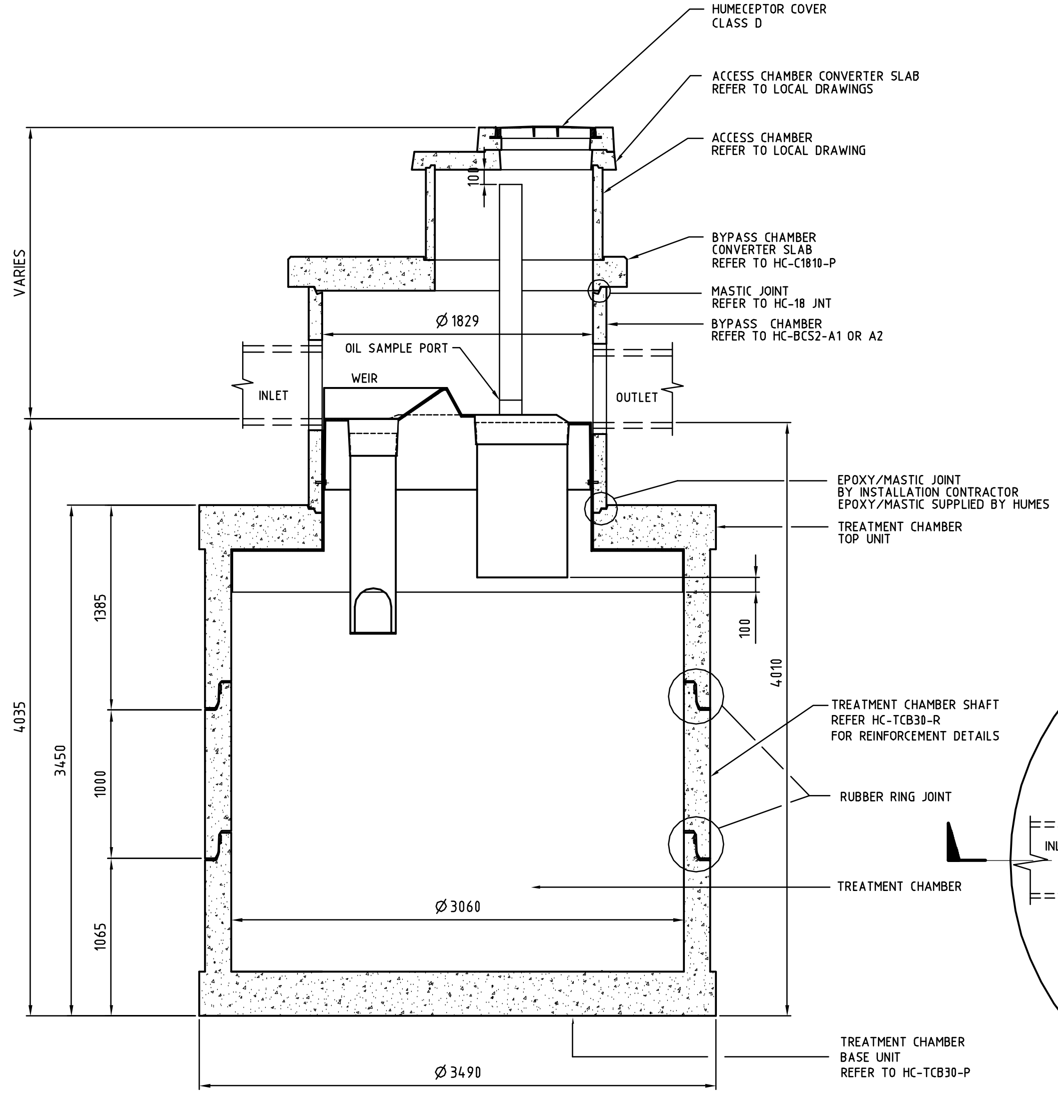
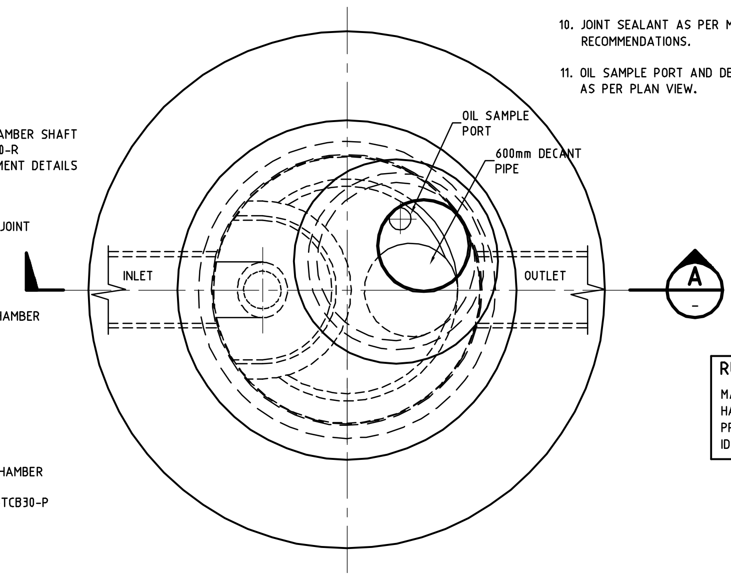


SECTION (A)
SCALE 1:25



PLAN
SCALE 1:25

NOTES:

1. TYPICAL ASSEMBLY DETAIL ONLY - REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS
2. DIMENSIONS INCLUDED ARE STANDARD
3. STORAGE VOLUMES
   TOTAL = 23200 LITRES
   OIL STORAGE VOLUME = 2980 LITRES
   SEDIMENT STORAGE VOLUME = 18.45 m3
4. COMPONENT MASSES
   TREATMENT CHAMBER BASE UNIT (INCL. SHAFT) = 11.2 TONNE
   TREATMENT CHAMBER TOP UNIT (CONV. SLAB + SHAFT) = 10.1 TONNE
   BYPASS CHAMBER = VARIES
   TREATMENT CHAMBER SHAFT = 4.6 TONNES
5. REFER TO BYPASS CHAMBER ASSEMBLY DRAWING FOR FIXING DETAILS FOR FIBREGLASS INSERT.
6. BYPASS CHAMBER CONVERTER SLAB TO SUIT LOCAL ACCESS CHAMBER UNITS.
7. FOR INLET AND OUTLET PIPE CONNECTION DETAILS REFER HC-BCS2-A1 OR A2 AND KOR-N-SEAL INSTALLATION INSTRUCTIONS.
8. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS (REFER PRODUCT DRAWINGS)
9. NOTE MARKINGS - INLET AND OUTLET OVER EACH.
10. JOINT SEALANT AS PER MANUFACTURERS RECOMMENDATIONS.
11. OIL SAMPLE PORT AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.

RUBBER RING SPECIFICATION	
MATERIAL	: NITRILE
HARDNESS	: 43 ± 3 IRHD (AS1646)
PROFILE	: L25
ID	: 2775 ± 16mm

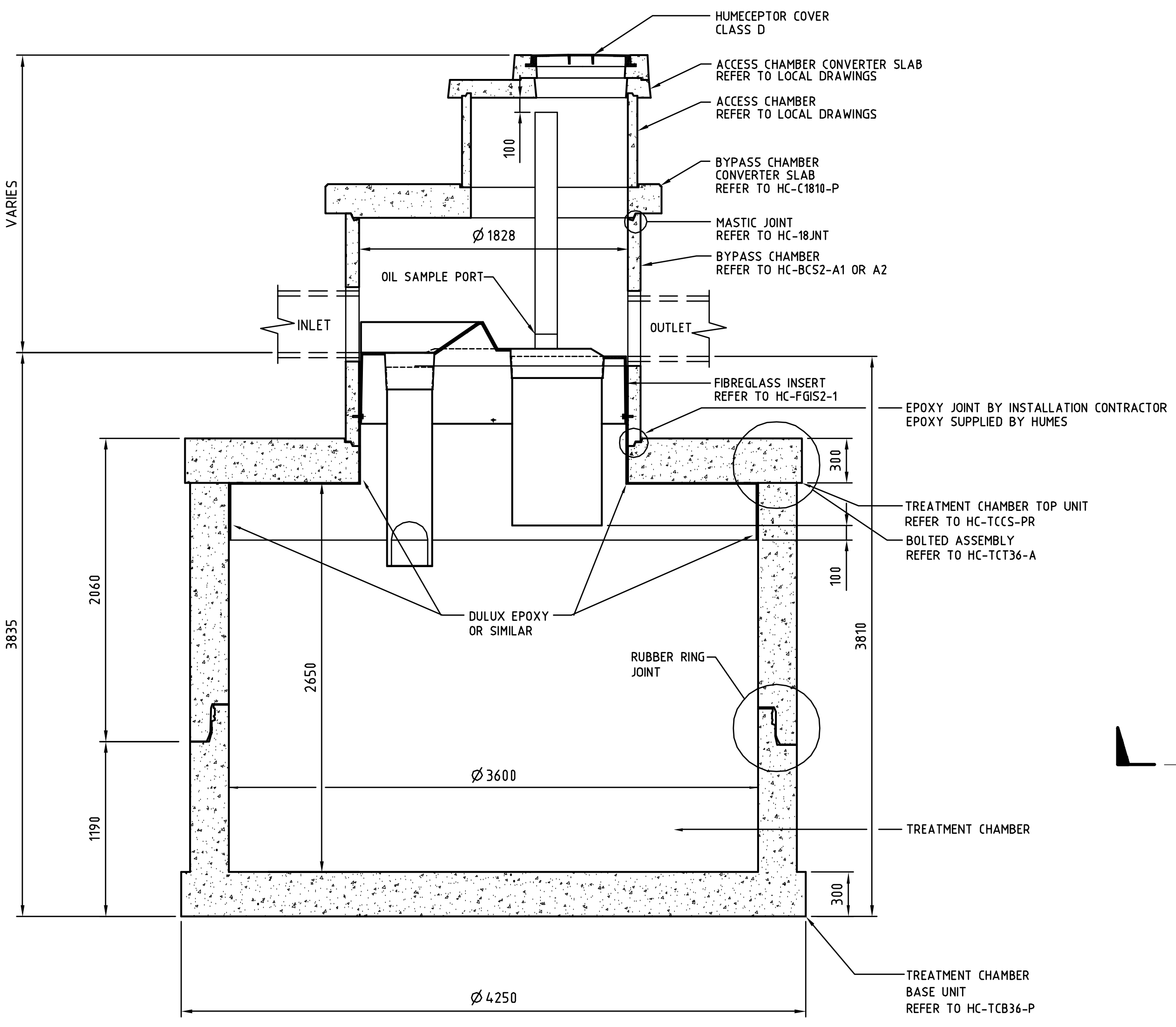
Humes TECHNICAL (DESIGN) SERVICES
BRISBANE, QUEENSLAND

DSN.	DFW	28-01-03
DWN.	M.Z.	28-01-03
CKD.	DFW	03-09-03
APP.	DFW	03-09-03

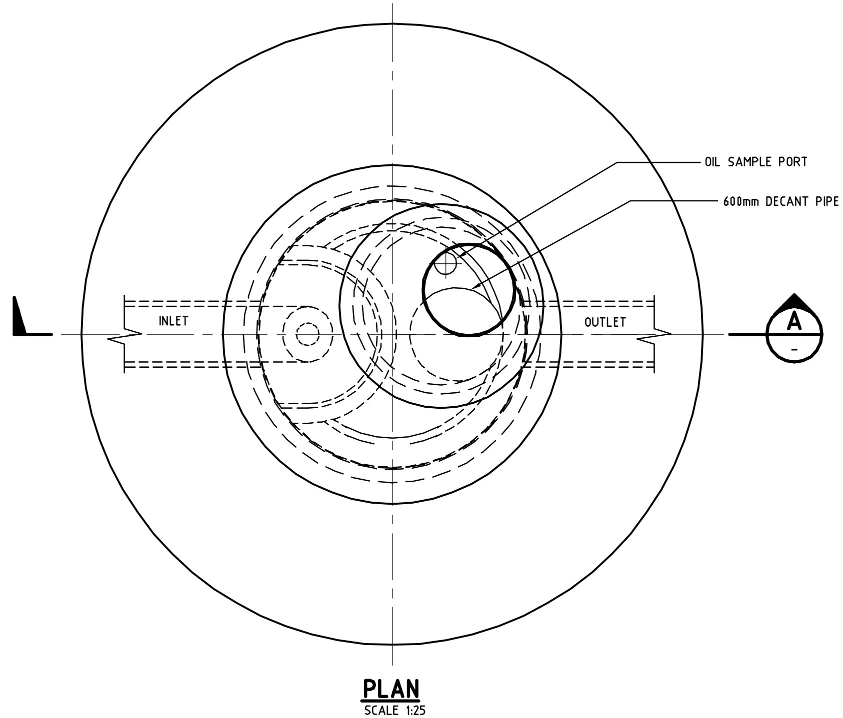
HUMECEPTOR™
STANDARD DRAWINGS
STC-23 HUMECEPTOR
ASSEMBLY DRAWING

SUPERSEDES	PLOT SCALE	SIZE	DRG. NO.	ISSUE
	1:25	A2	HC-STC23-A	0

ISSUE	DETAILS OF ALTERATIONS	DWN	DATE	CKD
0	UPDATED AND REISSUED FOR MANUFACTURE	RM	22-04-04	DFW



SECTION A
SCALE 1:25



PLAN
SCALE 1:25

NOTES:

1. TYPICAL ASSEMBLY DETAIL ONLY - REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS.
2. DIMENSIONS INCLUDED ARE STANDARD.
3. STORAGE VOLUMES TOTAL = 29220 LITRES OIL
   STORAGE VOLUME = 4290 LITRES
   SEDIMENT STORAGE VOLUME = 23.50 m3
4. COMPONENT MASSES TREATMENT CHAMBER BASE UNIT (INCL. SHAFT) = 18.3 t
   TREATMENT CHAMBER TOP UNIT (CONV. SLAB + SHAFT) = 23.2 t
5. BYPASS CHAMBER = VARIES REFER TO BYPASS CHAMBER ASSEMBLY DRAWING FOR FIXING DETAILS FOR FIBREGLASS INSERT.
6. BYPASS CHAMBER CONVERTER SLAB TO SUIT LOCAL ACCESS CHAMBER UNITS.
7. FOR INLET AND OUTLET PIPE CONNECTION DETAILS REFER HC-BCS2-A1 OR A2 AND KOR- N-SEAL INSTALLATION INSTRUCTIONS.
8. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS (REFER PRODUCT DRAWINGS)
9. NOTE MARKINGS - INLET AND OUTLET OVER EACH.
10. JOINT SEALANT AS PER MANUFACTURERS RECOMMENDATIONS.
11. VENT PIPE AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.

IMPORTANT INSTALLATION INFORMATION

1. FOUNDATION REQUIREMENTS - MIN. ALLOWABLE BEARING CAPACITY REQUIRED 200 kPa
2. UNIT TO BE PLACED ON 150mm THICK BED ZONE MATERIAL IN ACCORDANCE WITH AS3725 REQUIREMENTS
3. TREATMENT CHAMBER SHOULD BE FILLED WITH WATER TO 2/3 DEPTH IMMEDIATELY AFTER INSTALLATION (UNIT MAY FLOAT PRIOR TO BACKFILLING)

RUBBER RING JOINT SPECIFICATION

MATERIAL	: NITRILE
HARDNESS	: 43 (± 3) IRHD (AS1646)
PROFILE	: L 38 (REFER Dwg. J1002-01)
ID	: 3400 ± 16mm

Humes TECHNICAL (DESIGN) SERVICES BRISBANE, QUEENSLAND

DSN.	DFW	19-04-04
DWN.	RM	19-04-04
CKD.	DFW	19-04-04
APP.	DFW	19-04-04
SUPERSEDES		

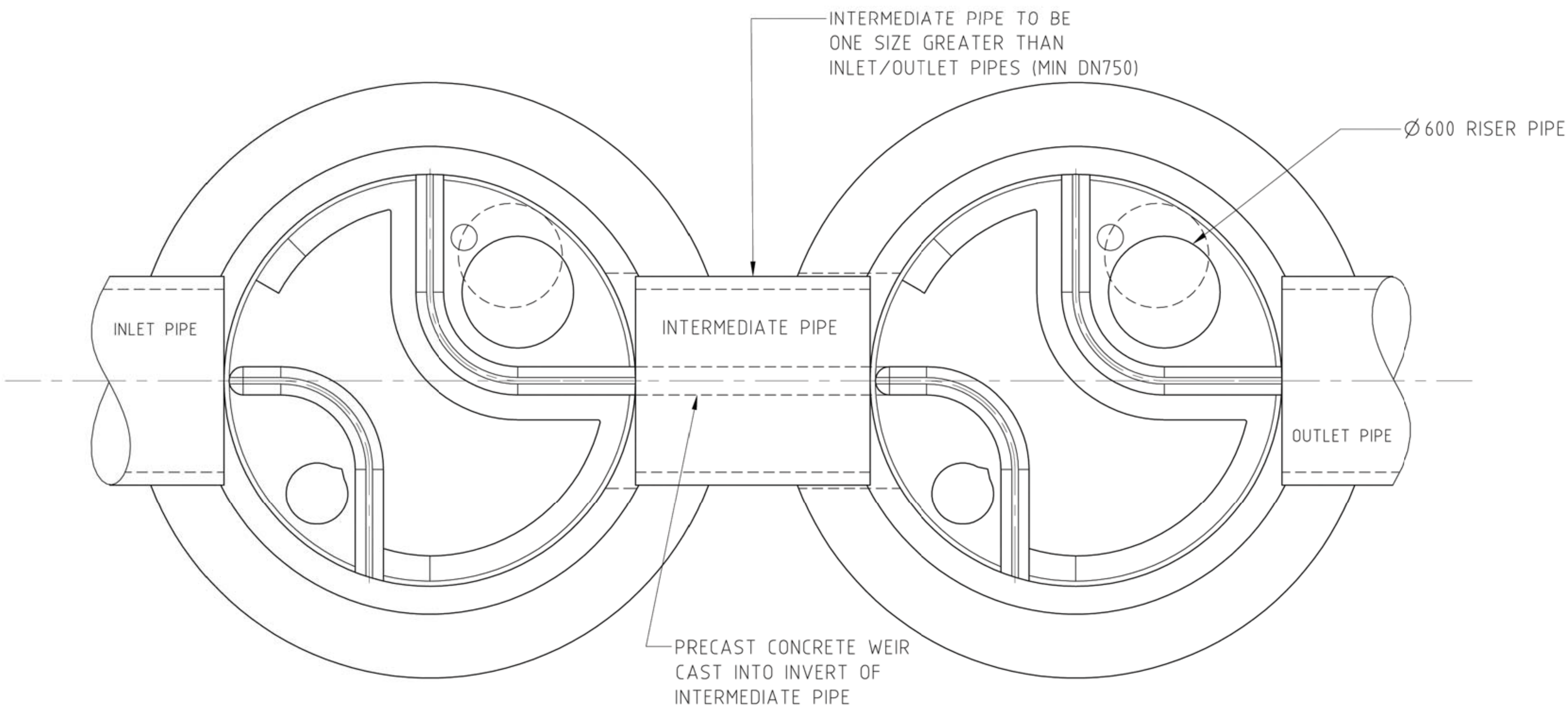
HUMECEPTOR™
STANDARD DRAWING
STC-27 HUMECEPTOR
ASSEMBLY DRAWING

PLOT SCALE	SIZE	DRG. NO.	ISSUE
1:25	A2	HC-STC27-A	0

Appendix 2
Duo*ceptor* ™ Drawings

OCTOBER 2007

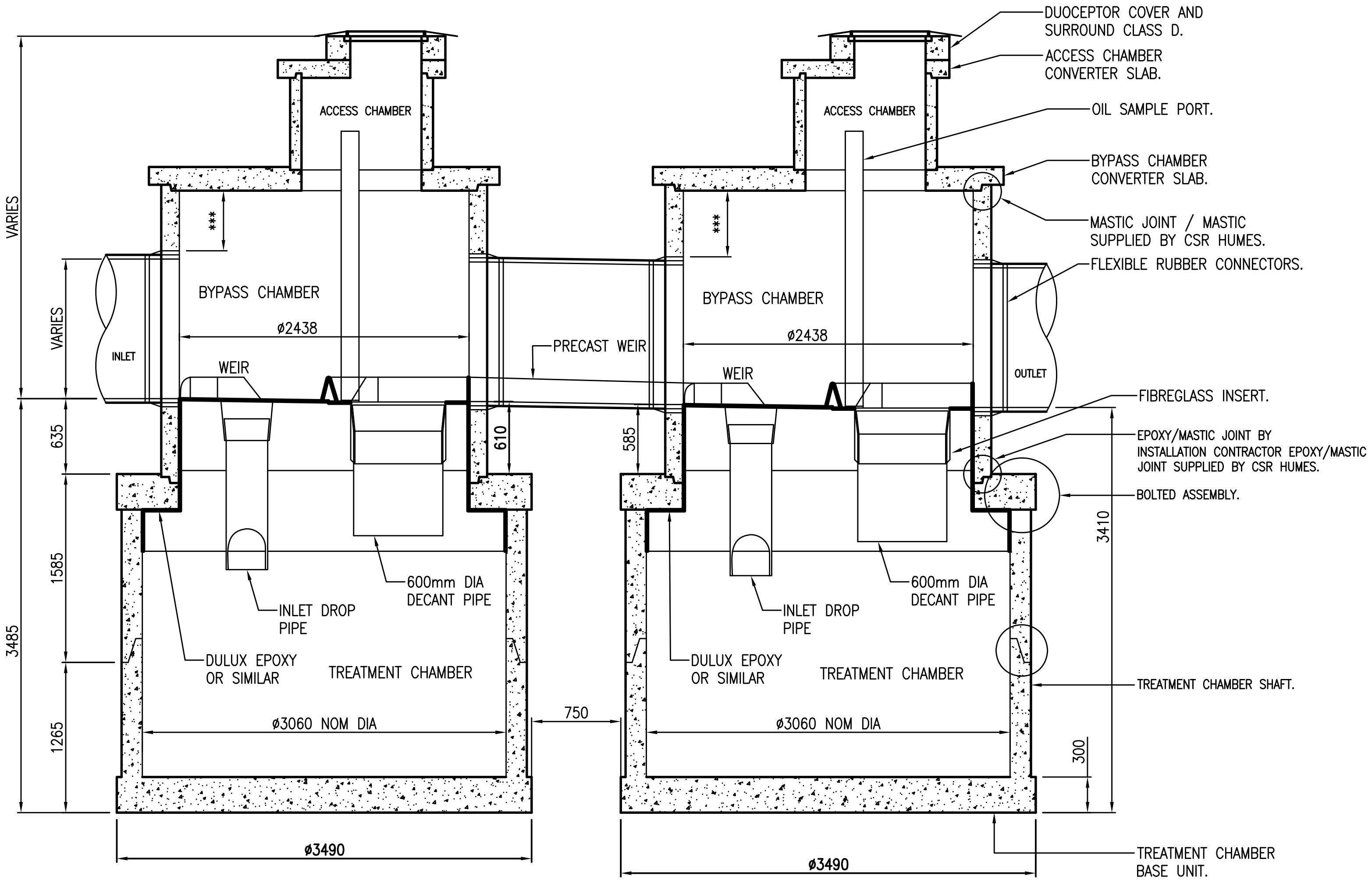
Humes
WATER SOLUTIONS



Duoceptor STC40 Model - General Assembly

PLAN

SCALE 1:25



FOR INFORMATION

*150 MIN FOR INLET /OUTLET PIPE < 675 DIA
*300 MIN FOR INLET /OUTLET PIPE > 750 DIA

1. TYPICAL ASSEMBLY DETAIL ONLY – REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS.
2. DIMENSIONS INCLUDED ARE STANDARD.
3. STORAGE VOLUMES
   TOTAL = 42,370 LITRES
   OIL STORAGE VOLUME = 10,585 LITRES
   SEDIMENT STORAGE VOLUME = 27 m3
4. COMPONENT MASSES
   TREATMENT CHAMBER BASS UNIT (INC. SHAFT) = 11.92 TONNE
   TREATMENT CHAMBER TOP UNIT (CONV. SLAB AND SHAFT) = 8.95 TONNE
   BYPASS CHAMBER = 9.74 TONNE
5. REFER TO INSTALLATION GUIDE FOR RECOMMENDED INSTALLATION PROCEDURE.
6. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS THE FOLLOWING SWIFTLIFT KNUCKLES WILL BE REQUIRED:
   6 x 1.3 TONNES
   8 x 2.5 TONNES
   8 x 10.0 TONNES
7. OIL SAMPLE PORT, STEP IRONS AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.
8. THE ABOVE WEIGHTS ARE ONLY APPROXIMATIONS OF THE ACTUAL FINAL WEIGHTS OF COMPONENTS AND ARE NOT TO BE USED.

NOT FOR CONSTRUCTION

Humes™ WATER SOLUTIONS

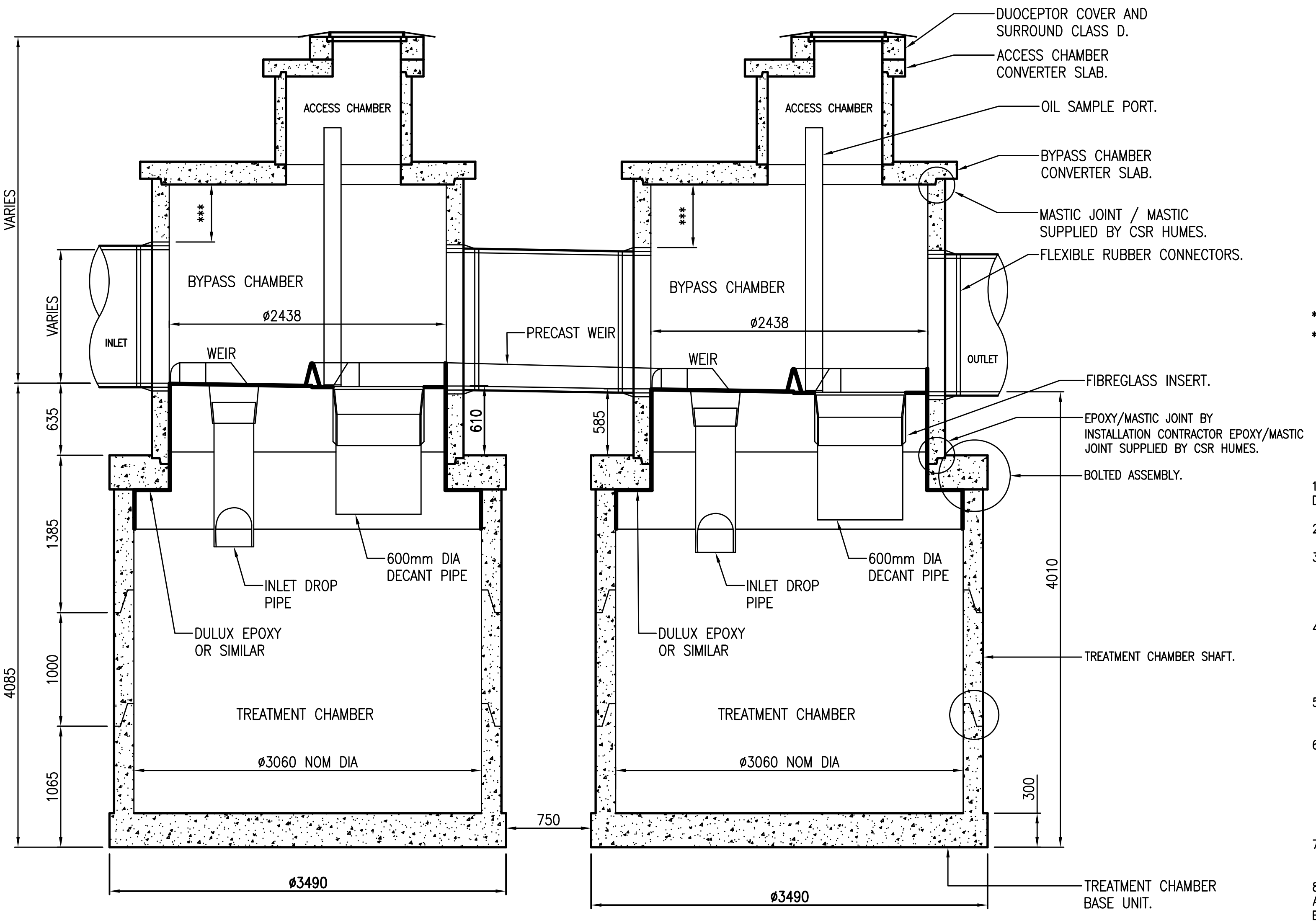
CLIENT:	N/A
CLIENT NAME:	

ISSUE	REVISION	INITIAL	DATE
A	ISSUE FOR CLIENT INFORMATION	JCM	25/10/07

JOB NAME: DUOCEPTOR STC40

JOB NO. N/A

DRAWING TITTLE:	GENERAL ARRANGEMENT				
DRAWING NO.	BIS-DUO-003				
DESIGNED BY:	–		MODEL:	STC60	
DRAWN BY:	JCM	25/10/07	SCALE:	1:40	
CHECKED BY:	CK	25/10/07	SIZE:	A3	REV. A



FOR INFORMATION

*150 MIN FOR INLET /OUTLET PIPE < 675 DIA

*300 MIN FOR INLET /OUTLET PIPE > 750 DIA

1. TYPICAL ASSEMBLY DETAIL ONLY – REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS.

2. DIMENSIONS INCLUDED ARE STANDARD.

3. STORAGE VOLUMES
   TOTAL = 50,525 LITRES
   OIL STORAGE VOLUME = 10,585 LITRES
   SEDIMENT STORAGE VOLUME = 35 m3

4. COMPONENT MASSES
   TREATMENT CHAMBER BASS UNIT (INC. SHAFT) = 11.02 TONNE
   TREATMENT CHAMBER TOP UNIT (CONV. SLAB AND SHAFT) = 12.50 TONNE
   BYPASS CHAMBER = 9.74 TONNE

5. REFER TO INSTALLATION GUIDE FOR RECOMMENDED INSTALLATION PROCEDURE.

6. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS THE FOLLOWING SWIFTLIFT KNUCKLES WILL BE REQUIRED:
   6 x 1.3 TONNES
   8 x 2.5 TONNES
   8 x 10.0 TONNES

7. OIL SAMPLE PORT, STEP IRONS AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.

8. THE ABOVE WEIGHTS ARE ONLY APPROXIMATIONS OF THE ACTUAL FINAL WEIGHTS OF COMPONENTS AND ARE NOT TO BE USED.

NOT FOR CONSTRUCTION

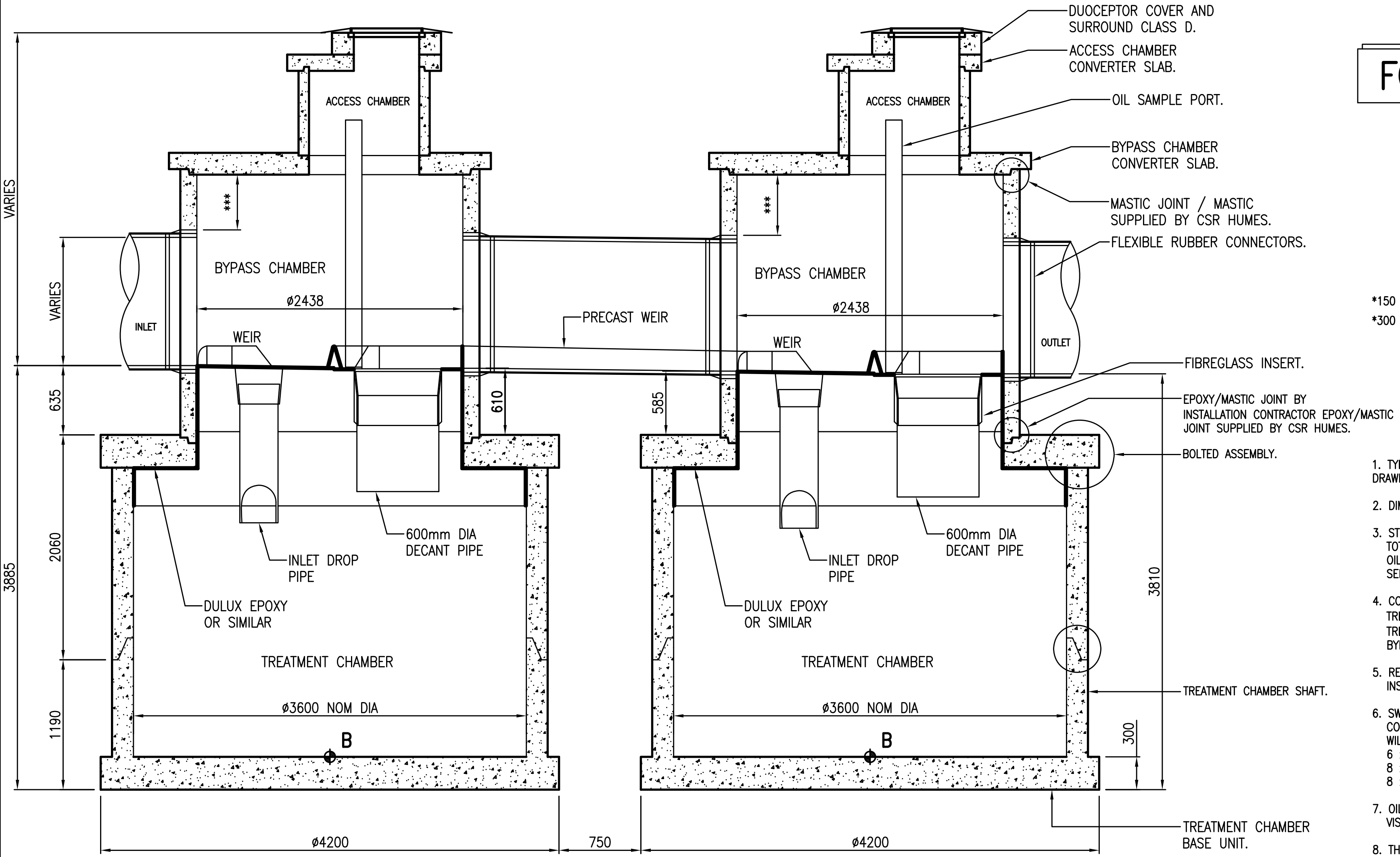
Humes™ WATER SOLUTIONS

CLIENT: N/A			
CLIENT NAME:			
A	ISSUE FOR CLIENT INFORMATION	JCM	25/10/07
ISSUE	REVISION	INITIAL	DATE

JOB NAME: DUOCEPTOR STC50

JOB NO. N/A

DRAWING TITTLE:	GENERAL ARRANGEMENT				
DRAWING NO.	BIS-DUO-002				
DESIGNED BY:	–		MODEL: STC60		
DRAWN BY:	JCM	25/10/07	SCALE: 1:40		
CHECKED BY:	CK	25/10/07	SIZE: A3	REV.	A



FOR INFORMATION

*150 MIN FOR INLET /OUTLET PIPE < 675 DIA
*300 MIN FOR INLET /OUTLET PIPE > 750 DIA

1. TYPICAL ASSEMBLY DETAIL ONLY – REFER TO PROJECT DRAWING FOR ACTUAL REQUIREMENTS.
2. DIMENSIONS INCLUDED ARE STANDARD.
3. STORAGE VOLUMES
   TOTAL = 60,255 LITRES
   OIL STORAGE VOLUME = 11,560 LITRES
   SEDIMENT STORAGE VOLUME = 42 m3
4. COMPONENT MASSES
   TREATMENT CHAMBER BASS UNIT (INC. SHAFT) = 16.20 TONNE
   TREATMENT CHAMBER TOP UNIT (CONV. SLAB AND SHAFT) = 12.46 TONNE
   BYPASS CHAMBER = 9.74 TONNE
5. REFER TO INSTALLATION GUIDE FOR RECOMMENDED INSTALLATION PROCEDURE.
6. SWIFTLIFT LIFTING ANCHORS PROVIDED FOR LIFTING ALL COMPONENTS THE FOLLOWING SWIFTLIFT KNUCKLES WILL BE REQUIRED:
   6 x 1.3 TONNES
   8 x 2.5 TONNES
   8 x 10.0 TONNES
7. OIL SAMPLE PORT, STEP IRONS AND DECANT PIPE TO BE VISIBLE AS PER PLAN VIEW.
8. THE ABOVE WEIGHTS ARE ONLY APPROXIMATIONS OF THE ACTUAL FINAL WEIGHTS OF COMPONENTS AND ARE NOT TO BE USED.

NOT FOR CONSTRUCTION

Humes™ WATER SOLUTIONS

CLIENT: N/A
CLIENT NAME: ___

ISSUE	REVISION	INITIAL	DATE
A	ISSUE FOR CLIENT INFORMATION	JCM	25/10/07

JOB NAME: DOUCEPTOR STC60
JOB NO. N/A

DRAWING TITTLE:	GENERAL ARRANGEMENT		
DRAWING NO.	BIS-DUO-001		
DESIGNED BY:	–	MODEL:	STC60
DRAWN BY:	JCM 25/10/07	SCALE:	1:40
CHECKED BY:	CK 25/10/07	SIZE:	A3
		REV.	A

HEAD OFFICE
18 Little Cribb Street,
Milton. QLD 4064.
Tel: (07) 3364 2800 Fax: (07) 3364 2963

NORTH QUEENSLAND
Ingham Road,
Bohle. QLD 4818.
Tel: 1300 361 601 Fax: (07) 4758 6001

CENTRAL QUEENSLAND
MacLaughlin Street,
Rockhampton. QLD 4701.
Tel: 1300 361 601 Fax: (07) 4926 1837

SOUTH EAST QUEENSLAND
59 Sugarmill Road,
Meeandah. QLD 4008.
Tel: 1300 361 601 Fax: (07) 3866 7101

NEW SOUTH WALES
Cnr Woodstock Ave & Glendenning Rd,
Rooty Hill. NSW 2766.
Tel: 1300 361 601 Fax: (02) 9625 5200

NORTH WEST NEW SOUTH WALES
Showground Road,
Tamworth. NSW 2340.
Tel: 1300 361 601 Fax: (02) 6765 2683

VICTORIA
122a Doherty's Road,
Laverton North. VIC 3028.
Tel: 1300 361 601 Fax: (03) 9360 3887

TASMANIA
19-25 Churchill Park Drive,
Invermay. TAS 7248.
Tel: 1300 361 601 Fax: (03) 6335 6330

SOUTH AUSTRALIA
39-43 Maxwell Road,
Pooraka. SA 5095.
Tel: 1300 361 601 Fax: (08) 8168 4549

WESTERN AUSTRALIA
36-38 Felspar Street,
Welshpool. WA 6106.
Tel: 1300 361 601 Fax: (08) 9351 6944

NORTHERN TERRITORY
1606 Reichardt Road,
Winnellie. NT 0821.
Tel: 1300 361 601 Fax: (08) 8984 1614

For further information please contact your nearest Humes office:

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