Stormwater Management Plan Report

Proposed Industrial Subdivision and General Industrial Building Development

2 & 10 Bowman Road
MOSS VALE 2577

For

SAAS Pty Ltd
c/o Jackson Environment and Planning
Suite 102, Level 1, 25-29 Berry St
North Sydney NSW 2060

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2. Introduction and Background

2.1. Purpose

The purpose of this stormwater management plan is to provide a summary of the stormwater drainage system design and demonstrate that the proposed stormwater system will meet the requirements of Wingecarribee Shire Council and WaterNSW.

The principal objectives of this review are to provide:

- A summary of stormwater design parameters.
- A summary of Australian Standards used and the relevant stormwater authority's stormwater requirements.
- A summary of the stormwater design strategy.
- A maintenance schedule of each stormwater drainage component proposed for the development.

2.2. Site Description

The site is described as Lot 2 in DP1070888 and part of Lot 10 in DP130176. The development site is addressed as 2 & 10 Bowman Road, Moss Vale. The location of the site is shown in Figure 2.1, below.

Figure 2.1: Aerial photograph of the site location (SIXMaps)

The site currently consists of an agricultural lot with a single residential structure. The site is bounded by industrial developments to the east, Whites Creek to the South, agricultural land to the west, and a Council-operated waste transfer station to the north. The site slopes from north to south with an approximate grade of 4.5%.

2.3. Proposed Development

SAAS Aus Pty Ltd (SAAS) is seeking to create a subdivision that will include industrial land from the property at 2 Bowman Road, Moss Vale (Lot 2, DP1070888), and a small portion of the adjacent property at 10 Bowman Road

(Lot 51, DP130176), and the remaining rural land from the properties. General industrial buildings are proposed to be constructed on three of the created lots with industrial land use zoning. The buildings will be used to house SAAS' scaffolding supply businesses.

Lot 2 covers an area of approximately 14.2 ha and is divided into three areas separated by a road and gas pipeline easement. The Lot consists of the following land use zones (Figure 2.2):

- E4 General Industrial
- RU2 Rural Landscape

The property at 2 Bowman Road also includes Lot 1, DP103123, a C3 Environmental Management zoned portion of land on the opposite side of Whites Creek (Figure 2.2). No development is proposed on this portion of land, and it will not be included in the subdivision.

The adjacent property at 10 Bowman Road (Lot 51, DP130176) is a 48 ha rural property adjacent to the western boundary of Lot 2 (Figure 2.2). An area of approximately 12,500 m^2 in the north-east portion of the Lot is zoned E4 and is proposed to be incorporated into the industrial subdivision and building development. The remainder of the property is zoned RU2.

Subdivision

The subdivision will result in the creation of four new lots and leave Lot 1, DP103123 in its current arrangement. The proposed subdivision will result in the following lots as shown in Figure 2.3:

- Created Lot 1: Approximately 2.88 ha of land zoned E4 General Industrial. Access to the lot will be directly from Bowman Road at the eastern end of the lot. The road frontage will be approximately 157 m, and the depth of the lot will vary from approximately 148 m on the southern boundary, to approximately 224 m on the northern boundary.
- Created Lot 2: Approximately 2.64 ha of land zoned E4 General Industrial. This lot will be formed by adjusting the boundaries of Lot 51 and Lot 2 to match the land use zone boundaries. This lot has a frontage to Bowman Road at the eastern end of the lot approximately 127 m wide. The lot will be approximately 352 m deep, tapering to a width of approximately 35 m at the western boundary. This lot is affected by the gas pipeline easement at the south-eastern end.
- Created Lot 3: Approximately 2.62 ha of land zoned E4 General Industrial. This is an irregularly shaped lot with a frontage to Bowman Road of approximately 388 m. This lot also has a frontage of approximately 132 m to an unformed paper road (Hutchinson Road) on the southern boundary. The northern portion of this lot is affected by the gas pipeline easement.
- Created Lot 4: Approximately 54.64 ha of RU2 Rural Landscape zoned land. This is the RU2 portion of Lot 2, DP1070888 separated from the remainder of the lot by the paper road along its northern boundary. The southern boundary of this lot is defined by Whites Creek and is within Wingecarribee Shire Council's Flood Planning Area. This part of the lot is to be merged with the remainder of the RU2 Rural Landscape lot of 51, DP130176.

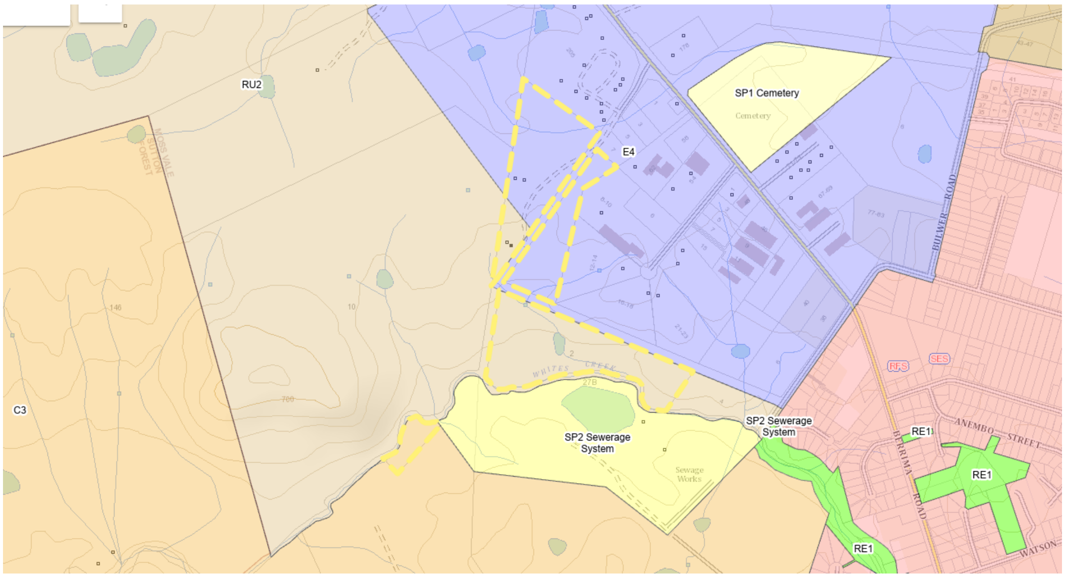


Figure 2.2: Existing property boundaries and land use zoning for 2 Bowman Road, Moss Vale NSW 2577. Existing Lot 2, DP1070888 (yellow dashed line), Lot 51, DP130176 (blue dashed line) and Lot 1, DP103123 (green dashed line) are shown. E4 General Industrial; RU2

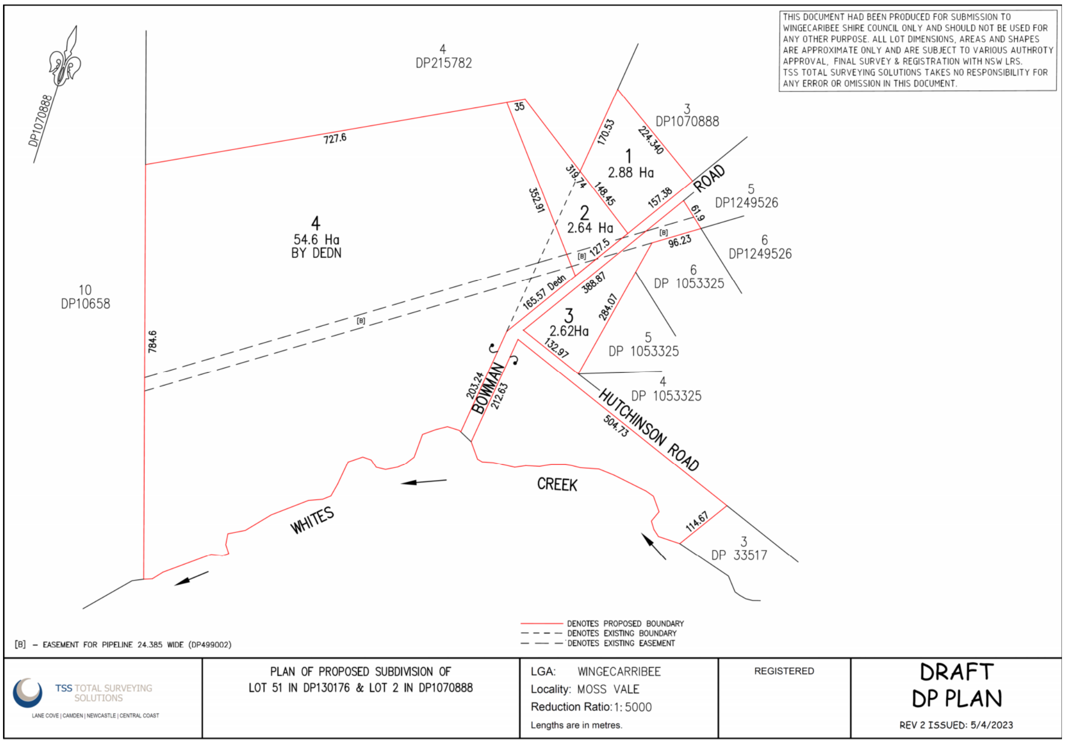


Figure 2.3: Proposed subdivision layout

Building Development

The development proposes the following elements (Figure 2.4):

- Building 1: An irregularly shaped building to be located in Created Lot 1 of the proposed subdivision. The north-east corner of the building will accommodate 956 m^2 office and staff amenities area split over the ground floor, first floor, and second floor, outdoor visitor parking along the eastern side of the building, and a basement carpark under the south-east corner of the building. The outdoor hardstand will provide truck parking along the southern lot boundary, an enclosed loading/unloading area along the entire southern side of the building, and a smaller, covered loading/unloading area on the northern side. A fire sprinkler system will be installed within the building. A 200,000 L underground tank will be installed to capture rainwater for re-use on site.

- Building 2: An irregularly shaped building to be located on Created Lot 2 of the subdivision. The building will provide 1,392 m^2 of office space and amenities over a ground and first floor. There will be a covered outdoor loading area at the north-western end of the building. A fire sprinkler system will be installed within the building. A 200,000 L underground tank will be installed to capture rainwater for re-use on site.
- Building 3: This building will be constructed as a split-level general industrial building with the upper and lower levels divided and provided with separate amenities and access. It will be located in the southern portion of Created Lot 3, away from the gas pipeline easement. Building 3A will be further split into two sections (North and South) and will include offices and staff amenities over a ground and first floor within its north-west corner. Parking and access will be provided at the northern end for Building 3A. Building 3B (also split into North and South sections) will include offices and staff amenities within its south-west corner over a ground and first floor. Parking and access will be provided at the southern end for Building 3A. Fire sprinklers will be installed in all sections of the buildings. A 120,000 L underground tank will be installed to capture rainwater for re-use on site.
- Extension of Bowman Road and formation of the paper Hutchinson Rd to provide access to all created lots and buildings. Hutchinson Road will terminate in an industrial cul-de-sac near the south-eastern corner of Created Lot 3. An easement will be created within the northern portion of Created Lot 4 to accommodate this cul-de-sac.
- Internal haul roads to accommodate up to 26m B-Doubles (Buildings 1 and 2); heavy vehicles to use Building 3 will be limited to 19m semi-trailers.
- Outdoor hardstand areas surrounding each building.
- Individual stormwater capture and treatment systems to be provided to each building will include a HumeCeptor Gross Pollutant Trap to remove suspended solids and hydrocarbons, and a HumeFilter Universal Pollutant Trap to capture suspended solids, nitrogen, phosphorous and gross pollutants in stormwater runoff. The treatment systems will discharge to below ground on-site detention basin/s with discharge control to manage stormwater flow volumes.
- Stormwater from the proposed development will discharge to the northern portion of Created Lot 4 via an outlet headwall with scour protection. An easement will be created within the lot to facilitate construction and maintenance.
- Solar collection arrays on all building roofs.
- Landscaping along site boundaries and within parking areas.
- 1.8m high open black palisade fencing for security.

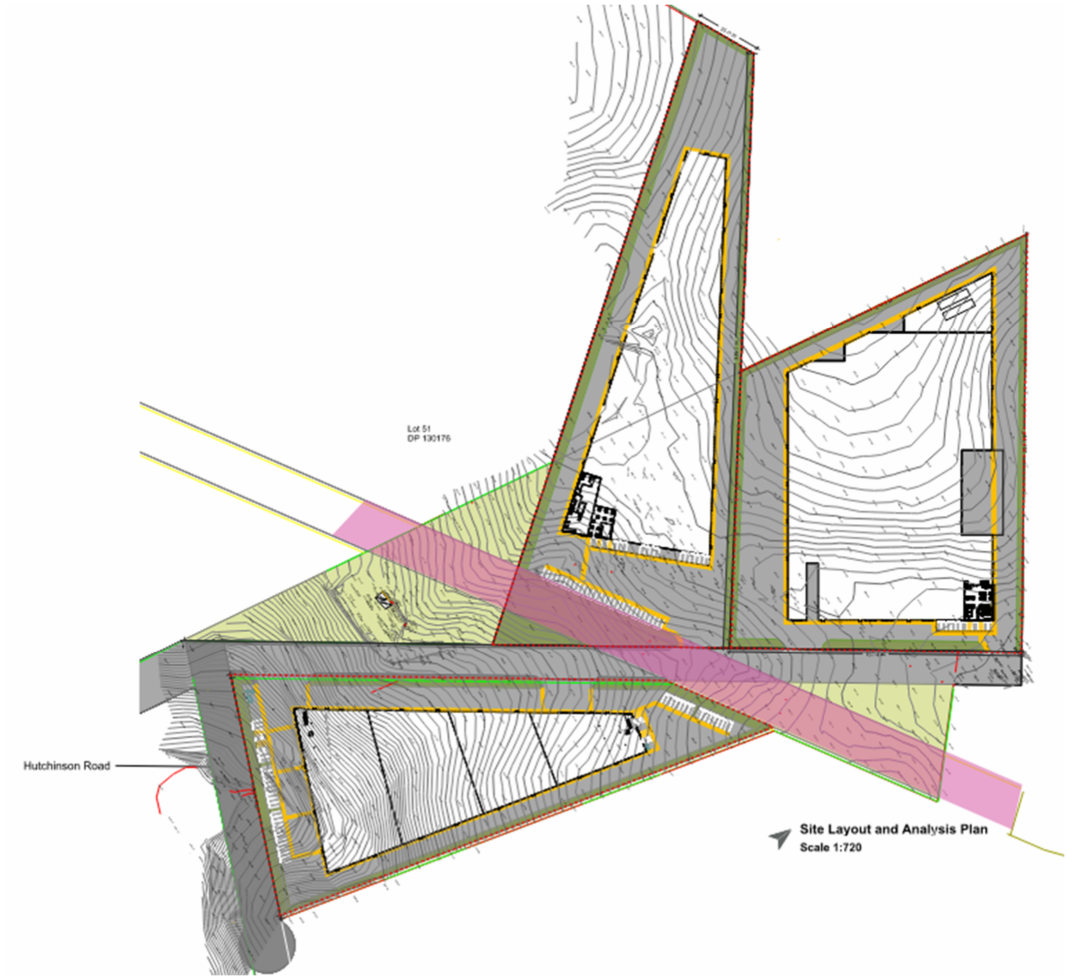


Figure 2.4: Proposed development site plan (Jackson Environment and Planning)

2.4. Proposed Catchment Areas

The catchment areas for the proposed development are shown in Figures 2.5 to 2.9 below.

Figure 2.5: Catchment areas for Building 1

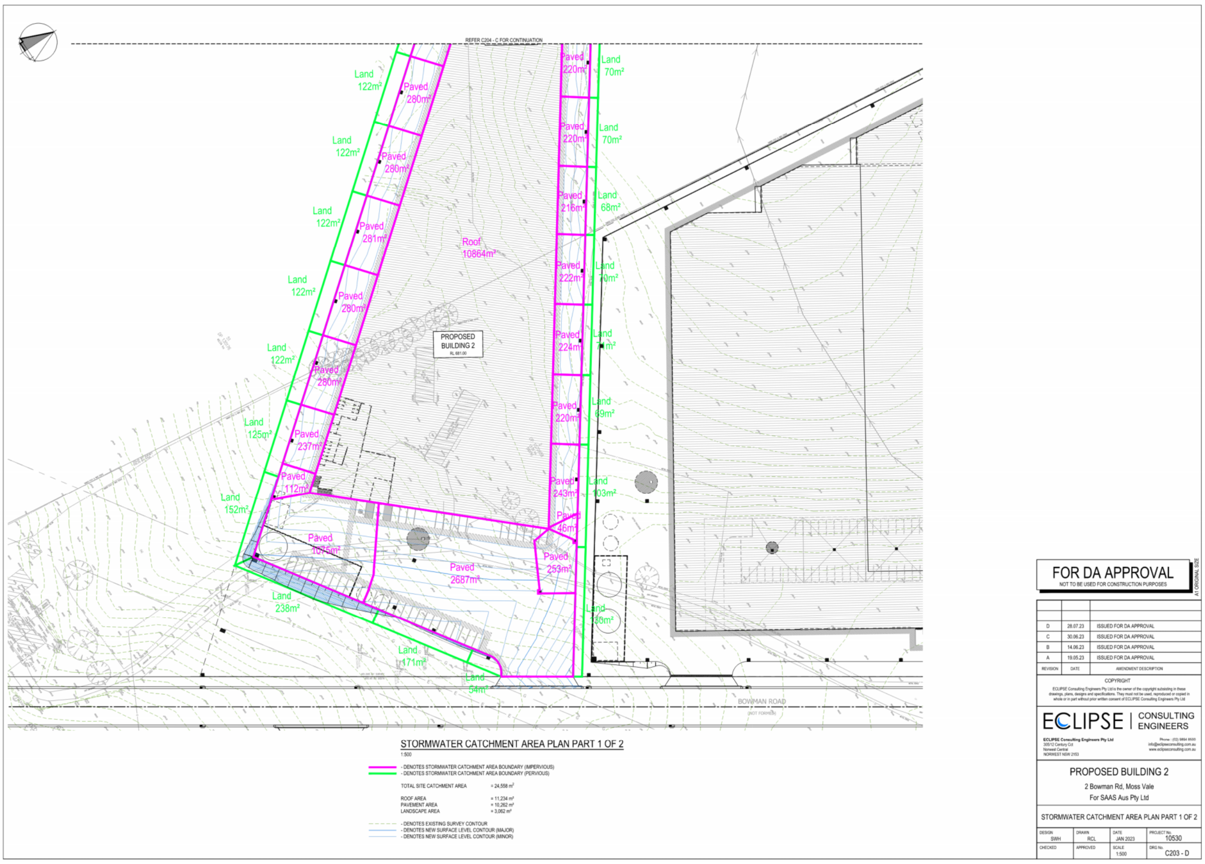


Figure 2.6: Catchment areas for Building 2 - Part 1

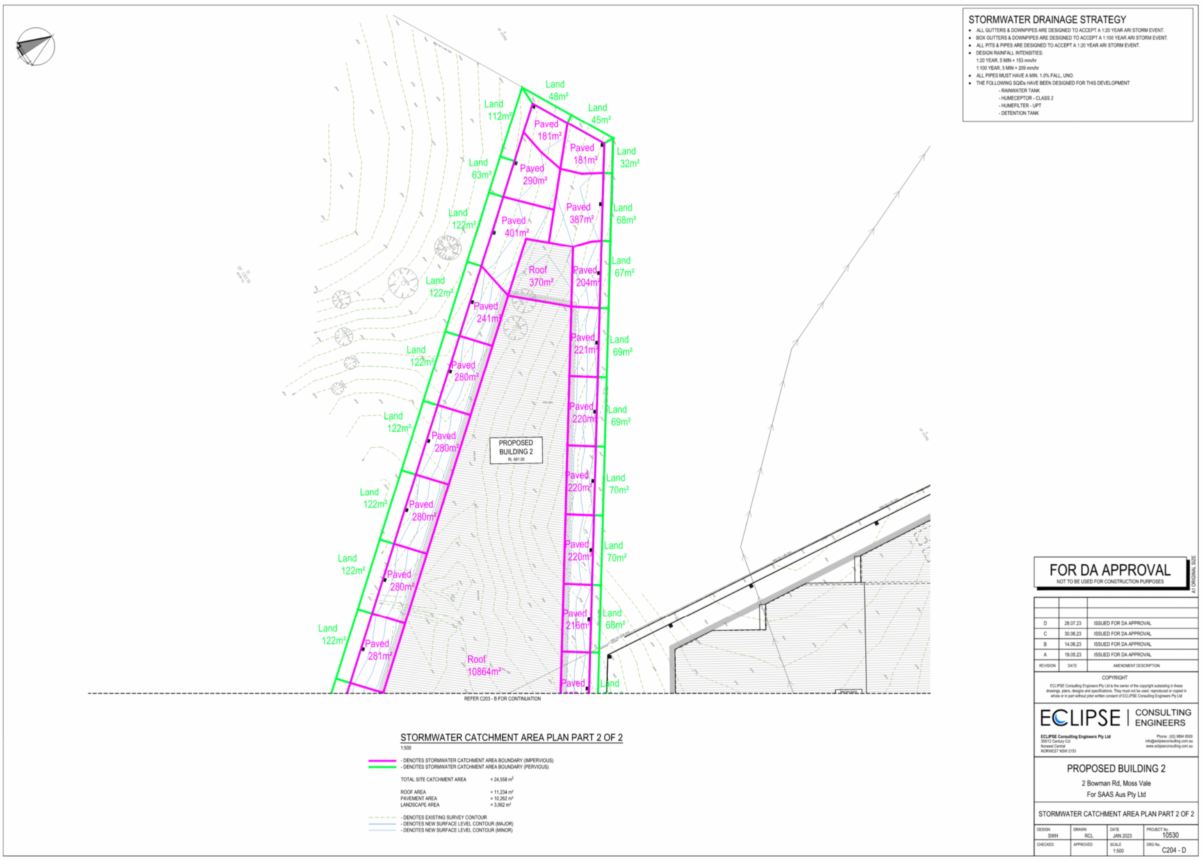


Figure 2.7: Catchment areas for Building 2 - Part 2

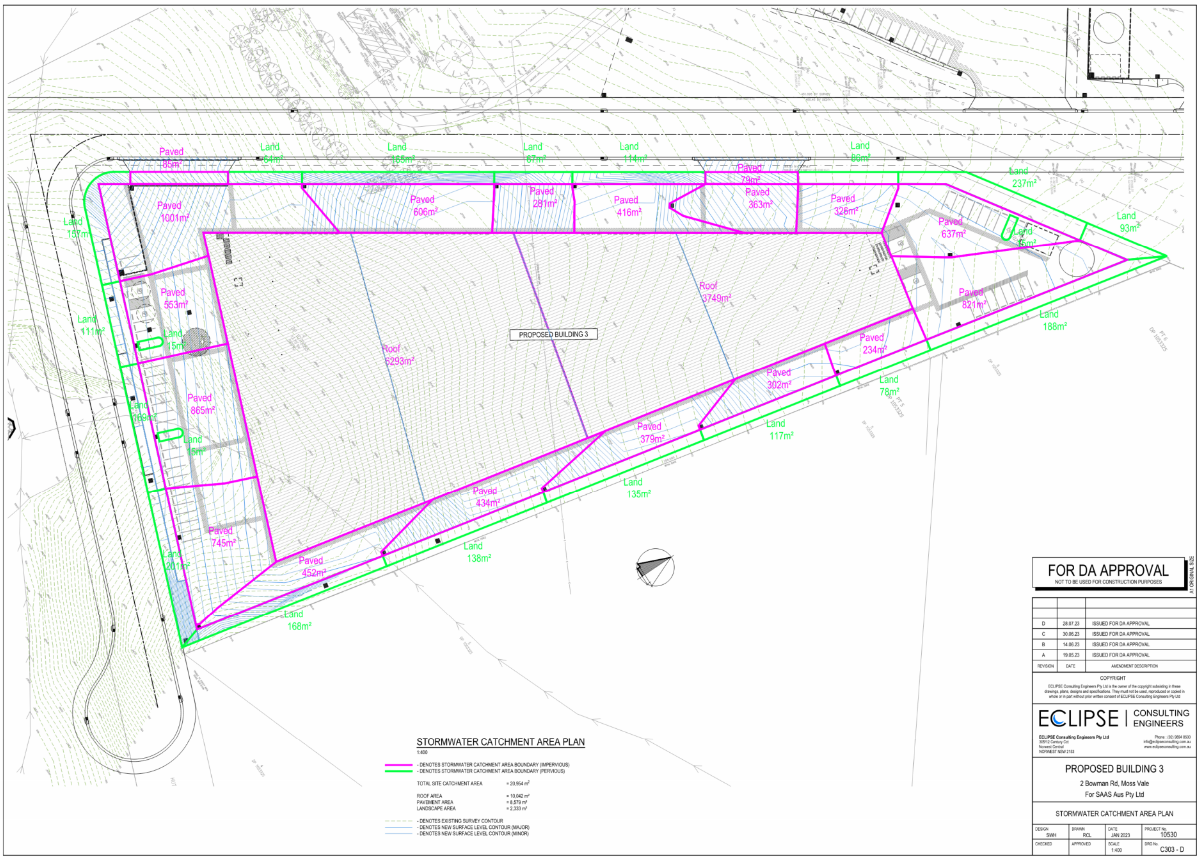


Figure 2.8: Catchment areas for Building 3

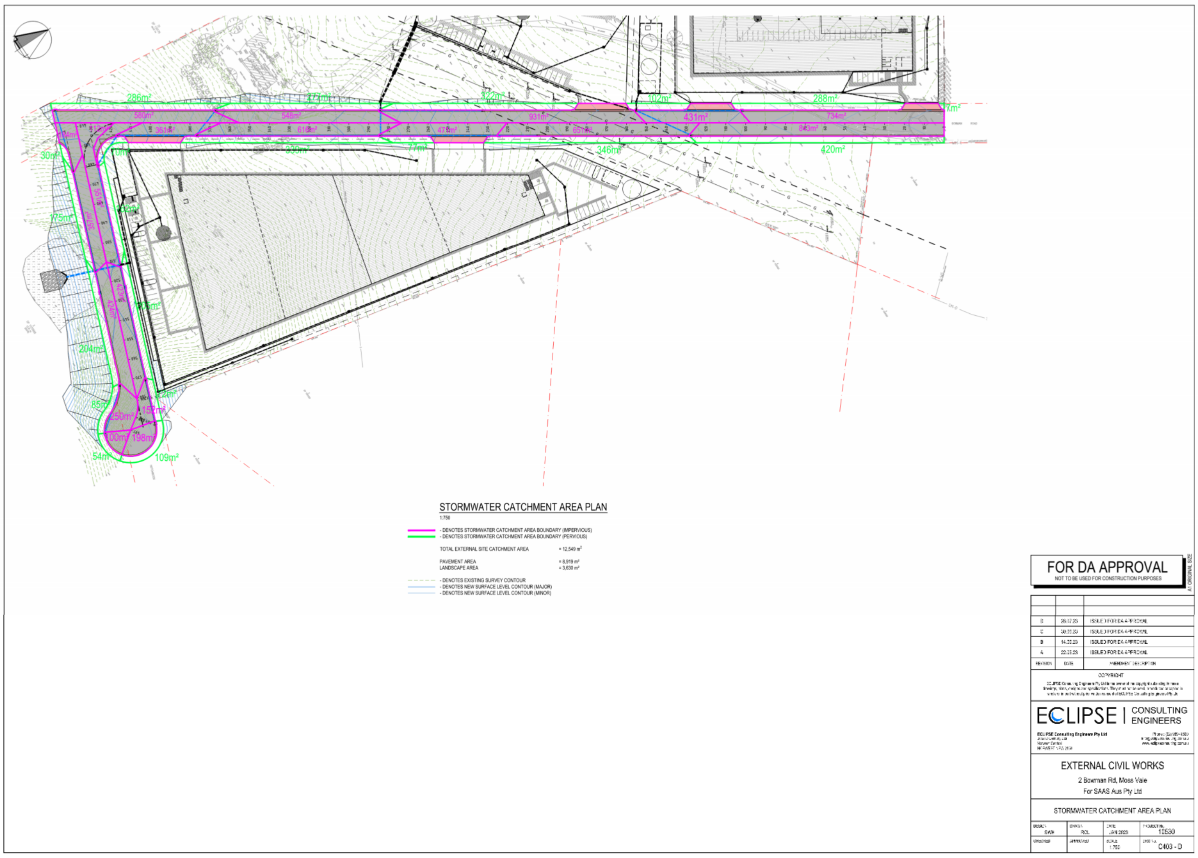


Figure 2.9: Catchment area plan for external works

3. Design Standards & Council Requirements

3.1. Methodology

The stormwater design of the site has been based on the following design standards:

- AS/NZS 3500.3:2018 – Plumbing and Drainage, Part 3: Stormwater Drainage

3.2. Stormwater Requirements

The stormwater requirements for the development site have been determined by the Industrial Land section of the Wingecarribee Development Control Plan 2021, particularly Chapter A2.5 – Water Sensitive Design and WaterNSW's Developments in the Sydney Drinking Water Catchment – Water Quality Information Requirements. The proposed development site is also partially subject to the Moss Vale Enterprise Corridor Development Control Plan 2008. The controls relating to stormwater management do not supersede the requirements outlined in the Wingecarribee Development Control Plan 2021 or WaterNSW's Developments in the Sydney Drinking Water Catchment.

Retention

Section A2.1.3 – Controls of the Wingecarribee Development Control Plan 2021 – Industrial Land specifies that all developments are to provide rainwater tanks for storage of roofwater to be reused for watering of landscaping and may be plumbed to toilets and/or laundry facilities. Rainwater tanks should be sized to capture the first 10 mm of rainfall runoff from all building roofs proposed on site.

Stormwater Quality Requirements.

In accordance with the NSW Government's State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011, the development site is located within the Sydney Drinking Water Catchment. Refer to Appendix A for mapping information. Due to its location, the stormwater quality requirements for the proposed development are subject to WaterNSW's Developments in the Sydney Drinking Water Catchment – Water Quality Information Requirements. Section 5 – Stormwater Requirements outlines that a stormwater quality model such as the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) should be used to achieve the following:

- Compare annual pollutant loads before and after development for Total Suspended Solids, Total Phosphorus, and Total Nitrogen. The modelling results should aim for an improvement of 10% to ensure the neutral of beneficial effect (NorBE) on water quality requirement can be met given the uncertainty in the modelled outcomes.
- The modelling results must compare cumulative frequency curves of pollutant concentrations before and after development. They must show that pollutant concentrations after development will be better to or equal to previous pollutant concentrations for 50-98% of the time.

Stormwater Detention Requirements

Wingecarribee Shire Council's Engineering Design Specification D09 Stormwater Drainage Design (D09) Section 3.44 – On-site stormwater detention specifies that stormwater detention is required for new developments such that the maximum discharge for all storms from the 20% to 1% AEP events shall not exceed any of the following:

- Pre-development discharge
- Permissible site discharge if provided within Council's flood study
- Downstream capacity

Flooding

A small portion of the Lot 2 is subject to floodwaters in major flooding events, as outlined in Wingecarribee Shire Council's Review of Whites Creek Floodplain Risk Management Study & Plan. The proposed development site is not within the area which is subject to flooding. As such, specific controls are not required for the proposed development for the mitigation of flood risks. Notwithstanding this, the proposed development is subject to two existing watercourse flows as shown in Figures 3.1 and 3.2 below.

Figure 3.1: Identification of existing northern watercourse impacting the development site (NSW Water Management Regulation 2018)

Figure 3.2: Identification of existing southern watercourse impacting the development site (NSW Water Management Regulation 2018)

The northern watercourse forms part of a catchment contributing to Stony Creek to the northwest, and the southern watercourse forms part of a catchment contributing to Whites Creek to the south. The effects that the proposed development will have on these watercourses is explored in greater detail in the accompanying Flood Study Report (10530-004-fs).

Minor System Drainage

The proposed outlet structure is subject to civil design requirements as outlined in Wingecarribee Shire Council's Engineering Design Specification D09 Stormwater Drainage (Design). As a minor drainage system with a peak discharge of less than 10 m^3/s, the following criteria are to be met in design:

- The design of the minor system shall take full account of existing downstream systems and flows from upstream catchments.
- The subdivision design shall make provision for the disposal of stormwater from individual sites in such a way as not to cause a nuisance or damage to other properties.
- Interallotment drainage must be provided for the properties that cannot discharge to the road drainage. The design AEP and other aspects to be determined in consultation with the development engineers as detailed in this booklet.

The catchment downstream of the proposed outlet location consists of an overland flow route discharging into Whites Creek. Overland flows from upstream catchments are considered in detail in the accompanying Flood Study Report (10530-004-fs).

A concept design of interallotment drainage and the proposed outlet structure have been undertaken, with detailed design to be completed at construction stage. At this stage, no concerns have been identified which would limit the design of the subdivision drainage.

4. Stormwater Retention for Reuse

4.1. Roofwater Catchment Areas

The proposed development includes 3 general industrial buildings with the following total roofwater catchment areas:

- Building 1: 17,730 m^2
- Building 2: 11,234 m^2
- Building 3: 10,042 m^2

4.2. Stormwater Retention Volume

As outlined in Section 3, the proposed development is required to intercept a volume equivalent to 10 mm of rainwater across the total roof area. The following summarises the minimum volume requirement for each building in the proposed development and the designed rainwater tank size:

- Building 1: Required volume = 177.3 kL Designed volume = 200 kL
- Building 2: Required volume = 112.3 kL Designed volume = 120 kL
- Building 3: Required volume = 100.4 kL Designed volume = 120 kL

4.3. Water Balance Analysis

In addition to the minimum storage volume requirement, a water balance analysis has been undertaken for each building to determine the potential reduction in use of potable water that may be achieved through the reuse of collected rainwater.

The reuse analysis conducted has used the available daily rainfall record for the site and records the proportion of days in which collected rainwater is available and when town water is required. This is reported as an average across the length of the rainfall record. The results of the analysis are summarised in Table 4.1 below.

Rainfall record: 068239 – Moss Vale AWS First year: 2001 Last year: 2023

	Building 1	Building 2	Building 3
Roof area (m^2)	17,730	11,234	10,042
Toilet reuse demand (kL/day)	1.5	0.7	1.7
Landscaping irrigation reuse demand (kL/yr)	866.8	1224.8	933.2
Reuse demand met (%)	98.99	92.41	90.31
Overflow frequency (%)	17.37	15.28	14.22

Table 4.1: Reuse analysis calculation summary

5. Stormwater Quality Design

5.1. General

The water quality for the proposed development has been designed in accordance with WaterNSW's Water Sensitive Urban Design (WSUD) objectives as outlined in Section 3, where requires that the proposed development has Neutral or Beneficial Effect (NorBE) on receiving waters.

To determine compliance with this requirement, a full analysis of the water quality of the stormwater discharging from the site was undertaken using the Model for Urban Stormwater Quality Improvement Conceptualisation (MUSIC) software modelling package.

The analysis has considered the use of the following stormwater quality improvement devices for the proposed development:

- Rainwater tanks
- Humes Humeceptor
- Humes Humefilter

5.2. MUSIC Input Parameters

Climate Data

Climate data for use the Drinking Water Catchment is provided by WaterNSW. The appropriate records to use are dependent on the geographical location of the development site in accordance with the SCA Climate Zones map shown in Figure 5.1 below.

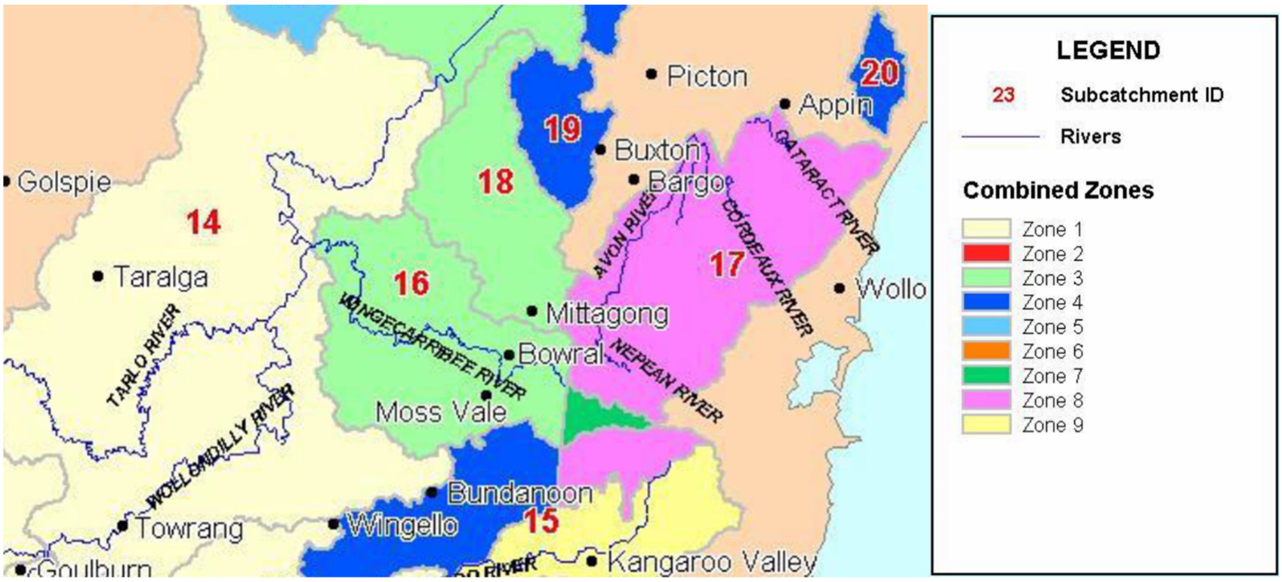


Figure 5.1: Excerpt of SCA Climate Zones (WaterNSW)

The full map has been included in Appendix B.

The map identifies the proposed development site as being within Zone 3. As such, the climate data file for Zone 3 has been used in the development of the MUSIC model for this project.

Source Nodes

Base and storm flow pollutant concentration parameters have been adopted based on recommendations in WaterNSW's Using MUSIC in the Sydney Drinking Water Catchment as summarised in Tables 5.1 and 5.2 below.

Concentration (mg/L-log10)	Total suspended solids		Total phosphorus		Total nitrogen	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Surface type						
Roofs[2]	-	-	-	-	-	-
Sealed roads[3]	1.20	0.17	-0.85	0.19	0.11	0.12
Unsealed roads[4]	1.20	0.17	-0.85	0.19	0.11	0.12
Eroding gullies[4]	1.20	0.17	-0.85	0.19	0.11	0.12
Revegetated land[4, 5]	1.15	0.17	-1.22	0.19	-0.05	0.12
Quarries[4]	1.20	0.17	-0.85	0.19	0.11	0.12
Land use/zoning						
Residential	1.20	0.17	-0.85	0.19	0.11	0.12
Commercial	1.20	0.17	-0.85	0.19	0.11	0.12
Industrial	1.20	0.17	-0.85	0.19	0.11	0.12
Rural residential	1.15	0.17	-1.22	0.19	-0.05	0.12
Agricultural	1.30	0.13	-1.05	0.13	0.04	0.13
Forest	0.78	0.13	-1.52	0.13	-0.52	0.13

[1] Derived for NSW.
[2] Roofs have no base flow.
[3] Most urban sealed roads are fully sealed to a gutter or concrete edge and thus have no baseflow, whereas rural sealed roads invariably include unsealed shoulders, which do generate baseflow. Rural sealed roads should therefore be modelled with the shoulders and given a 50% impervious value – see footnote Table 4.2.
[4] Additional surface types not included in Fletcher et al. (2004).
[5] Revegetated land means cleared land that has been replanted with trees and shrubs and fenced-off from livestock.

Table 5.1: Base flow pollutant concentration parameters (WaterNSW)

Concentration (mg/L-log10)	Total suspended solids		Total phosphorus		Total nitrogen	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Surface type						
Roofs	1.30	0.32	-0.89	0.25	0.30	0.19
Sealed roads	2.43	0.32	-0.30	0.25	0.34	0.19
Unsealed roads[2]	3.00	0.32	-0.30	0.25	0.34	0.19
Eroding gullies[2]	3.00	0.32	-0.30	0.25	0.34	0.19
Revegetated land[2, 3]	1.95	0.32	-0.66	0.25	0.30	0.19
Quarries[2]	3.00	0.32	-0.30	0.25	0.34	0.19
Land use/zoning						
Residential	2.15	0.32	-0.60	0.25	0.30	0.19
Commercial	2.15	0.32	-0.60	0.25	0.30	0.19
Industrial	2.15	0.32	-0.60	0.25	0.30	0.19
Rural residential	1.95	0.32	-0.66	0.25	0.30	0.19
Agricultural	2.15	0.31	-0.22	0.30	0.48	0.26
Forest	1.60	0.20	-1.10	0.22	-0.05	0.24

[1] Derived for NSW.
[2] Additional surface types not included in Fletcher et al. (2004).
[3] Revegetated land means cleared land that has been replanted with trees and shrubs and fenced-off.

Table 5.2: Storm flow pollutant concentration parameters (WaterNSW)

Rainfall threshold values have been adopted based on recommendations in WaterNSW's Using MUSIC in the Sydney Drinking Water Catchment as summarised in Table 5.3 below.

Surface type	Rainfall threshold (mm) [1]
Roofs	0.3
Sealed roads, driveways, paving, car parks and paths	1.5
Unsealed roads and car parks	1.5
Permeable paving (open proportion)[2]	0
Permeable paving (paved proportion)[1]	1.5
Land use zoning	
For all land uses (residential, rural residential etc.)	1.0

[1] Rainfall threshold is related to impervious areas only. Any changes to rainfall thresholds must be justified.

[2] Refer to Section 5.2.2.2 for further discussion on modelling permeable paving

Table 5.3: Default rainfall threshold values (WaterNSW)

Soil storage capacities and field capacities, in conjunction with additional rainfall-runoff parameters have been adopted based on recommendations in WaterNSW's Using MUSIC in the Sydney Drinking Water Catchment as summarised in Tables 5.4 and 5.5 below.

Dominant soil description	Root zone soil depth (0.5 m)	
	Soil storage capacity (mm)	Field capacity (mm)
Sand	175	74
Loamy sand	139	69
Clayey sand	107	75
Sandy loam	98	70
Loam	97	79
Silty loam	100	87
Sandy clay loam	108	73
Clay loam	119	99
Clay loam, sandy	133	89
Silty clay loam	88	70
Sandy clay	142	94
Silty clay	54	51
Light clay	98	73
Light-medium clay	90	67
Medium clay	94	70
Medium-heavy clay	94	70
Heavy clay	90	58

Table 5.4: Soil storage capacity and field capacity for a 0.5 m root-zone depth (WaterNSW)

Dominant soil description	Soil rainfall-runoff parameters[1]				
	Infiltration capacity coefficient-a (mm/d)	Infiltration capacity exponent-b	Daily recharge rate (%)	Daily baseflow rate (%)	Daily seepage rate (%)
Sand, loamy sand	360	0.5	100	50	0
Clayey sand, sandy loam, loam, silty loam, sandy clay loam	250	1.3	60	45	0
Clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay	180	3.0	25	25	0
Light clay, light medium clay, medium clay, medium heavy clay, heavy clay	135	4.0	10	10	0

[1] These parameter estimates are based on soil properties only. There is no allowance for rainfall losses associated with depression storage, mulch, vegetation interception and other non-soil sources of water storage in a catchment.

Table 5.5: Other soil rainfall-runoff parameters for a 0.5 m root-zone depth (WaterNSW)

Treatment Node Properties

As proprietary stormwater treatment devices have been proposed for this development, the treatment node properties have been determined in accordance with their documentation. The following proprietary devices have been proposed for this development:

- Humes Humeceptor (Class 2)
- Humes Humefilter UPT

A generic treatment node has also been included in each catchment representing a trash screen. This is intended to be a final physical barrier in the treatment train to prevent the movement of gross pollutant into the detention tank.

These devices have been assigned treatment efficiencies in MUSIC summarised in Table 5.6 below.

	Humeceptor				Humefilter				Trash Screen			
	TSS	**TP**	**TN**	**GP**	**TSS**	**TP**	**TN**	**GP**	**TSS**	**TP**	**TN**	**GP**
Input (mg/L)	500	5.0	5.0	15.0	1000	5.0	5.0	15	-	-	-	50
Output (mg/L)	100	3.5	3.5	1.5	30	2.75	2.90	0	-	-	-	0

Table 5.6: Treatment node performance summary (Humes)

The size and model of each device used is determined by the high flow bypass flow node property. The final sizing of each device will be determined in conjunction with Humes prior to construction stage.

5.3. MUSIC Model Summary

Figures 5.2 to 5.4 summarise the MUSIC model layouts for each of the three building catchments on this project.

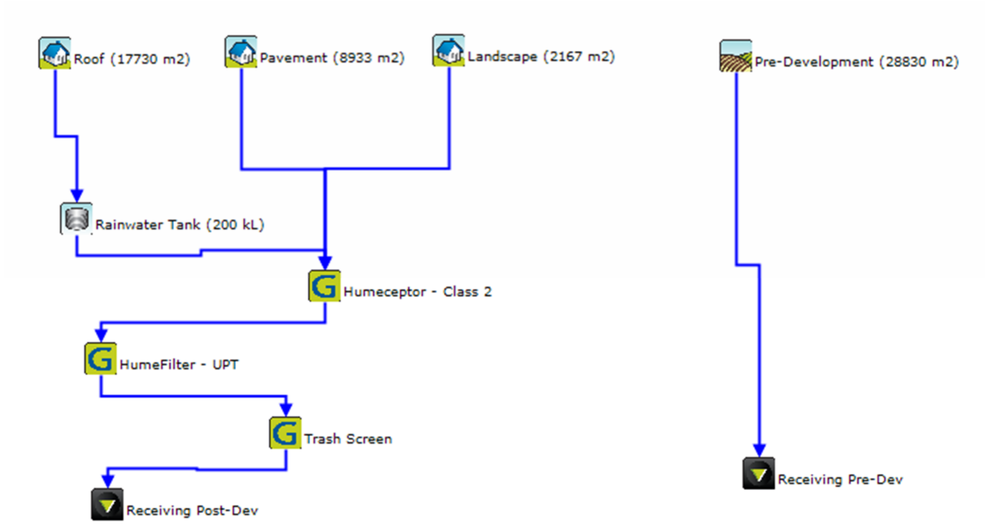


Figure 5.2: Building 1 MUSIC model layout

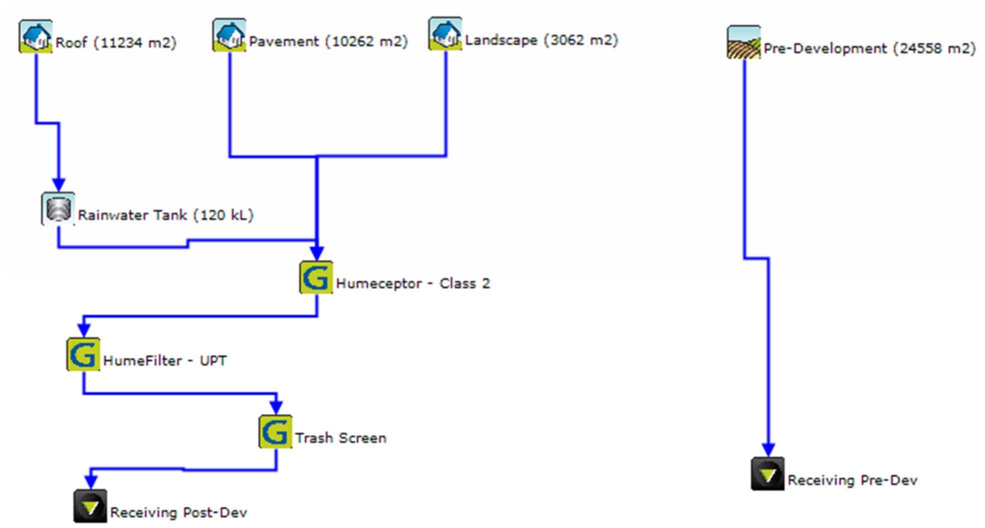


Figure 5.3: Building 2 MUSIC model layout

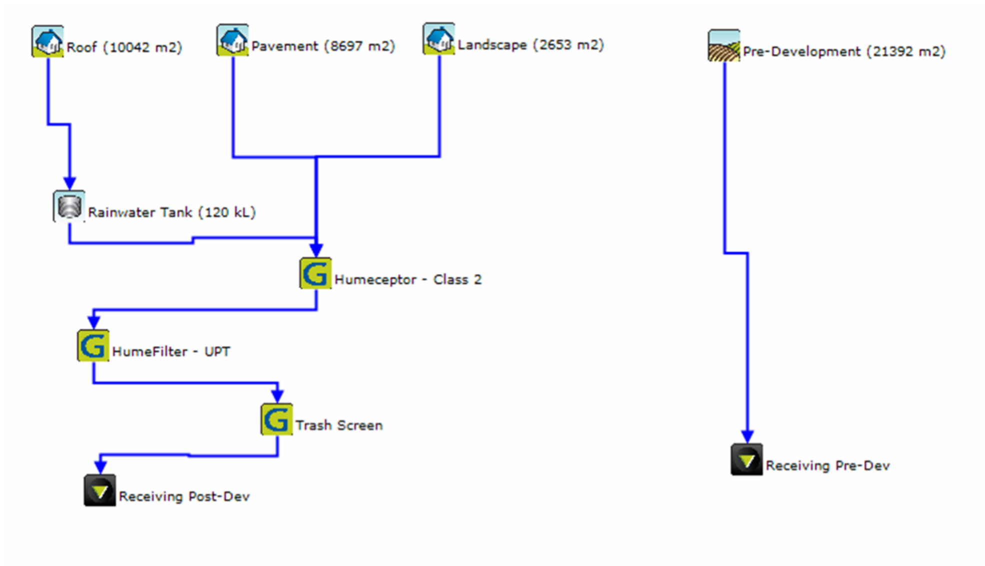


Figure 5.4: Building 3 MUSIC model layout

5.4. MUSIC Model Output

The annual treatment train residual pollutant loads for post-development at each building has been compared to the pre-development scenario. These results have been summarised in Tables 5.7 to 5.9 below.

Pollutant	Pre-Development Residual Load	Post-Development Residual Load	Reduction (%)
Flow (ML/year)	6.75	20.32	-201.25
Total Suspended Solids	1083.30	26.82	97.52
Total Phosphorus	3.07	1.65	46.35
Total Nitrogen	22.88	18.52	19.04
Gross Pollutants	34.68	0.00	100.00

Table 5.7: Building 1 treatment train performance

Pollutant	Pre-Development Residual Load	Post-Development Residual Load	Reduction
Flow (ML/year)	5.75	16.03	-178.99
Total Suspended Solids	931.03	26.88	97.11
Total Phosphorus	2.71	1.45	46.51
Total Nitrogen	18.64	14.64	21.48
Gross Pollutants	29.54	0.00	100.00

Table 5.8: Building 2 treatment train performance

Pollutant	Pre-Development Residual Load	Post-Development Residual Load	Reduction
Flow (ML/year)	4.82	13.61	-182.40
Total Suspended Solids	793.71	18.28	97.70
Total Phosphorus	2.15	1.19	44.59
Total Nitrogen	15.41	12.36	19.78
Gross Pollutants	24.78	0.00	100.00

Table 5.9: Building 3 treatment train performance

The results above indicate that on a mean annual load basis, neutral or beneficial effect has been achieved for each of the three buildings.

Figures 5.5 to 5.15 below show the flow-based cumulative frequency curves for each of total suspended solids, total phosphorus, and total nitrogen between the 50^{th} and 98^{th} percentiles.

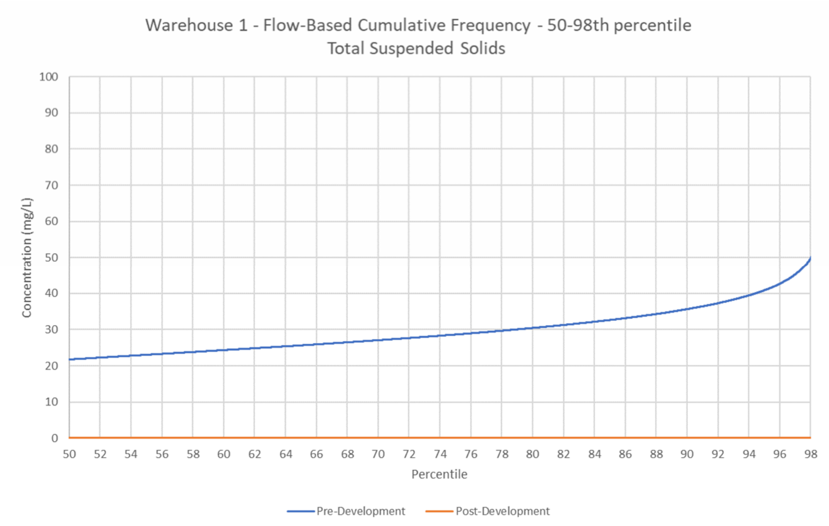


Figure 5.5: Building 1 - Flow-based cumulative frequency - Total suspended solids

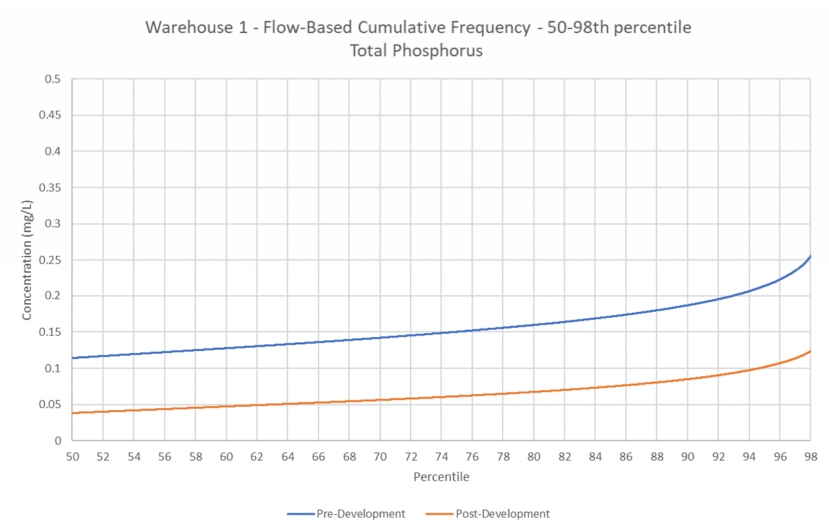


Figure 5.6: Building 1 - Flow-based cumulative frequency - Total phosphorus

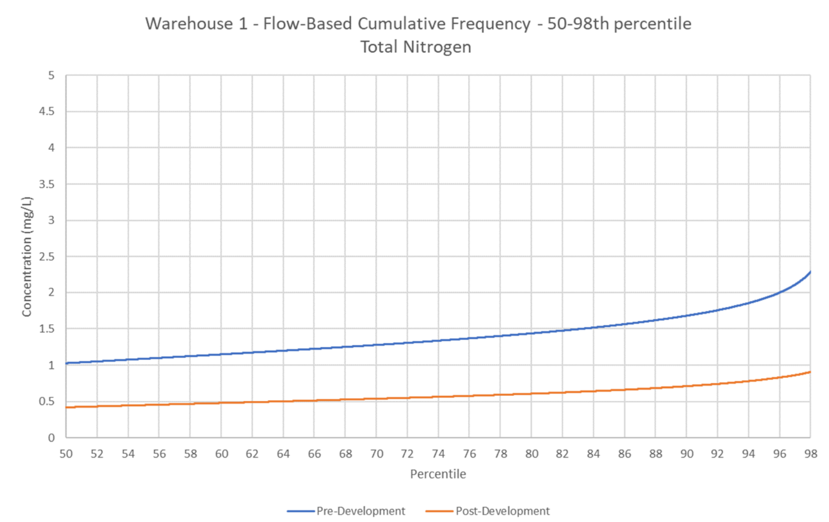


Figure 5.7: Building 1 - Flow-based cumulative frequency - Total nitrogen

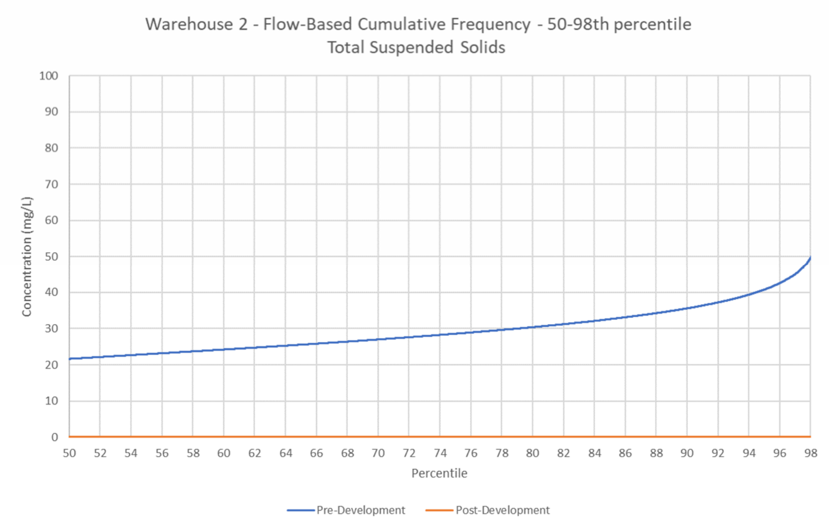


Figure 5.8: Building 2 - Flow-based cumulative frequency - Total suspended solids

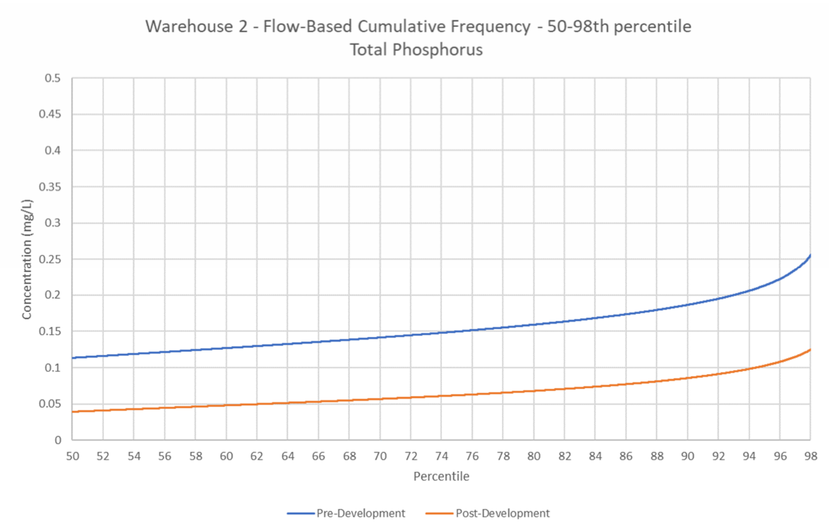


Figure 5.9: Building 2 - Flow-based cumulative frequency - Total phosphorus

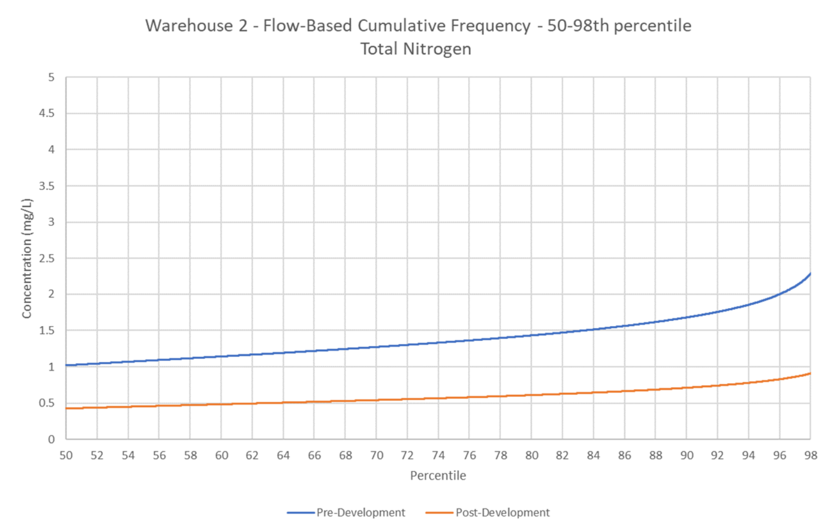


Figure 5.10: Building 2 - Flow-based cumulative frequency - Total nitrogen

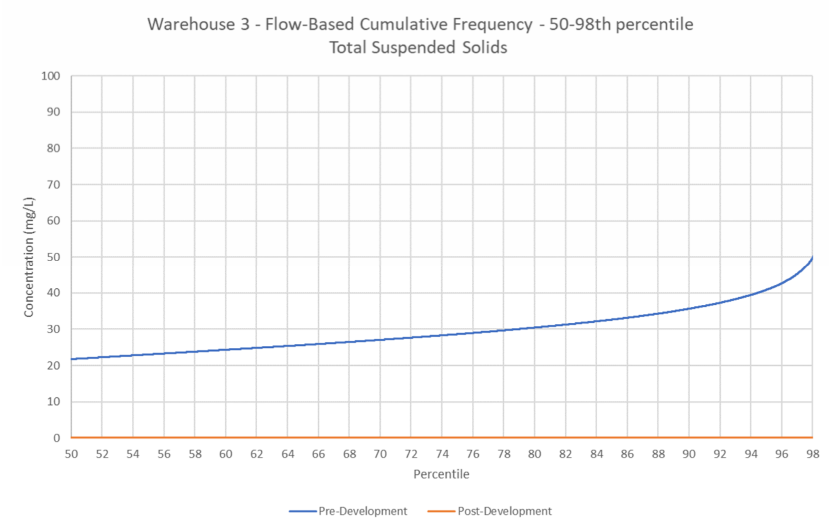


Figure 5.11: Building 3 - Flow-based cumulative frequency - Total suspended solids

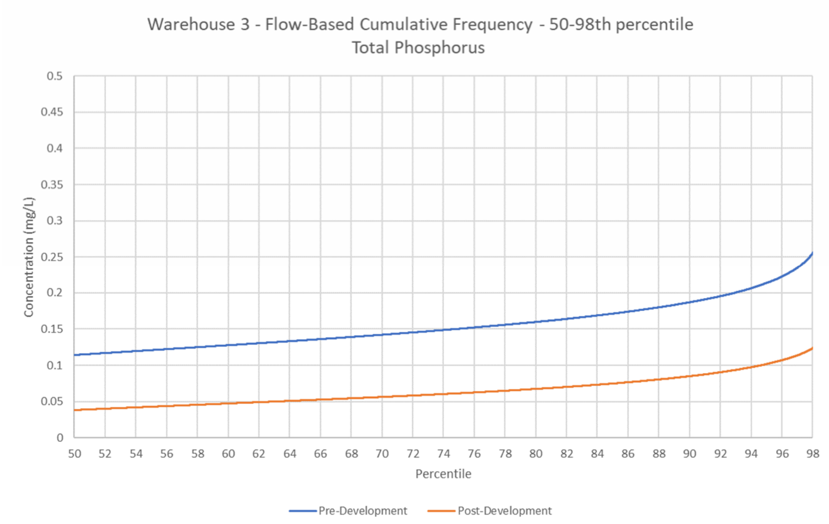


Figure 5.12: Building 3 - Flow-based cumulative frequency - Total phosphorus

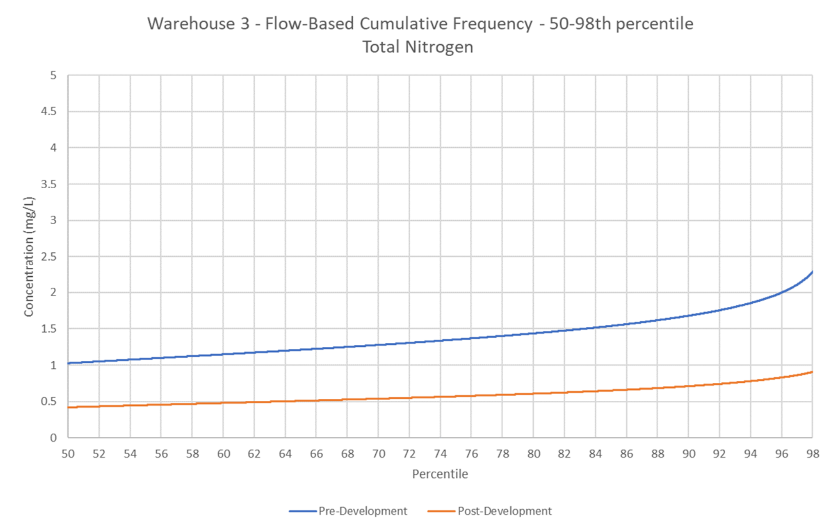


Figure 5.13: Building 3 - Flow-based cumulative frequency - Total nitrogen

For each pollutant type at each building, the flow-based cumulative frequency charts indicate that the post-development pollutant loads are lower than the pre-development scenario between the 50^{th} and 98^{th} percentiles. As such, the proposed development is considered to meet the NorBE requirements provided by WaterNSW.

5.5. Stormwater Isolation

In the event of fire or major chemical spill, the proposed stormwater system would be subject to contamination by foreign pollutants. As such, installation of a stormwater isolation valve for each of the building developments will be required to ensure that captured wastewater is not discharged into the downstream stormwater system.

The proposed valves are to be installed in a stormwater junction pit in the first pit downstream of each proposed building's detention tank, outside the extent of pavement, as indicated on plan. The valves are to be operable mechanically by hand in the event of a power outage.

6. Stormwater Quantity Design

The on-site detention system for each of the proposed building sites in the development has been designed to meet the stormwater quantity requirements outlined in Section 3. The system is recognised as providing an improvement to the stormwater quality through allowing the settlement of pollutants but has not been considered in the stormwater quality analysis. This section discusses the method and results of the analyses used in the design of this system.

6.1. Hydrological Data

A DRAINS model has been prepared in the design of the on-site detention systems used in discharge control of stormwater. The rainfall depth data shown in Table 6.1 below was used in conjunction with the procedures outlined in Australian Rainfall and Runoff 2019 to determine pre- and post-development discharge rates.

Rainfall Depths (mm) [34.5375 (S), 150.3375 (E)] issued 24 March 2023						
	Annual Exceedance Probability (AEP)					
Duration	**50%**	**20%**	**10%**	**5%**	**2%**	**1%**
1 min	2.02	2.77	3.31	3.87	4.67	5.31
2 min	3.16	4.2	4.97	5.76	6.89	7.85
3 min	4.43	5.94	7.04	8.17	9.79	11.1
4 min	5.64	7.61	9.05	10.5	12.6	14.4
5 min	6.73	9.15	10.9	12.7	15.3	17.4
10 min	10.8	14.9	17.8	20.9	25.2	28.7
15 min	13.4	18.4	22.1	25.9	31.3	35.7
20 min	15.2	20.9	25.1	29.4	35.5	40.4
25 min	16.6	22.8	27.2	31.9	38.5	43.9
30 min	17.8	24.2	29	33.9	40.9	46.6
45 min	20.3	27.5	32.8	38.2	45.9	52.3
1 hour	22.3	30	35.6	41.4	49.7	56.4
1.5 hour	25.5	34	40.2	46.6	55.6	63.1
2 hour	28.2	37.5	44.3	51.2	60.9	68.9
3 hour	32.9	43.9	51.7	59.6	70.7	79.6
6 hour	45	60.7	71.7	82.8	97.7	109
12 hour	64.1	88.7	106	123	145	162

Table 6.1: Design rainfall depths for the development site (Bureau of Meteorology)

6.2. Pre-Development Discharge Calculations

An Initial Loss/Continuing Loss hydrological model was used to determine the pre-development discharge rates from the site. The discharge rates shown in Table 6.2 below summarise the critical results from each of the proposed building developments.

Rainfall Event (AEP)	Pre-Development Flow (L/s)		
	Building 1	Building 2	Building 3
50%	286	244	212
20%	613	522	455
10%	809	689	600
5%	963	820	715
2%	1208	1029	896
1%	1377	1174	1022

Table 6.2: Pre-development stormwater discharge (DRAINS)

6.3. On-Site Detention Parameters

Stormwater quantity control is required for the development such that the outflow from the site is limited to pre-development conditions in all rainfall events up to and including the 1% AEP event. All rainfall falling on impervious areas for each building development is directed to the OSD system prior to discharge from the site.

The typical characteristics of each below-ground detention tank for each building are summarised in Table 6.3 below.

Characteristic	Building 1	Building 2	Building 3
Detention tank area (m^2)	175	175	125
Detention tank volume (m^3)	350	350	250
Internal weir height (mm)	1600	1600	1600
Orifice diameter (mm)	375	375	300
Outlet pipe diameter (mm)	675	675	525

Table 6.3: Detention tank characteristics

A summary diagram of the DRAINS model used to represent the above parameters is shown in Figure 6.1.

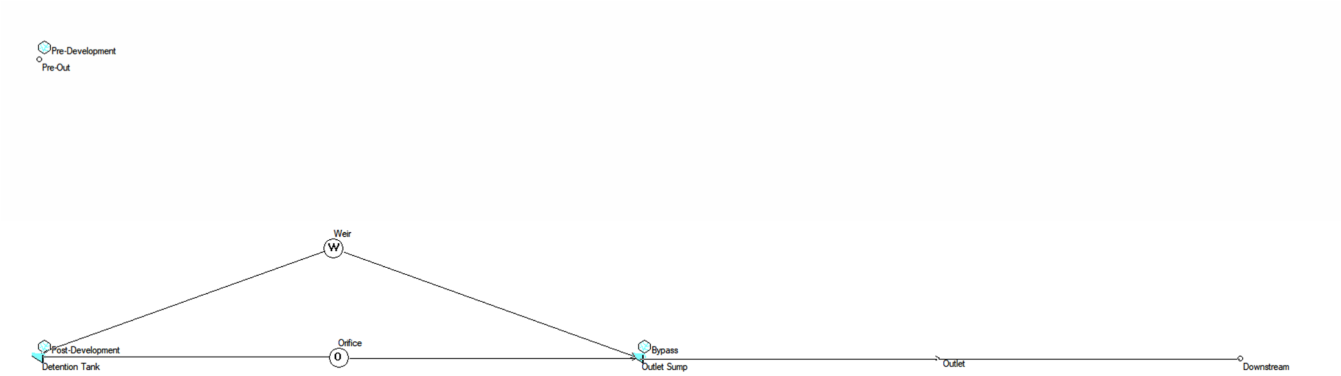


Figure 6.1: DRAINS model arrangement of the on-site detention systems

The model arrangement for each building site in the proposed development is functionally identical.

6.4. Analysis Results

The peak post-development flows downstream, and the storage volume required to achieve these flows, for the detention tank for each development are summarised in Table 6.3 below.

Rainfall Event (AEP)	Post-Development Flow (L/s)			Storage Volume Required (m^3)		
	Building 1	**Building 2**	**Building 3**	**Building 1**	**Building 2**	**Building 3**
50%	283	235	192	177.3	141.7	127.6
20%	397	353	332	257.0	203.4	187.3
10%	674	413	502	292.9	250.3	208.8
5%	894	627	655	305.9	287.9	218.1
2%	1099	843	729	323.8	302.1	240.6
1%	1202	1065	823	350.6	316.3	271.1

Table 6.4: Post-development stormwater discharge (DRAINS)

These results show that the post-development flows are effectively reduced to match the pre-development flows from the site, meeting the requirements of Wingecarribee Shire Council.

7. Maintenance Schedule

7.1. Stormwater Drainage System Maintenance

To ensure the system functions efficiently long term, regular maintenance must be conducted on the stormwater system and water quality treatment devices. The maintenance of the on-site detention systems will be undertaken during regular inspections and a maintenance schedule is included in Appendix C.

Appendix A – NSW State Planning Policy (Sydney Drinking Water Catchment) 2011 – Sydney Drinking Water Catchment SDWC_015

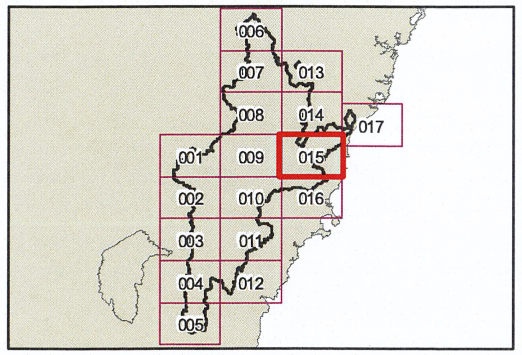
NSW GOVERNMENT | Planning

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 - Sydney Drinking Water Catchment Map

SDWC_015

Legend

- Subject Land
- SubCatchment Boundaries
- Local Government Boundaries
- Major Rivers
- Major Roads
- Roads



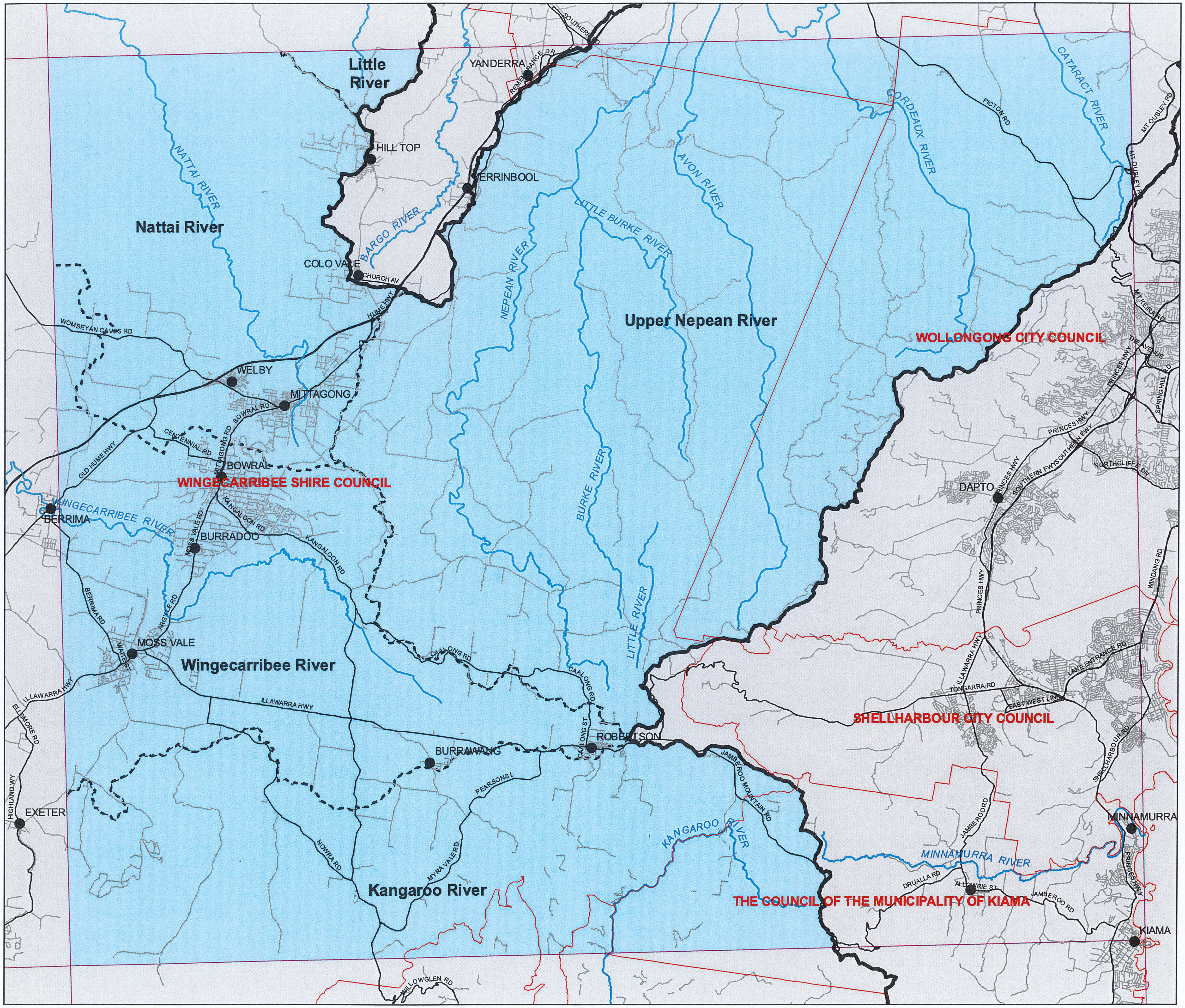
N W E S

0 2 4 6 Kilometers

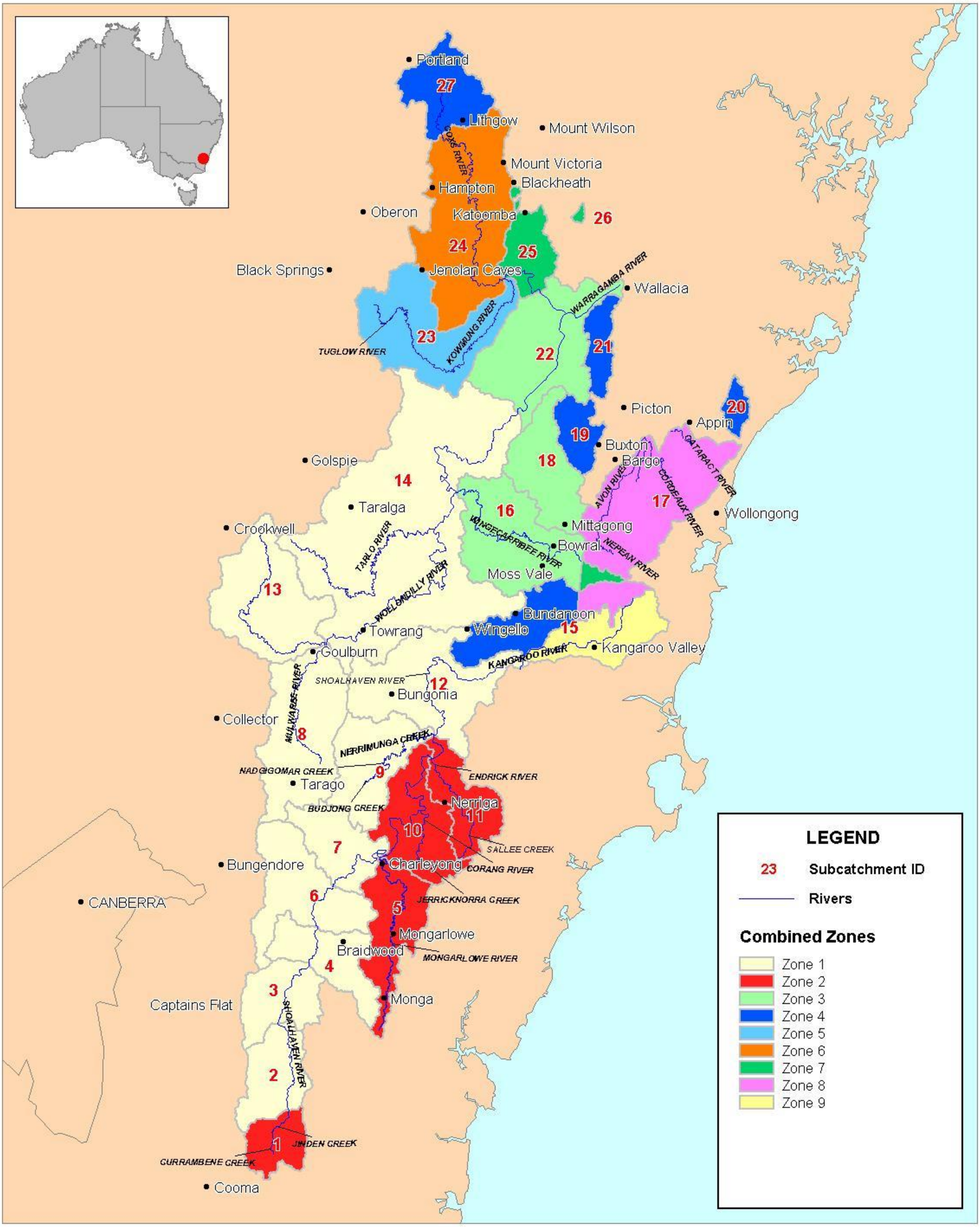
Projection: MGA Zone 56
Datum: GDA94

Scale: 1:160,000 @ A3

Map Identification Number
SEPP_SDWC_015_20101215



Appendix B – SCA Climate Zone Map



Title:
SCA Climate Zones

Figure: **4-2**

Rev: **A**

N

0 30 60km
Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : I:\B16201_I_brh_SCA_MUSIC\DRG\WQU_001_080730_Rainfall_Zones.WOR

Appendix C – Stormwater System Maintenance Schedule

Proposed General Industrial Building Development – 2 Bowman Road, Moss Vale

Stormwater Pits – Surface Inlet Pits without Gross Pollutant Traps			
Maintenance Action	**Frequency**	**Responsibility**	**Procedure**
Inspect all pits for sediment and gross pollutants	Monthly or after storm	Owner	• Inspect all pits. Remove all pollutants and sediment.
Inspect grates for damage and/or blockage	Monthly	Owner	• Check grates for corrosion, damage and/or blockage (especially corners and welds) and replace if required.
Inspect all pits for cracks or spalling	Annually	Maintenance Contractor	• Remove grate and inspect walls, repair wall if required. • Clear vegetation from pits if necessary.

Stormwater Pits – Surface Inlet Pits with Gross Pollutant Traps			
Maintenance Action	**Frequency**	**Responsibility**	**Procedure**
Inspect all pits for sediment and gross pollutants	Monthly or after storm	Owner	• Inspect all pits. Empty all contents from pollutant traps and remove all pollutants and sediment. Refer to attached maintenance guidelines.
Inspect grates for damage and/or blockage	Monthly	Owner	• Check grates for corrosion, damage and/or blockage (especially corners and welds) and replace if required. Refer to attached maintenance guidelines.
Inspect all pits for cracks or spalling	Annually	Maintenance Contractor	• Remove grate and inspect walls, repair wall if required. • Clear vegetation from pits if necessary. Refer to attached maintenance guidelines.

On-Site Detention System			
Maintenance Action	**Frequency**	**Responsibility**	**Procedure**
Check system operational performance	End of first month after installation and annually	Maintenance Contractor	• Inspect and check all components in the OSD system are operating normally. Repair if required.
Inspect system	Quarterly, after storm and/or oil spill	Maintenance Contractor	• Inspect all pits, internal, external and overflow structures. Repair and/or replace if required. • Check all pits and remove debris if required.
Clean system	Annually	Maintenance Contractor	• Clean and check the system and grates for corrosion, damage and/or blockages (especially corners and welds). Replace if required.

Appendix D – Humes Installation and Maintenance Manuals

Humes

Strength. Performance. Passion.

HumeCeptor® system Installation guide

Purpose of this guide

This guide outlines the construction procedures and requirements for the installation of the HumeCeptor® system. This document should be reviewed by supervisory personnel prior to commencing installation.

The following information is of a general nature only and is not intended to be exhaustive or impose or imply any paticular requirements and should be read in conjunction with project-specific documents including the contract, project specifications and project drawings. This guide is not a substitute for the project documentation.

For typical installation requirements please refer to the Humes general assembly standard drawings or Humes project-specific drawings. These are system assembly drawings only and do not constitute and should not be construed as a site layout; the site layout should be specified in project documents provided by the consulting engineer who has been engaged by the asset owner.

Where the contents of this guide differ from project specifications and drawings, supervisory personnel should consult with a Humes engineer. In the event of any conflict between the information in this guide and local legislative requirements, the legislative requirements will take precedence.

It is the responsibility of the site owner and its contractors and consulting engineers to determine the site's suitability for construction, including access for plant, equipment and other issues.

Nothing in this guide is to be construed as a representation, endorsement, promise, guarantee or warranty whether expressed or implied.

Humes makes no representation or warranty, implied or otherwise that, amongst others, the content of this guide is free from errors or omissions or in relation to the adequacy of the information contained in this guide and where appropriate you will seek verification from an independent third party before relying on any information in this guide. Humes is not liable or responsible to any person for any use or reliance of any information arising out of or in connection with this guide.

Safety advice

The HumeCeptor® system must be installed in accordance with all relevant health and safety requirements, including the use of PPE and fall protection where required.

Confined space entry

Installation of the unit may require confined space entry. All equipment and training must comply to SHE regulations. It is the responsibility of the contractor or person/s entering the unit to proceed safely at all times.

Personal safety equipment

The contractor is responsible for the provision of appropriate personal protection equipment including, but not limited to safety boots, hard hat, reflective vest, protective eyewear, gloves and fall protection equipment. Make sure all equipment is used by trained and certified personnel, and is checked for proper operation and safety features prior to use.

Handling

The customer is responsible for unloading of the precast components from the delivery vehicle. The customer should familiarise themself with the site conditions, having regard for suitable space above and around the excavation in order to install the unit safely. Particular attention should be given to safety hazards such as overhead power lines and other services in the vicinity when considering positioning of cranes.

Installation of STC2 model

1. Excavate a hole approximately 2.5 m x 2.5 m at base to accommodate the Humeceptor STC2 which is 1560 mm diameter. If shoring is required, allow 3.5 m x 3.5 m to allow for removal of shoring struts prior to backfilling.

2. Depth from surface level to inlet invert will vary from unit to unit. For depth from inlet invert to underside of base refer to the project drawing for exact dimension.

3. It may be necessary (subject to design by the project engineer) to place a suitable separation type geotextile followed by an aggregate subgrade (200 - 300 mm depth) prior to placing the treatment chamber base section.

4. Place treatment chamber base section onto levelled subgrade. The use of a lifting beam is recommended to ensure a straight chain lift and avoid damage to the joint profile. Check for centre using string line and plumb. Ensure base is level.

5. Mix 2-part megapoxy in accordance with the manufacturer's directions. Trowel megapoxy onto both bottom and top faces of base section joint around complete circumference and lower the bypass chamber onto base section. Ensure correct alignment of inlet and outlet.

6. Place Bostik mastic sealant or equivalent (in accordance with the manufacturer's directions) onto top face of bypass chamber joint around complete circumference and lower the bypass chamber converter slab. Ensure correct alignment of inlet grate opening, directly above the 300 mm inlet drop pipe. When looking from directly above you should be able to see the 100 mm oil sample port and all of the 300 mm inlet drop pipe opening (see Figure 2).

Figure 1 – HumeCeptor® STC2 components

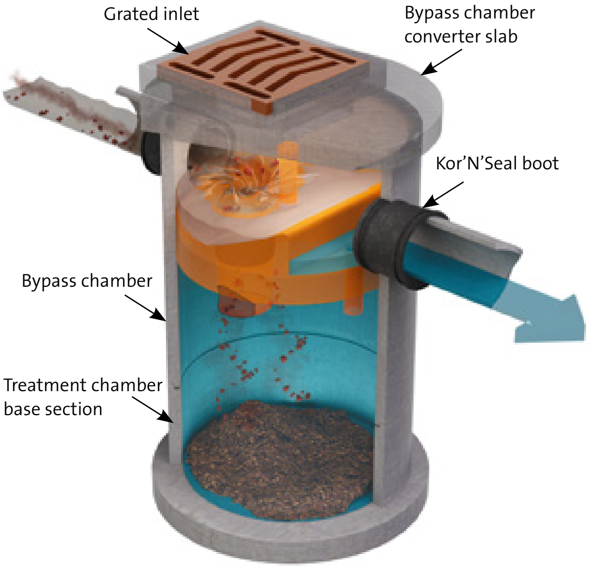
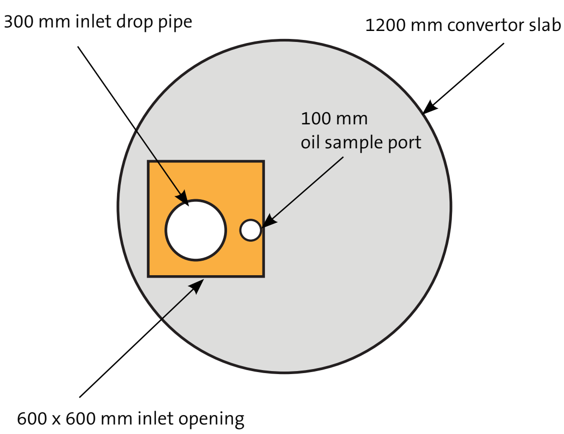


Figure 2 – Component alignment - Plan view



7. Where there is a requirement to extend the bypass chamber towards surface level, trowel megapoxy onto top faces of the sections to be joined and join.

8. Fix concrete surround/frame and grate over opening. Make up rings may be used to adjust finished surface level.

9. Backfill to outlet pipe level, using granular material and good compaction methods.

10. Connect inlet and outlet pipes (normally using Kor'N'Seal boots). Lube Kor'N'Seal boots prior to insertion of pipes if required. Place stainless steel pipe clamps around Kor'N'Seal boots and tighten.

11. Backfill and compact to surface level.

Left:
HumeCeptor® STC2 with extended bypass chamber and Kor'N'Seal boots.

Installation of P-Series STC2 model

1. Excavate a hole approximately 2.5 m x 2.5 m at base to accommodate the P-Series STC2 which is 1560 mm diameter. If shoring is required, allow 3.5 m x 3.5 m to allow for removal of shoring struts prior to backfilling.

2. Place 150 mm layer of well graded sand or similar foundation material to level in the base of the excavation.

3. The unit will require the plastic wrapping to be removed and the strapping cut so that it can be lifted off the pallet. A lifting point is located on the top of the unit so that a bar and soft slings can be used to lower the device into position. The total weight of the unit is approximately 200 kg.

4. If groundwater is present, the unit may need to be stabilised against buoyancy forces. This involves using a concrete foundation in order to anchor the unit around the base in the ground. There are four lugs with eyes on the base of the unit. These are for putting rebar in when concreting around the base of the unit.

Figure 3 – Lifting using a bar and soft sling

Figure 4 – Standard installation

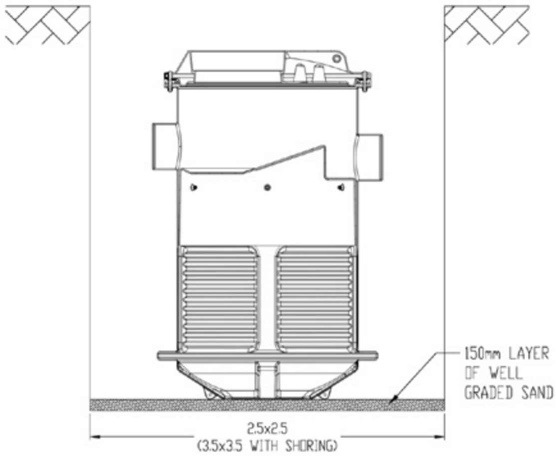
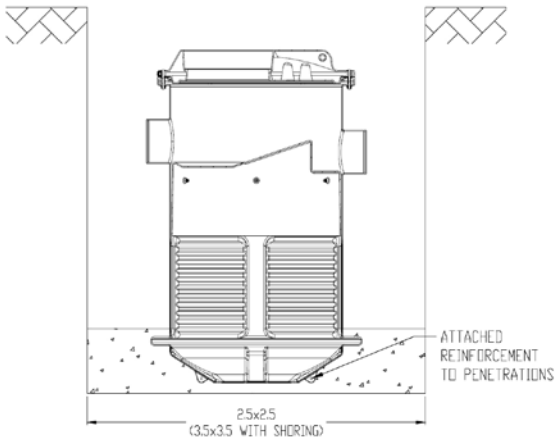


Figure 5 – Groundwater installation



5. Pipe connections vary depending on the types of pipes involved. In general, the inlet and outlet need to be cut out with a sabre saw or similar to the outside diameter of the pipes. They should then be inserted so as to protrude about 20mm on the inside, and the joint sealed with a flexible sealant such as Sikaflex. The P-Series STC2 can have a maximum inlet and outlet pipe diameter of 300 mm PVC, but can be reduced as required with the use of standard PVC pipe reducer fittings.

6. The P-Series STC2 is not supplied with a polymer riser; should a riser be required a 600 mm diameter section of PVC pipe (or similar) can be used.

7. The riser at the required length is inserted into the opening in the top of the unit, and sealed with a suitable sealant such as Sikaflex or similar.

8. **Extremely important:** Prior to backfilling, the unit must be filled with water. This is achieved by pumping into the inlet pipe side, or directly down through the riser and into the opening in the deck on the inlet side. The P-Series STC2 is full when water starts to flow out through the outlet pipe.

9. Once filled with water the excavation can be backfilled. Backfill should be to local requirements and the specifications by the design engineer. Fill should not contain rock particles larger than 10 mm and a relative density of 95% MDD is recommended. Backfill should be evenly compacted around the sump with a plate compactor on medium setting.

10. The P-Series STC2 Humeceptor has been designed to withstand the loads associated with a maximum 300 mm of select backfill cover (equivalent to a ground permanent load of 6 kPa) and up to 2 kPa of surcharge load in accordance with the relevant Australian Standards.

11. Place the cast iron access cover (or grate) in its surround onto the compacted backfill so that it does not bear onto the unit, or riser, directly.

Figure 6 – Inlet penetration detail

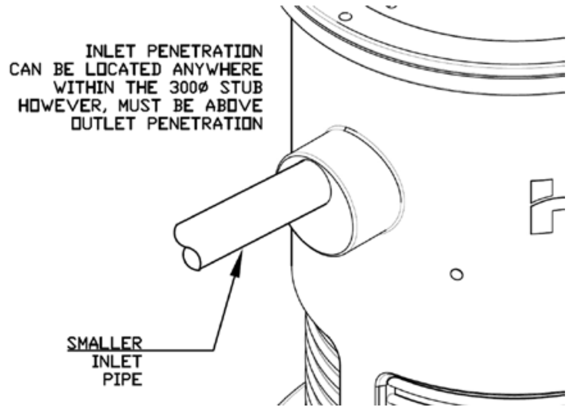


Figure 7 – Outlet penetration detail

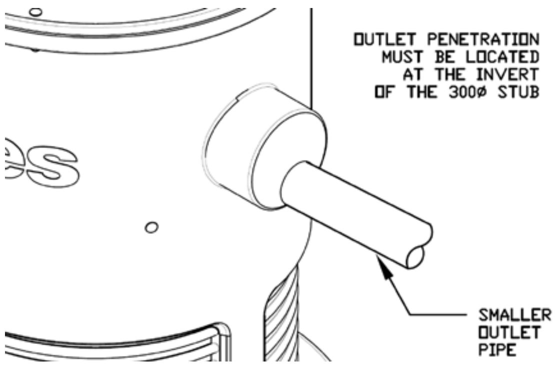
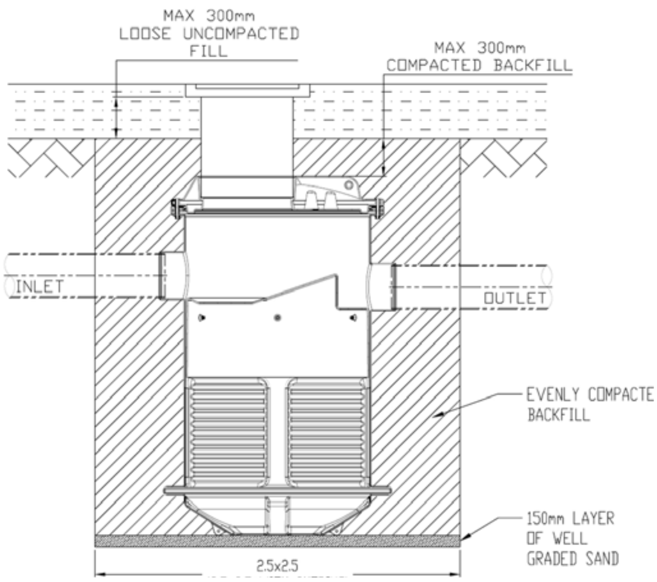


Figure 8 – Complete installation



Installation of STC3 - STC7 models

1. Excavate a hole large enough to accommodate the treatment chamber base section. If shoring is required, allow sufficient space all around to allow for removal of shoring struts prior to backfilling.

2. Depth from surface level to inlet invert will vary from unit to unit. For depth from inlet invert to underside of base refer to the project drawing for exact dimension.

3. It may be necessary (subject to design by the project engineer) to place a suitable separation type geotextile followed by an aggregate subgrade (200 - 300 mm depth) prior to placing the treatment chamber base section.

4. Place treatment chamber base section onto levelled subgrade. The use of a lifting beam is recommended to ensure a straight chain lift and avoid damage to the joint profile. Check for centre using string line and plumb. Ensure base is level.

5. Mix 2-part megapoxy in accordance with the manufacturer's directions. Trowel megapoxy onto both bottom and top faces of base section joint around complete circumference and lower the bypass chamber onto base section. Ensure correct alignment of inlet and outlet.

6. Place Bostik mastic sealant or equivalent (in accordance with the manufacturers directions) onto top face of bypass chamber joint around complete circumference and lower by-pass chamber convertor slab into place. Ensure correct alignment of access chamber opening in relation to the 600 mm decant pipe opening and 150 mm oil sample port. When looking from directly above you should be able to see down the 150 mm oil sample port opening and be able to see most of the 600 mm opening in the fibreglass insert (see Figure 10).

Figure 9 – HumeCeptor® components

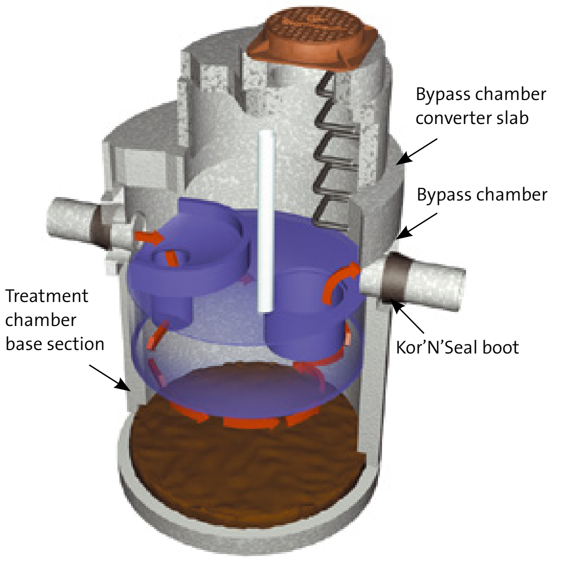
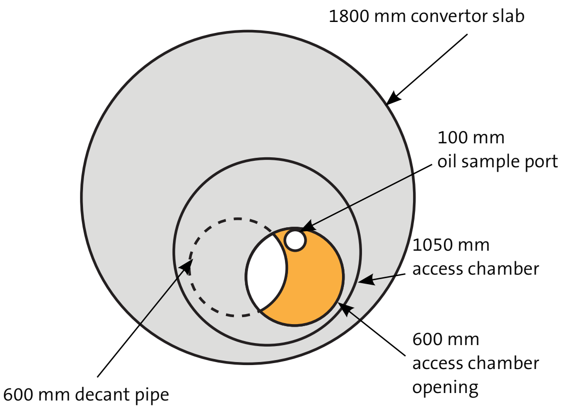


Figure 10 – Component alignment - Plan view



7. Where there is a 1050 mm access chamber, trowel megapoxy onto the surfaces to be joined. Lower 1050 mm access chamber convertor slab (reducing to 600 mm opening) onto access chamber, again ensuring correct alignment with clear view of entire 150 mm oil sample port, and partial view of 600 mm opening in fibreglass insert.

8. Fix concrete surround/frame and grate over opening. Make up rings may be used to adjust finished surface level.

9. Backfill to outlet pipe level, using granular material and good compaction methods.

10. Connect inlet and outlet pipes (normally using Kor'N'Seal boots). Lube Kor'N'Seal boots prior to insertion of pipes if required. Place stainless steel pipe clamps around Kor'N'Seal boots and tighten.

11. Backfill and compact to surface level.

Installation of STC9 - STC27 models

1. Excavate a hole large enough to accommodate the treatment chamber base section. If shoring is required, allow sufficient space all around to allow for removal of shoring struts prior to backfilling.

2. Depth from surface level to inlet invert will vary from unit to unit. For depth from inlet invert to underside of base refer to the project drawing for exact dimension.

3. It may be necessary (subject to design by the project engineer) to place a suitable separation type geotextile followed by an aggregate subgrade (200 - 300 mm depth) prior to placing the treatment chamber base section.

4. Place treatment chamber base section onto levelled subgrade. The use of a lifting beam is recommended to ensure a straight chain lift and avoid damage to the joint profile. Check for centre using string line and plumb. Ensure base is level.

5. Fit skid ring (rubber ring) to treatment chamber base. It is important to ensure that the tension in the ring is evenly distributed. Running a smooth bar around underneath the ring several times does this. Uneven tension can be detected by variability in ease of running bar around. Try to redistribute slack into the tense part of ring.

6. Lubricate skid ring and socket of treatment chamber top section with approved non-deleterious lubricant. Do not allow dirt to contaminate lubricant. Do not allow lubricant to get under ring.

Figure 11 – HumeCeptor® components

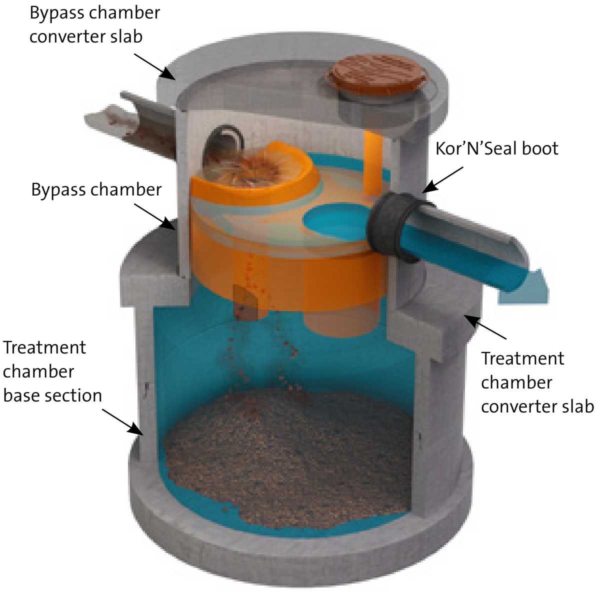
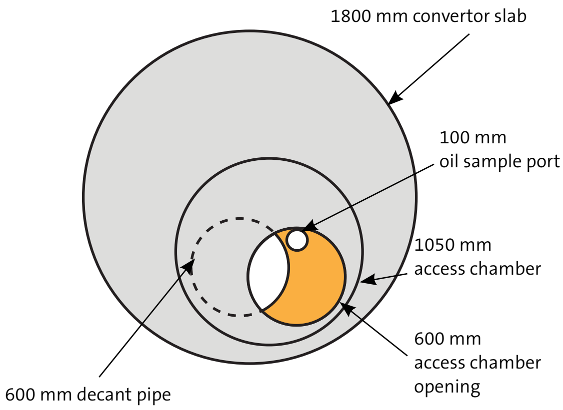


Figure 12 – Component alignment - Plan view



7. Again using a lifting beam, gently lower treatment chamber top section onto base section. Ensure that the top section is level prior to lowering fully. This can be achieved by placing 50 mm x 25 mm timbers on bottom, outside lip of base section in three equal spaces around circumference. Once down equally on timbers, crane can take up weight to allow removal of timbers and then gently lower. If top section drops down to one side **do not force** as this can result in major damage to chamber socket. Lift up and re-level prior to lowering again. The top section should drop down to fully meet bottom section around full circumference.

8. Mix 2-part megapoxy in accordance with the manufacturer's directions. Trowel megapoxy into treatment chamber convertor slab joint recesses around complete circumference.

9. Lower bypass chamber onto treatment chamber convertor slab, ensuring correct alignment of inlet and outlet.

10. Install the inlet drop pipe and orifice plate. The inlet drop pipe will only fit into the inlet hole at the weir when aligned correctly as it is elliptical (no glue required). When pushed in there should be a 100 mm overlap. Similarly, the orifice plate should be pushed into the inlet hole so that it sits approx. 25 mm below invert level.

11. Install the 600 mm decant pipe extension. The decant pipe extension will only slide in one way as it is tapered. Apply a generous coating of Epirez PU mastic (supplied by Humes) around the outside of the extension, approximately 50 mm from the top. Slide the extension into the 600 mm decant opening. There should be a 100 mm overlap once fully installed. Ensure a seal has been achieved between the extension and insert.

12. Place Bostik mastic sealant or equivalent (in accordance with the manufacturers directions) onto top face of bypass chamber joint around complete circumference and lower by-pass chamber convertor slab into place. Ensure correct alignment of access chamber opening in relation to the 600 mm decant pipe opening and 150 mm oil sample port. When looking from directly above you should be able to see down the 150 mm oil sample port opening and be able to see most of the 600 mm opening in the fibreglass insert (see Figure 12).

13. Where there is a 1050 mm access chamber, trowel megapoxy onto the surfaces to be joined. Lower 1050 mm access chamber convertor slab (reducing to 600 mm opening) onto access chamber, again ensuring correct alignment with clear view of entire 150 mm oil sample port, and partial view of 600 mm opening in fibreglass insert.

14. Fix concrete surround/frame and cover in place. Make up rings may be used to adjust to finished surface level. A length of pipe will already be connected to the oil sample port location. It may be necessary to extend this pipe with a female-ended length of pipe as per the Humeceptor assembly drawing.

15. Backfill to outlet pipe level, using granular material and good compaction methods.

16. Connect inlet and outlet pipes (normally using Kor'N'Seal boots). Lube Kor'N'Seal boots prior to insertion of pipes if required. Place stainless steel pipe clamps around Kor'N'Seal boots and tighten.

17. Backfill and compact to surface level.

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Humes

Strength. Performance. Passion.

HumeFilter® UPT Installation guide

Purpose of this guide

This guide outlines the construction procedures and requirements for the installation of the HumeFilter® UPT. This document should be reviewed by supervisory personnel prior to commencing any HumeFilter® installation.

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The following information is of a general nature only and is not intended to be exhaustive or impose or imply any particular requirements and should be read in conjunction with project-specific documents including the contract, project specifications and project drawings. This guide is not a substitute for the project documentation.

For typical installation requirements please refer to the Humes general assembly standard drawings or Humes project-specific drawings. These are system assembly drawings only and do not constitute and should not be construed as a site layout; the site layout should be specified in project documents provided by the consulting engineer who has been engaged by the asset owner.

Where the contents of this guide differ from project specifications and drawings, supervisory personnel should consult with a Humes engineer. In the event of any conflict between the information in this guide and local legislative requirements, the legislative requirements will take precedence.

It is the responsibility of the site owner and its contractors and consulting engineers to determine the site's suitability for construction, including access for plant, equipment and other issues.

Nothing in this guide is to be construed as a representation, endorsement, promise, guarantee or warranty whether expressed or implied.

Humes makes no representation or warranty, implied or otherwise that, amongst others, the content of this guide is free from errors or omissions or in relation to the adequacy of the information contained in this guide and where appropriate you will seek verification from an independent third party before relying on any information in this guide. Humes is not liable or responsible to any person for any use or reliance of any information arising out of or in connection with this guide.

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Safety advice

The HumeFilter® UPT must be installed in accordance with all relevant health and safety requirements, including the use of PPE.

- Fall protection may be required.
- Prior to the fit out of the filters and insert, the HumeFilter® chamber is very deep and as such care must be taken when standing or walking around the structure.
- If the top slab, covers or hatches have not yet been installed, or are removed for any reason, great care must be taken to not drop anything onto the HumeFilter® insert or filters. The HumeFilter® insert and filters create a watertight seal that may be damaged under high impact loads. This type of activity voids all warranties.

Confined space entry

Entry into the HumeFilter® requires confined space entry. All equipment and training must comply to SHE regulations. It is the responsibility of the contractor or person/s entering the HumeFilter® unit to proceed safely at all times.

Personal safety equipment

The contractor is responsible for the provision of appropriate personal protection equipment including, but not limited to safety boots, hard hat, reflective vest, protective eyewear, gloves and fall protection equipment. Make sure all equipment is used by trained and certified personnel, and is checked for proper operation and safety features prior to use.

Installation

Installing the HumeFilter® UPT precast structure is in many ways the same as installing a manhole structure like a precast pump station, and should conform in general to state highway, provincial or local specifications.

Stage 1 – Prepare the site

a) Excavate

Site excavation, shoring and general site preparation for the installation of the HumeFilter® system is the responsibility of the contractor and should conform to local specifications and EH&S regulations.

- Verify the soil bearing capacity is adequate for the required load.
- Stockpile any topsoil removed during the excavation into designated areas, and do not mix this with subsoil or other materials.
- The HumeFilter® should not be installed on frozen ground.
- Excavate a minimum of 300 mm from the precast concrete surfaces, plus an allowance for shoring and bracing where required.
- If the bottom of the excavation provides an unsuitable foundation additional excavation may be required. In areas with a high water table, continuous dewatering may be required to ensure that the excavation is stable and free of water.

b) Prepare the base

Compact undisturbed sub-grade materials to 95% of maximum density at +/-2% of optimum moisture content prior to placement of crushed rock. Place granular sub-base and compact to State/Provincial and local standards as per the Engineers requirements to a depth of 300 mm. Unsuitable material below sub-grade shall be replaced per site engineer's approval. Level the sub- grade to the proper elevation. Verify the elevation against the HumeFilter® precast structure dimensions, the invert elevations, and the site plans. Adjust the base aggregate, if necessary.

Stage 2 – Take delivery of the HumeFilter®

a) Select a suitable crane

The contractor is responsible to provide a safe work site, including the appropriate selection of equipment to safely rig, lift, unload and set the HumeFilter® in place. Humes will provide the contractor with the maximum lift weight of the heaviest precast component. The lifting clutches required will be advised on the Humes manufacture drawings, which will be supplied by the contractor or crane company.

Safety considerations for crane size, placement, ground support, stability, and distance to excavation, swing and lifting radius, overhead conflicts, permits, or traffic control and other items must be carefully addressed but are outside Humes' responsibility. We encourage professional planning procedures be followed at every step.

b) Off-load and inspect HumeFilter® componentry

The contractor is responsible to safely rig and unload the HumeFilter® structure and associated components. Handle all HumeFilter® components with care. Special lift gear and rigging may be necessary to unload and handle any precast components. Do not damage the parts in handling or unloading, and if parts are damaged prior to off-loading, please call Humes immediately.

In all cases, the complete HumeFilter® has been preassembled at the factory before shipment, so when it arrives on site you can be assured that it will fit together correctly on your site. Prior to offloading, the contractor should confirm the quality and condition of the HumeFilter® components, and if there is any reason for concern, contact Humes immediately.

The contractor and/or site engineer are responsible for the inspection of all HumeFilter® unit components shipped at time of delivery. Any non-conformance to approved drawings or damage to any part of the system shall be documented on the shipping ticket, and Humes should be contacted immediately. Damage to the unit during and after unloading shall be corrected at the expense of the contractor. Any necessary repairs shall be approved by the site engineer/inspector.

HumeFilter® filter components list

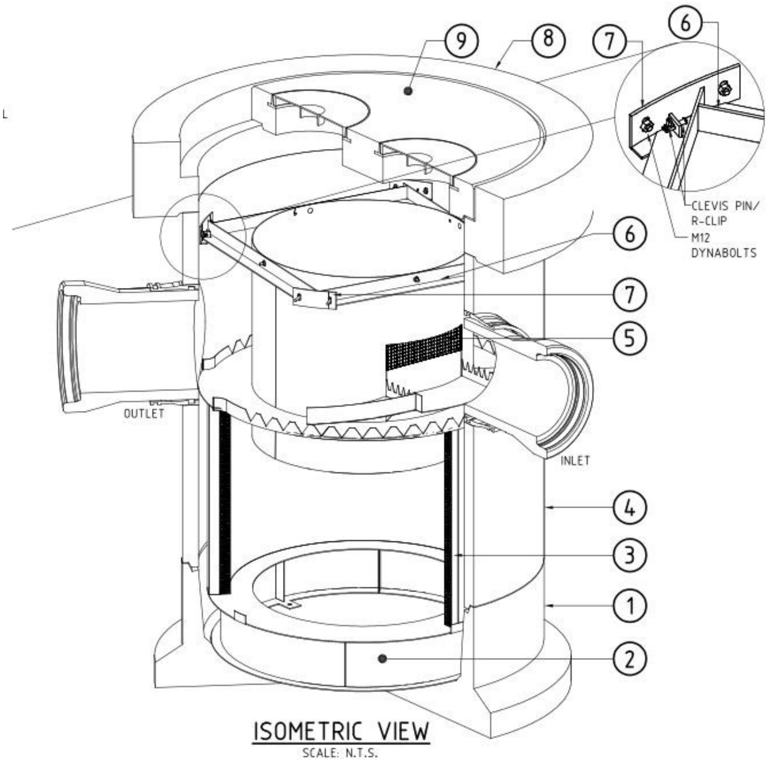
HumeFilter® components will be documented on the approved drawings, and typically include:

1. Precast concrete base unit
2. Stainless steel plinth already fitted into the precast base unit
3. Inner and outer filters that will require lowering into position after the Precast concrete shaft is fitted
4. Precast concrete shaft – note, there may also be an additional make up shaft to achieve the correct depth to invert level
5. Stainless steel insert that sits inside the precast concrete shaft and on top of the inner and outer filters
6. Stainless steel insert support bracket
7. Support frame mounting brackets (pre-fitted to the shaft in the factory)
8. Precast concrete surround
9. Precast concrete lid

Materials to be supplied by the contractor:

- All personal safety equipment
- Crane, and structure lifting and rigging gear for off- loading and setting
- Grout — Non-shrink grout to connect the inlet/outlet pipe
- Grout — Non-shrink grout to fill all entry and exit points and any holes for lift points
- Inlet and outlet pipe plugs

Figure 1 – HumeFilter® components



Stage 3 – Install the HumeFilter® UPT

1. Obtain a copy of the final approved shop drawing and site plan to orient and verify all components and their correct placement. Ensure the inlet(s) and outlets are oriented per the plans.

2. Set the base section of the HumeFilter® on solid sub-grade.

3. Add a watertight seal (either mastic and primer or rubber ring and lubricant, or megapoxy) to each of the precast sections.

4. Verify the level and elevation of the base section before adding any additional precast shaft sections. Manhole floor shall slope 6 mm maximum across the "width", and slope downstream 25 mm per 3.7 m of "length" ("length" is defined by a line running from the invert of the outlet through the centre of the manhole and "width" is the perpendicular to the "length").

5. Set shaft section(s) on top of the base section. This section will contain the filters and stainless steel inserts.

6. Verify the outlet pipe invert elevation.
   Note: All HumeFilter® elevations are based on the outlet pipe invert elevation (assuming the outlet pipe is centred in the hole provided). The HumeFilter® was designed and fabricated around the outlet elevation, unless otherwise stated in brackets.

7. Once the first shaft section has been installed, add the mastic, megapoxy or rubber ring and lubricant. Place the next shaft section (if required), ensuring the steps (if required) are correctly aligned.
   Note: Precast sections should assemble relatively easily and should not be forced.

8. Set the surround on top of the shaft. Note the top surround's orientation. The surround can be manufactured to accommodate a sloping site and therefore the orientation of the surround relative to the sites grade is important. The lid finish grade shall match the surrounding finish grade surface per the engineer's plans and the Humes approved shop drawings unless otherwise directed by the site engineer.

Above: Base, shaft, and surround installed

9. Install the inlet and outlet pipes ensuring that the non-shrink grout sealing the pipes is flush with the inside walls of the precast shaft. It is important that the grout doesn't protrude inside the shaft as it will interfere with fitting the stainless steel insert.

10. Once the watertight connection is established carefully backfill around them, compacting in "lifts" that will not deflect, disturb or damage the pipes in accordance with the site plans and specifications.

11. Contractor is responsible for sealing and making all joints, line entry and exit points watertight, and for sealing any holes used for lift points.

12. After the shaft sections and surround is installed, the outer filter is lowered onto the stainless steel plinth. There are 4 vertical tabs on the plinth to locate this filter. Next the inner filter is lowered inside the outer filter – see top image.

- **Note**: The UPT1200 filters and UPT1800 filters will arrive as fully circular filter elements and no assembly will be required prior to lowering them into position.
- The UPT2400, UPT3000, and UPT3600 filters will arrive on site as arced panels and require some assembly prior to lowering into position.
- Each panel will slide into the next and a bolt at the top and the bottom of each will need to be tightened. All the panels when bolted together will form a fully circular filter ready to be lowered into position. See images below.

Top:
Filters lowered into position

Middle:
Pleated cartridge panel for a UPT2400 filter

Bottom:
Multiple panels bolter together for a UPT2400 filter and bolting detail close-up

Top:
Stainless steel insert fitted into the shaft

Middle:
Pinned support frame

Bottom:
Site works completed

13. The filters are lowered into position; the stainless steel insert is lowered into the shaft and onto the top of the filters.

    - **Note**: The bolts for the brackets on the wall are loose to allow for adjustment on site. The intention is for some weight (sand bags or similar) to be placed on top of the support frame, to ensure that the watertight seals are compressed correctly.
    - Once the weight has been added, the brackets can be raised such that the hole on the vertical plate is above the support frame and the clevis pin/r-clip can be inserted.
    - Once inserted the bracket can be lowered under its own weight so its weight is supported by the pin, and the bolts on the wall can be tightened.
    - When the weight is removed from the support frame the tension of the filter seals will apply tension on the pins and lock the insert into the correct position. A Humes representative will be on site to provide guidance if required.

14. After the insert has been fitted the lid can be fitted and the site works completed

Stage 4 – Manage construction run-off

The HumeFilter® is a Post-Construction Best Management Practice for stormwater treatment, and was selected by the Engineer for post-construction stormwater quality treatment. It is the responsibility of the contractor to ensure appropriate erosion and sediment control (ESC) measures and construction BMPs are in place to protect the HumeFilter® from construction runoff, sediment and other debris until the site is fully stabilized post-construction. Methods to assist in maintaining cleanliness of the HumeFilter® during construction include:

1. Plug the inlet and outlet of an upstream flow splitter or bypass structure and downstream junction manhole to prevent construction run-off from reaching the HumeFilter®, or,
2. It is also possible to refrain from installing the filters until the unit has been fully cleaned, post-construction and the site stabilized.

The method ultimately selected shall be at the contractor's discretion and risk, knowing the HumeFilter® shall be clean and free of sediment and debris prior to filter installation.

Stage 5 – Activate the system

Once construction is complete and the site has been fully stabilized (i.e. landscaping is in place, grass growing and top course of pavement laid), the HumeFilter® system can be activated. The contractor is responsible for ensuring the HumeFilter® system is kept clean and free of debris and sediment prior to filter installation. The site shall be stabilized (non- erodible soil surfaces) and unit been confirmed to be clean and free of debris prior to filter installation and being placed in service for proper operation and performance. This delay avoids the potential of a large rainfall/runoff event that could load (and/or overload) the filters prematurely and shorten the service life for the owner.

Even so, care should be taken in project site-maintenance of erosion control practices and barriers to prevent an influx of sediment that would require vacuum truck maintenance costs prior to commissioning a new system. Even with care, some jobsite debris can enter the HumeFilter® system. All debris MUST be cleaned from the HumeFilter® PRIOR to filter installation. Keeping the system clean is the contractor's responsibility.

Depending on the methods used to protect the HumeFilter® from construction runoff, the contractor should:

1. Inspect the system to ensure maintenance is not required
2. Remove all upstream and downstream pipe plugs that were used to prevent construction runoff from reaching the structure. Standing water should be pumped out - the contractor must conform with all confined space requirements prior to entering any underground structure.

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Appendix E – ACO Stormbrixx Technical Handbook

Stormwater Management Systems

ACO STORMBRIXX®

Technical Handbook and Product Catalogue

Stormwater retention

Stormwater detention

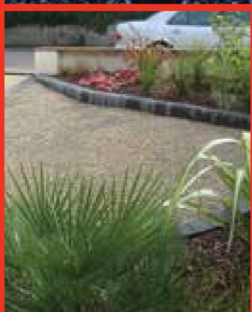
Stormwater infiltration

Introduction to the ACO Group

ACO branded drainage and surface water management systems are recognised throughout the world for their innovative design, high quality, environmental benefits and industry leading performance.

The ACO Group has a research and production base that reaches across four continents. This unmatched resource pioneers the development of solutions that are tailored to individual markets, meeting the need for high performance and sustainable products that deliver optimum value throughout their operational life.

The ACO Group / www.aco.com



ACO Pty Ltd

ACO Pty Ltd is part of the ACO Group, a multinational company specialising in products for stormwater, wastewater and cable management.

ACO has been supplying products and solutions to the Australian construction and building industry for over 25 years.

System Chain

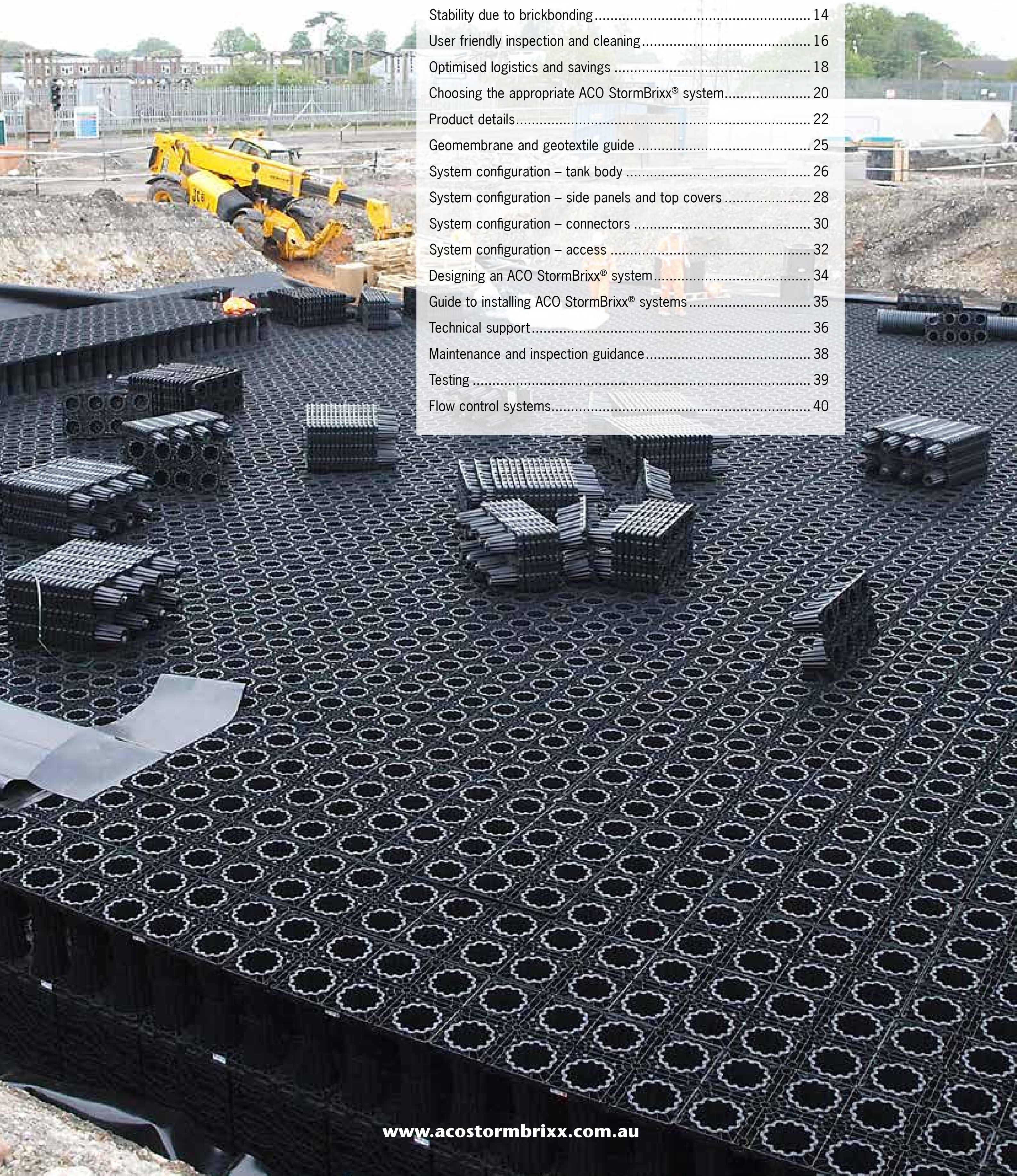
ACO manufactures a range of construction products from polymer concrete, stainless steel, mild steel, ductile iron and moulded plastics. These diverse materials are used to manufacture products for civil, urban and building architectural applications.

ACO is always bringing new products to the Australian market and works in conjunction with the ACO Group's established Research and Development Department responsible for continuous development, quality and testing to ensure ACO products continue to lead the market.

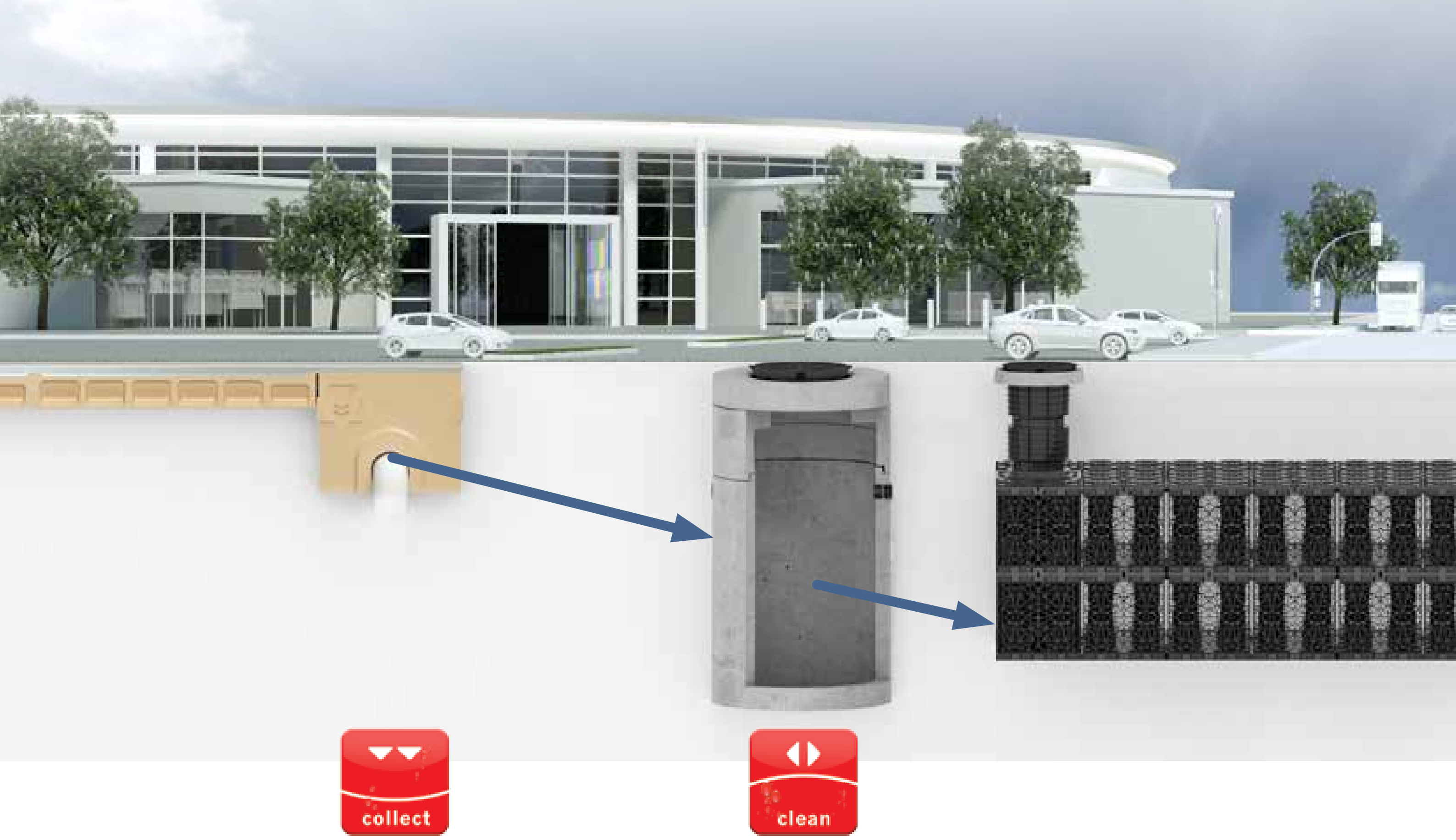
Service Chain

ACO provides onsite support for all aspects of the business from specification advice to installation expertise. Through dedicated training programs, ACO is recognised for providing architects and engineers surface drainage education.

Contents



The Surface Water Management Cycle



Where surface water management and water protection begins

Surface water management begins with an assessment of the hydrological demands of the project landscape. The rainfall and topography determine the surface water solution devised. ACO provides expertise in both the assessment and provision of product solutions to collect surface water across the site.

In hard surfaced areas, the extensive range and capacity of ACO trench drainage products offer a high capture performance along the total length of the trench run, thereby reducing the occurrence of ponding or unwanted runoff.

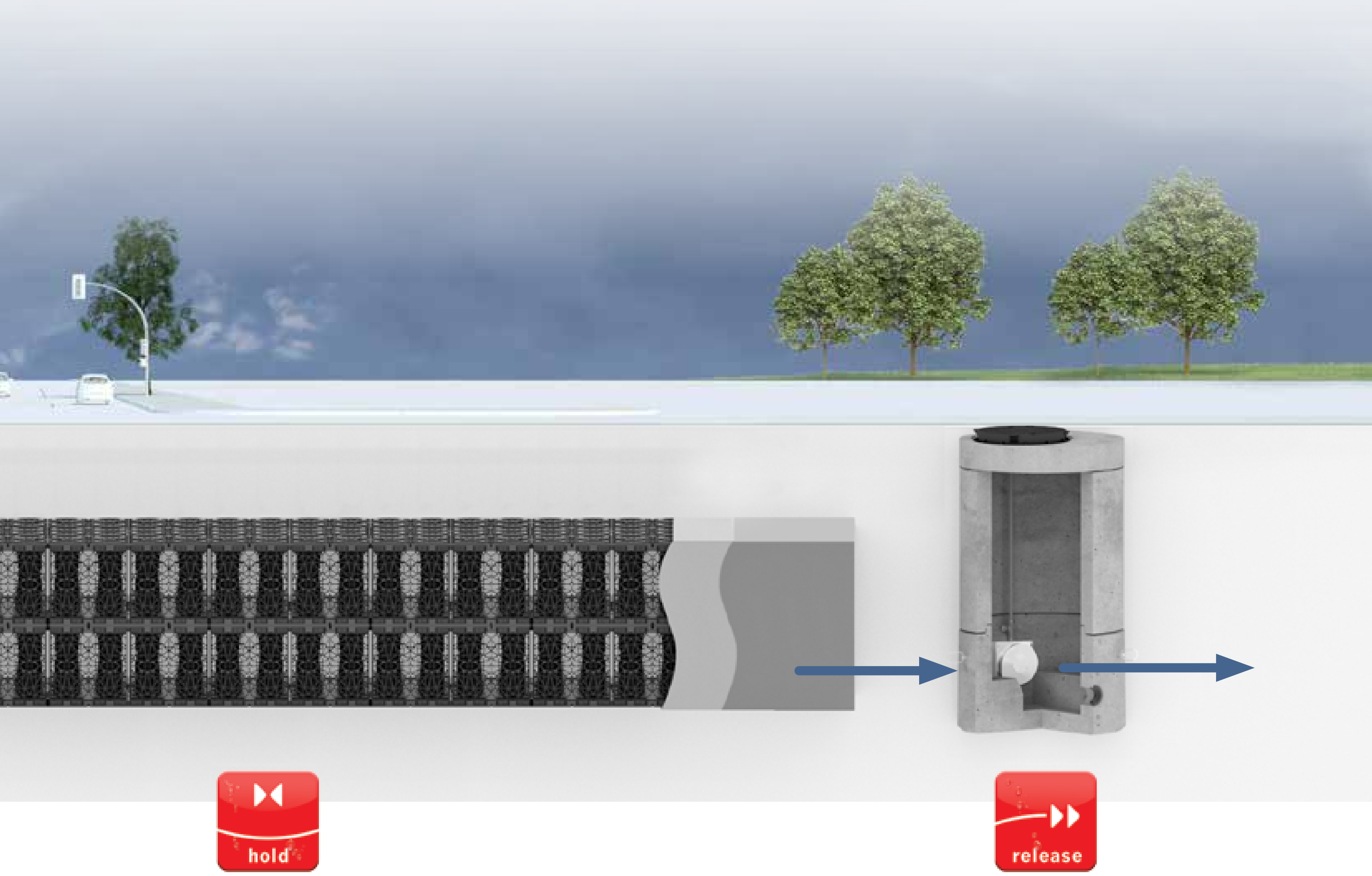
The safety and convenience of people, buildings and traffic is assured with ACO trench drainage products and surface water is managed on to its next stage in the water management process.

Achieving the right water quality

Water quality is an important factor when designing a surface water management solution. Surface water run-off is at greater risk of contamination from increased urbanisation and transportation demands on the environment. Government policy and planning guidelines require water quality to be taken into account to prevent contamination of surface and groundwater. If untreated water is discharged into the natural surroundings, it could endanger plant and wildlife, therefore preventative methods should be put in place.

Contaminations come in many forms, such as siltation containing suspended hydrocarbons and heavy metals, tyre wear, brake dust, soot and sediments, as well as de-icing products used during winter months in alpine regions.

ACO offers a number of treatment units to deal with water quality including heavy metal and suspended solids separators, and gas/oil interceptors. These can be combined with swales, so clean water can nourish an onsite wildlife area and allow wildlife and biodiversity to flourish.



Reducing surface runoff to a natural level

With increasing urbanisation, larger areas of landscape are being covered with impermeable surfacing. This increases the risk of flooding. The natural water cycle of infiltration, evaporation and evapotranspiration is hindered. Solutions such as ACO StormBrixx® can be used to store and slow down the surface water runoff rate to natural levels. These geocellular systems can be used for retention, detention and infiltration as well as contributing to Water-Sensitive Urban Design (WSUD).

ACO StormBrixx® can help support the stormwater network by providing capacity to meet these high risk flooding scenarios. They can also be used to protect surrounding water networks and inhabited areas through a controlled discharge into the groundwater that mimics natural infiltration.

Control discharge rate to the required level

To meet the limiting capacity requirements of stormwater networks and natural waterways, water discharge rates are controlled on site by either an orifice plate or vortex flow controllers.

ACO has solutions for both environments with units sized to match legislated run-off rates or the runoff rate from a greenfield equivalent to ensure that the infrastructure and environment are not put under strain.

Introduction to ACO StormBrixx® Range

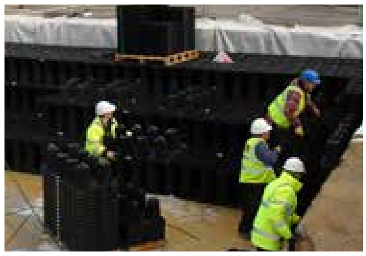
ACO StormBrixx® is a unique, and patented, plastic geocellular stormwater management system. Designed for surface water infiltration and storage, its versatility allows it to be used in applications across all construction environments as a standalone solution or as part of a Water Sensitive Urban Design (WSUD).

What is ACO StormBrixx®?

Sustainable surface water management is becoming an integral part of most major planning applications. Consideration should be given to management of both quantity and quality of water discharged off-site, along with ongoing maintainability.

Plastic geocellular systems are a widely accepted method of creating retention, detention and infiltration tanks. They have been installed in a variety of applications for a number of years. A drawback of some types of systems is a lack of accessibility for maintenance.

ACO StormBrixx® addresses the ongoing maintenance requirements by providing 3D access for inspection and maintenance, while retaining the structural integrity of the installation.



The ACO StormBrixx® system

The ACO StormBrixx® system consists of a single, recyclable, polypropylene body that can be assembled in a variety of ways to form an open bonded structure.

ACO StormBrixx® has a unique pillar structure that gives a high void ratio of 95 to 97 percent. This minimises excavation required to achieve a specified storage capacity, reduces the aggregate needed for backfilling and improves the flow characteristics of runoff through the tank.

Side panels are added to the perimeter of the system for lateral support, and top covers are added to ensure consistent vertical support for cover fill material.

ACO StormBrixx® benefits from a patented cell brick and cross bonding feature, which provides unparalleled stability in the construction of the tank. Where brickbonding is not used, or for multilayered tank structures, connectors are available to support the integrity of the structure.

Additional accessories available include inspection point and pipe connectors, as well as a range of chambers for inspection and maintenance.

ACO StormBrixx® can be configured to minimise silt accumulation and can accommodate a sediment bay or silt trap facility, ensuring the system can be properly maintained throughout its life.

Why choose ACO StormBrixx® ?

Structural integrity

The ACO StormBrixx® system has been tested independently to certify structural integrity and the long term life expectancy.

The patented brickbonding and cross bonding feature provides a strong, long life installation and helps improve the construction speed of the tank.

Access and maintenance

ACO StormBrixx® addresses the fundamental requirement of access and maintenance for local authorities. The open cell structure permits completely free access for CCTV and jetting equipment which allows the whole system, including all the extremities, to be inspected and maintained from a few access points.

Simplified logistics

ACO StormBrixx® simplifies delivery, site logistics and installation as a result of its stackable design. Each single injection moulded body nestles, optimising logistical and installation cost significantly, thus helping to reduce the carbon footprint of the system.

System benefits

- Brick bonded and cross bonding connection for optimal stability
- Sediment bay and silt trap options for silt management
- Maintenance access and 3D inspection access to tank interior
- Environmentally efficient solution, minimising carbon emissions in manufacture, transportation and on-site assembly
- High void ratio minimises excavation volume
- Fully certified performance
- Manufactured from recyclable polypropylene
- Suitable for all industrial, commercial and residential applications

ACO StormBrixx® Applications and Case Studies

Typical applications

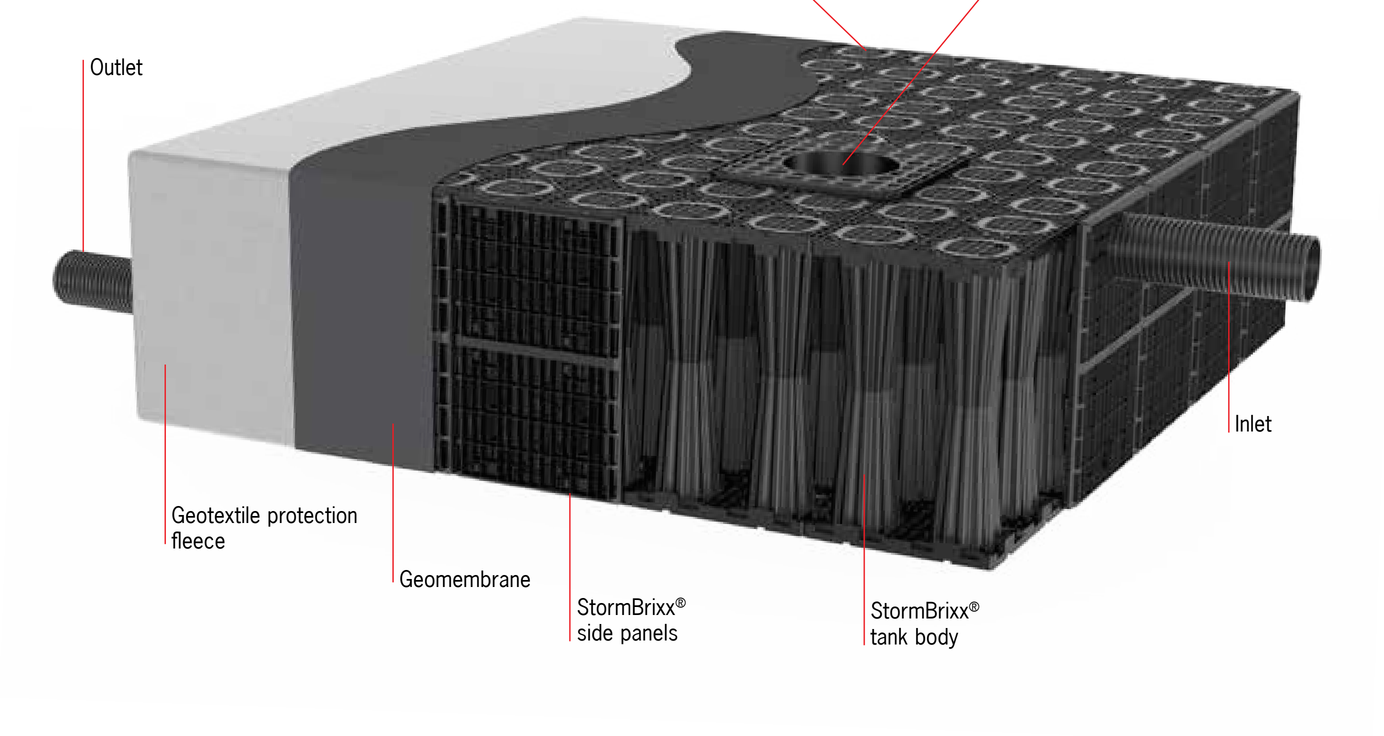

Car parks


Educational facilities

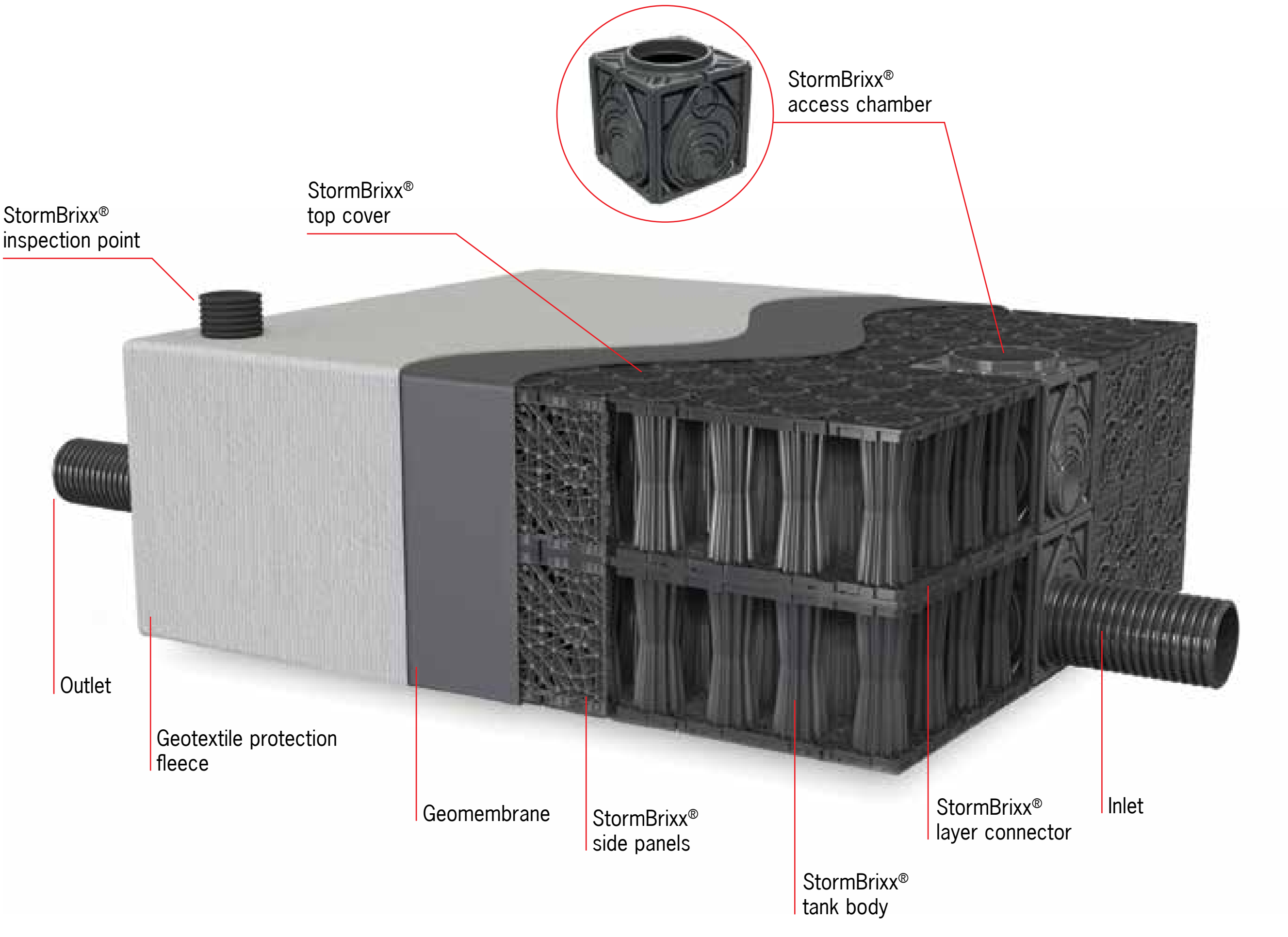

Housing developments


WSUD schemes

StormBrixx® SD (Standard Duty) range is ideal for retention and detention for light to medium duty applications



StormBrixx® HD (Heavy Duty) range is ideal for retention and detention



ACO StormBrixx® Case Study

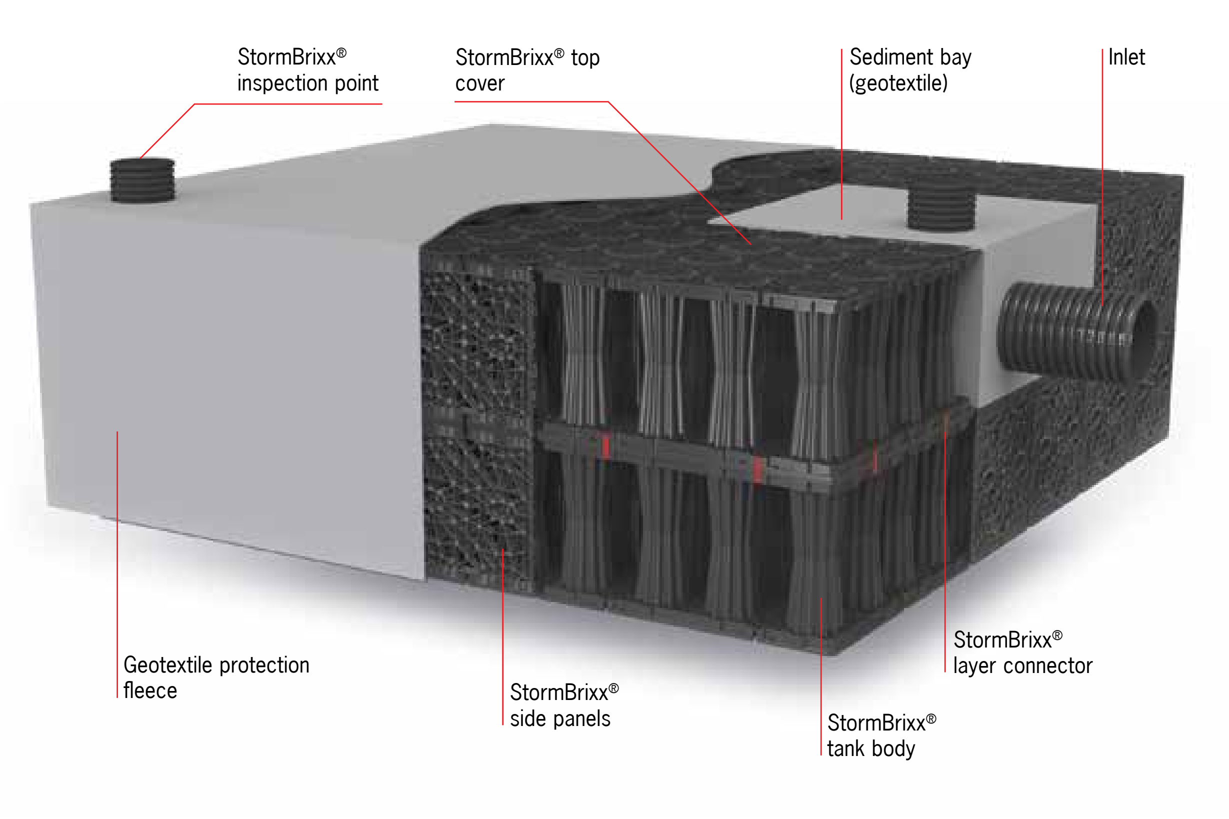
Project requirement: Mitigate surge effect

Project name: University of Canberra Public Hospital
Design engineer: Sellick Consultants
Contractor: A Plus Plumbing
Location: Canberra, ACT
Size: 116m^3

The University of Canberra Public Hospital is a new purpose built rehabilitation hospital which will be the first of its kind in the ACT. It will provide rehabilitation and support for people with illness or injuries or who are recovering from surgery. The new hospital has been built at the University of Canberra and will be a teaching hospital which will enhance training and research opportunities.

Designers were asked to incorporate a stormwater management system to deal with runoff from the car park pavements. The stormwater management system will have two different tank systems and is to act as both an infiltration system and detention system to relieve stormwater pressure from the car park areas. The detention system will spread the peak flow of a storm event over a longer period of time, mitigating the surge effect downstream.

StormBrixx® SD and StormBrixx® HD with sediment bay is ideal for infiltration applications



ACO StormBrixx® Case Study

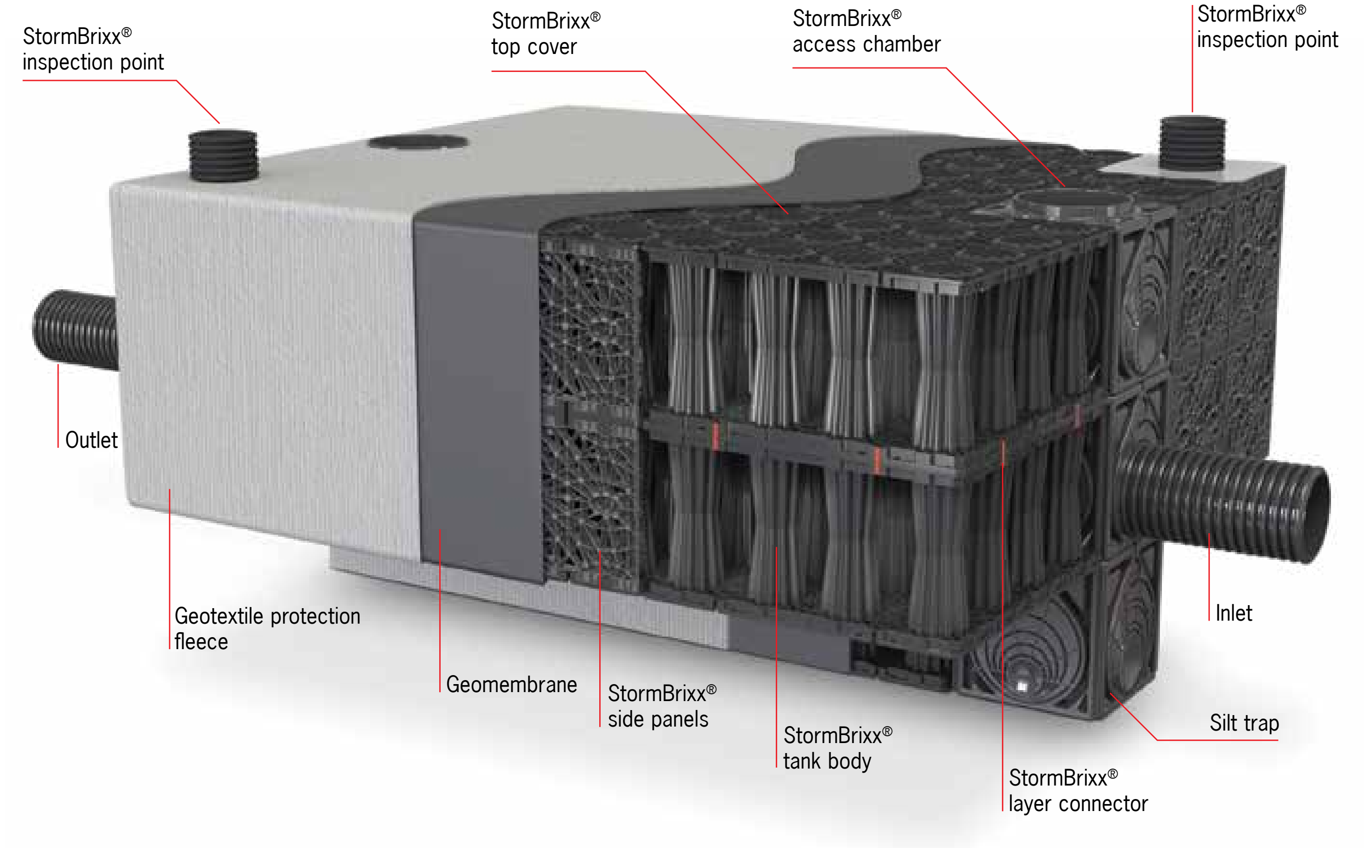
Project requirement: Infiltration

Project name: St Maria Goretti Primary School
Design engineer: P.J Wright & Associates
Contractor: Casotti Plumbers
Location: Redcliffe, WA
Size: 74m³

St Maria Goretti Primary School is managed by the Sisters of Mercy and caters for children from Kindergarten to Grade 6. The school has students from 28 different cultural backgrounds and currently has 252 students that will grow to an estimated 440 students over the next six years. The school has commenced a building program to cater for the increase in student population.

Part of the building program included a new kindergarten, administration building and upgrade to the carpark. Designers required a high capacity and durable stormwater management system to resolve a drainage problem in the school. The system was required to collect the excess water, filter it and gradually release the water back into the water table. ACO StormBrixx® provided an easy, stable infiltration tank to address this requirement.

StormBrixx® SD and StormBrixx® HD with silt trap is ideal for retention and detention applications



ACO StormBrixx® Case Study

Project requirement: Logistics and detention

Project name: Upminster Depot
Client & design engineer: London Underground Limited and Taylor Woodrow, World Class Civil Engineering
Contractor: Vinci Construction UK Ltd
Size: 88m³

StormBrixx® HD system was used in the Upminster, London Underground depot, working closely with Taylor Woodrow, the Design Engineers, to install a 15x9.6x0.61m tank to meet the detention requirement of the busy depot.

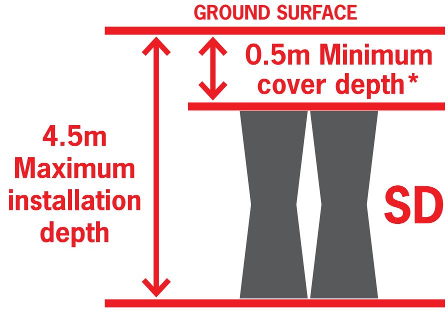
Having London Underground approval for the product, which involved a stringent set of measures that ACO successfully navigated, assured the construction team of the quality of ACO StormBrixx®.

Logistics to the site was not an issue as the ACO StormBrixx® stackable system meant the product could be delivered and more crucially stored in a small area before construction began.

ACO StormBrixx® Features

StormBrixx® SD

50 YEARS
DESIGN LIFE



Recommended Installation Depths

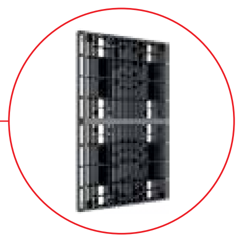
SD & HD – Functional design combined with an intelligent snap-lock system make for easy handling and rapid installation

High void ratio of 97% of total volume available for storage

3 Half bodies per cubic metre

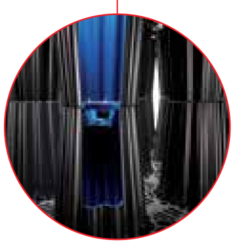
Height of 1 layer: 914mm

*Min. cover depth:
0.5m – landscaped
0.6m – car park



SD & HD – Side panels are used on the outer walls of the structure to enable geotextiles and geomembranes to be installed

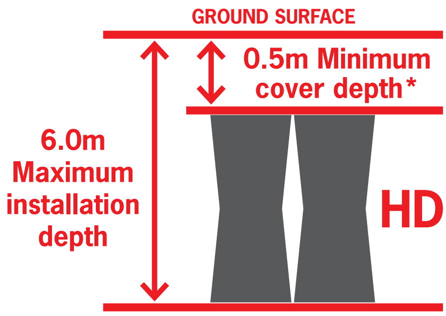
SD & HD – Recyclable polypropylene material provides a robust and corrosion-resistant basis for a long-lasting stormwater management system



SD & HD – Small openings at the base of the pillars allow water to fill and drain. This allows the pillars to form part of the storage volume

StormBrixx® HD

60 YEARS DESIGN LIFE



Recommended Installation Depths

SD & HD – Half bodies are laid and connected together in a brick bonded format to create structural rigidity in the overall system

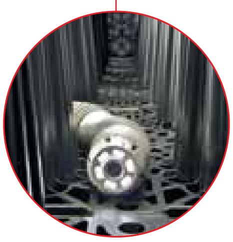
4.5 Half bodies per cubic metre

High void ratio of 95% of total volume available for storage

Height of 1 layer: 610mm

*Min. cover depth:
0.5m – landscaped
0.6m – car park
0.8m – truck traffic

SD & HD – StormBrixx® units can be cut in half to allow integration into the overall system



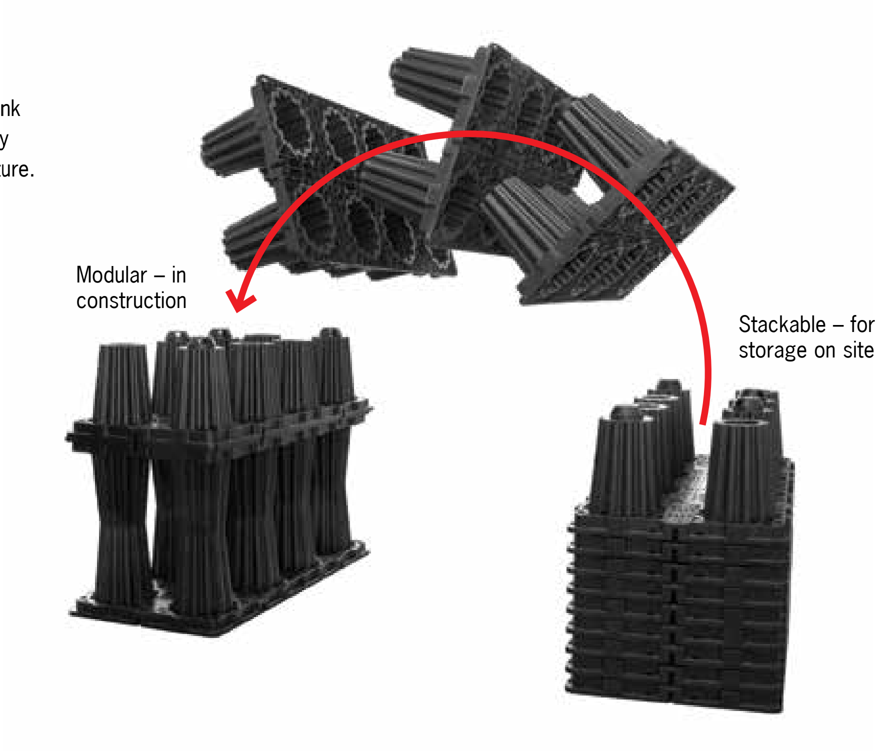
SD & HD – The open structure of StormBrixx® allows inspection cameras and cleaning devices to have free passage through the system

Stability due to brickbonding

The modular system

ACO StormBrixx® is a geocellular tank that is designed to fit together easily to form a strong, long lasting structure.

- Modular configuration
- Robust construction
- High integral strength



Two half bodies equal one layer

Ease of installation

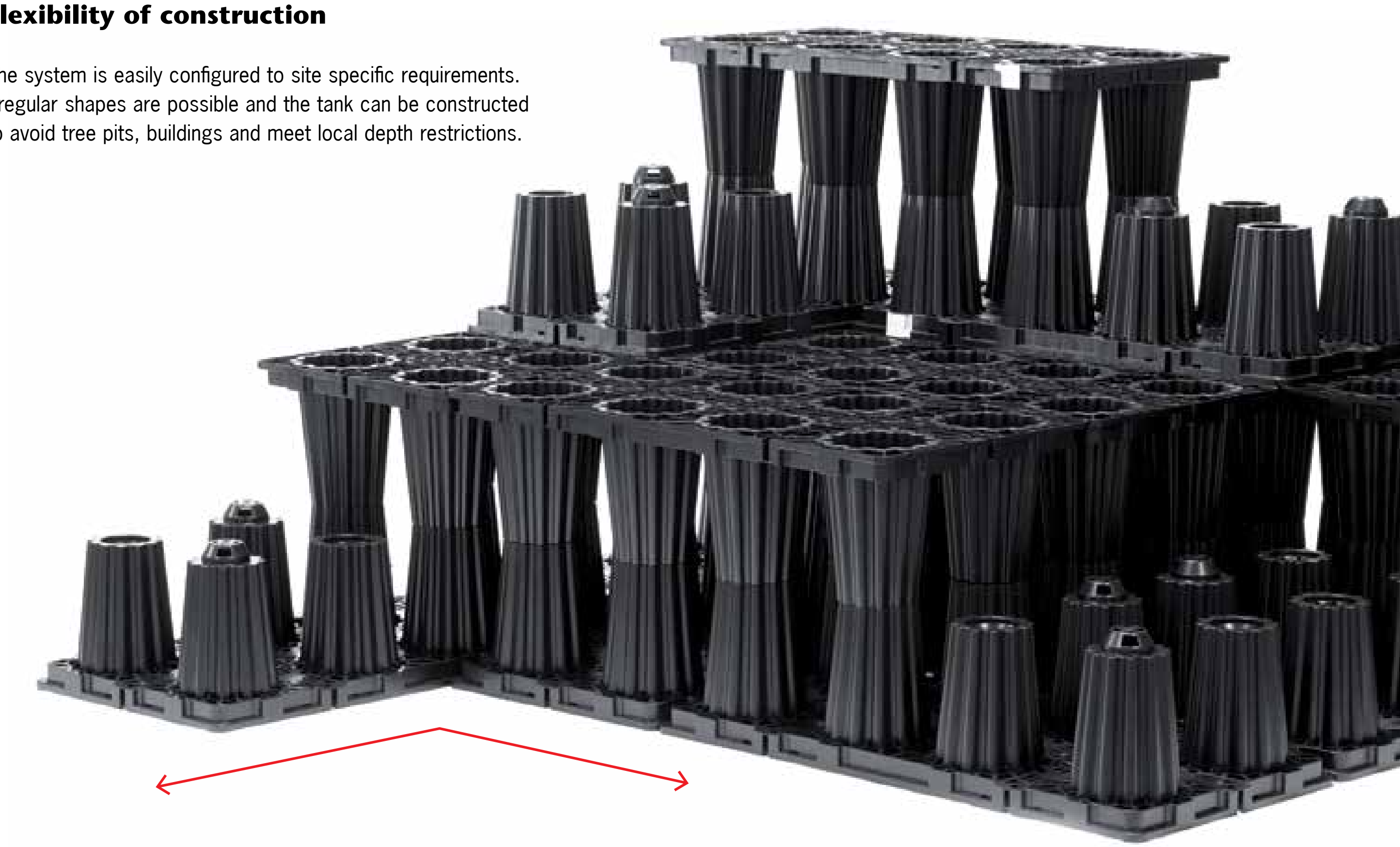
This is due to a snap-lock system consisting of male and female connectors that audibly lock into place during assembly, providing an exceptional level of structural integrity throughout the overall system.

Structural strength

A patented brickbonding and cross bonding feature. When constructed, the load-bearing pillars of the system align exactly above one another, enabling loads to be distributed downwards evenly.

Flexibility of construction

The system is easily configured to site specific requirements. Irregular shapes are possible and the tank can be constructed to avoid tree pits, buildings and meet local depth restrictions.



User-friendly inspection and cleaning

Meeting the need for access

ACO StormBrixx® addresses the fundamental requirement of access and maintenance to retention, detention and infiltration systems. Many councils, utility and conservation authorities now stipulate minimum maintenance regimes when approving the use of geocellular structures. ACO StormBrixx® can address all of these.

Inspection & maintenance

The complete system, including all extremities can be inspected and maintained from a few access points.

From the access points optimum maintenance and inspection of the system is possible in the longitudinal and transverse direction.

Inspection and cleaning equipment can be inserted vertically into the access shafts integrated within the ACO StormBrixx® system.

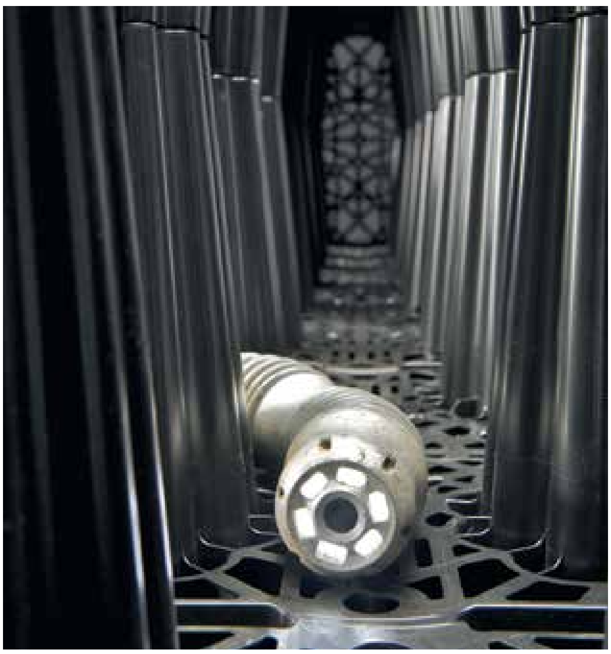
Inspection cameras are introduced into the system through the access shaft.

Fully accessible for maintenance

Open cell structure

The open cell tank structure permits completely free access for CCTV and jetting equipment.

StormBrixx® HD and StormBrixx® SD has a 95% and 97% void ratio available for storage respectively.



Inspection
Cameras can be easily used in the ACO StormBrixx® system.

Cleaning
Deposits that may be in the system can be pressure-jetted and suctioned at the same time with jetting heads.

Optimised logistics and savings

Freight savings

The stackable design of ACO StormBrixx®, where the tank body units nest together, means less vehicles are needed for transportation to site compared with other stormwater tank manufacturers. The side panels and other accessories also nest together.

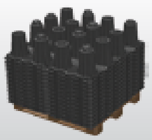
For each delivery of ACO StormBrixx®, up to 4 truck loads of competitor product may be required, making ACO StormBrixx® 75% more efficient to deliver.

This results in lower freight costs:
- StormBrixx® SD – 347m³ per truck
- StormBrixx® HD – 309m³ per truck

The coordination of deliveries, with multiple trucks needing to park while waiting to unload, is also simplified.

Environmental savings

Having fewer vehicles moving ACO StormBrixx® reduces CO_2 emissions and traffic congestion in urban areas.

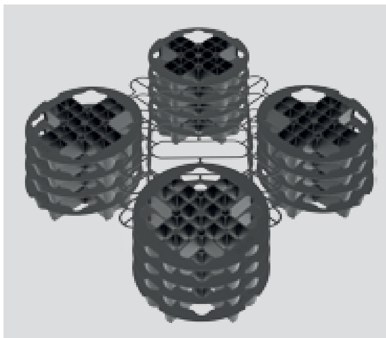


The stackable design reduces transportation costs and improves the carbon footprint of the product.

Example: 280m³ storage volume is required for project A. Using ACO StormBrixx® the project requirement can be transported on a single vehicle whereas up to four vehicles may be required for other comparable systems.

Accessory stacking

Side panels, top covers and other accessories are also stackable for easy delivery and storage.



On site storage and reduced handling

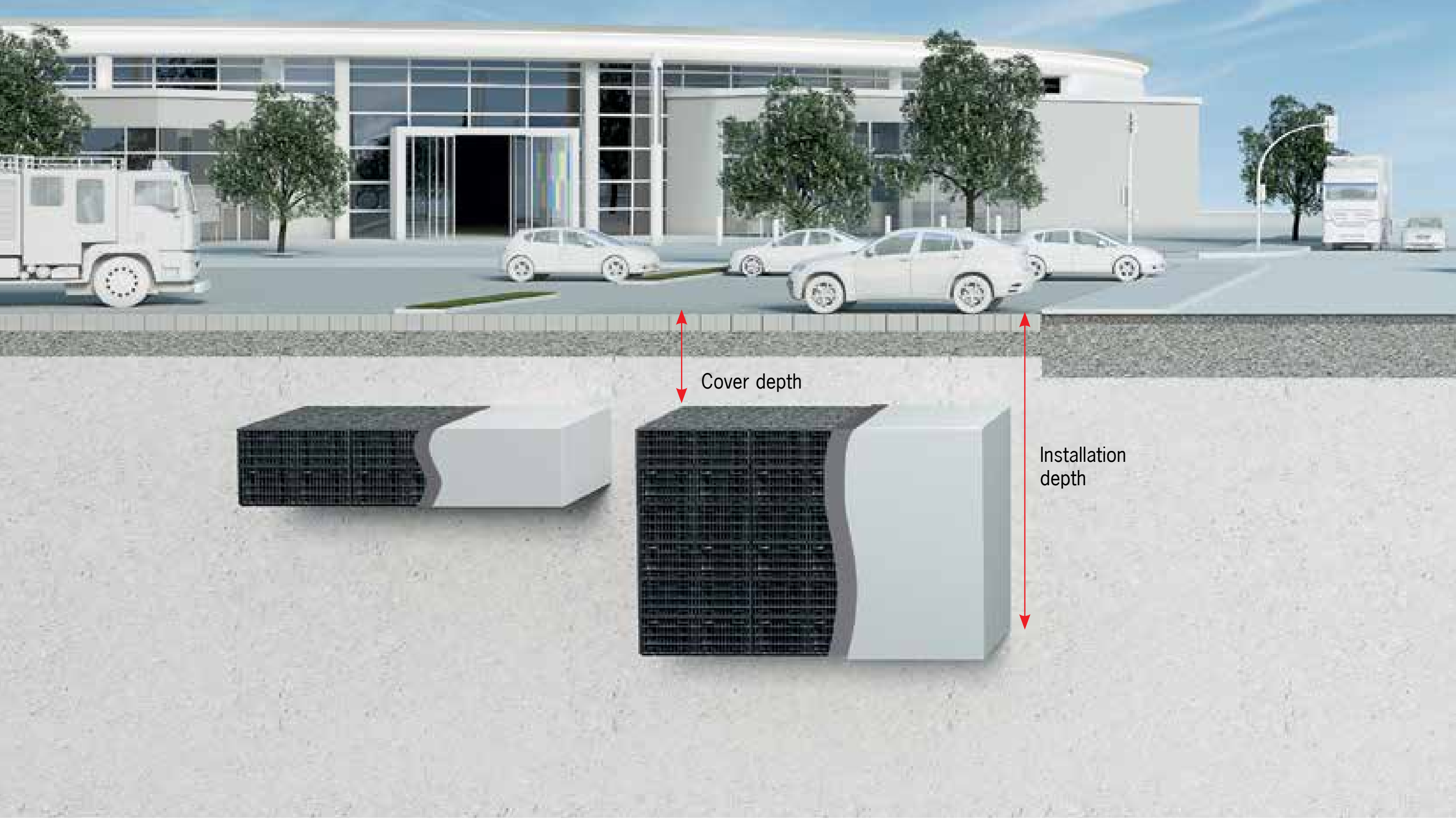
ACO StormBrixx® can be easily unloaded from the vehicle and stored in the same stackable layout on site. Due to the compact arrangement of ACO StormBrixx® compared to other geocellular units, they occupy little room on site and rarely need to be moved out of the way.

This can save storage time and money as movements around site are reduced by up to 75%.

Time and cost savings

All the benefits of easier logistics, to a site and on-site storage with reduced double handling required, add up to increased time and cost savings for the installer.

Choosing the appropriate ACO StormBrixx® System



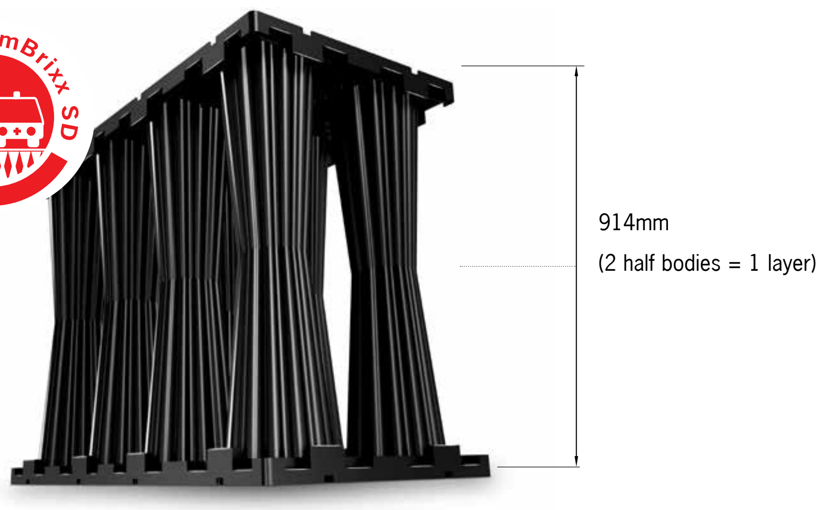
StormBrixx® SD
– Standard Duty

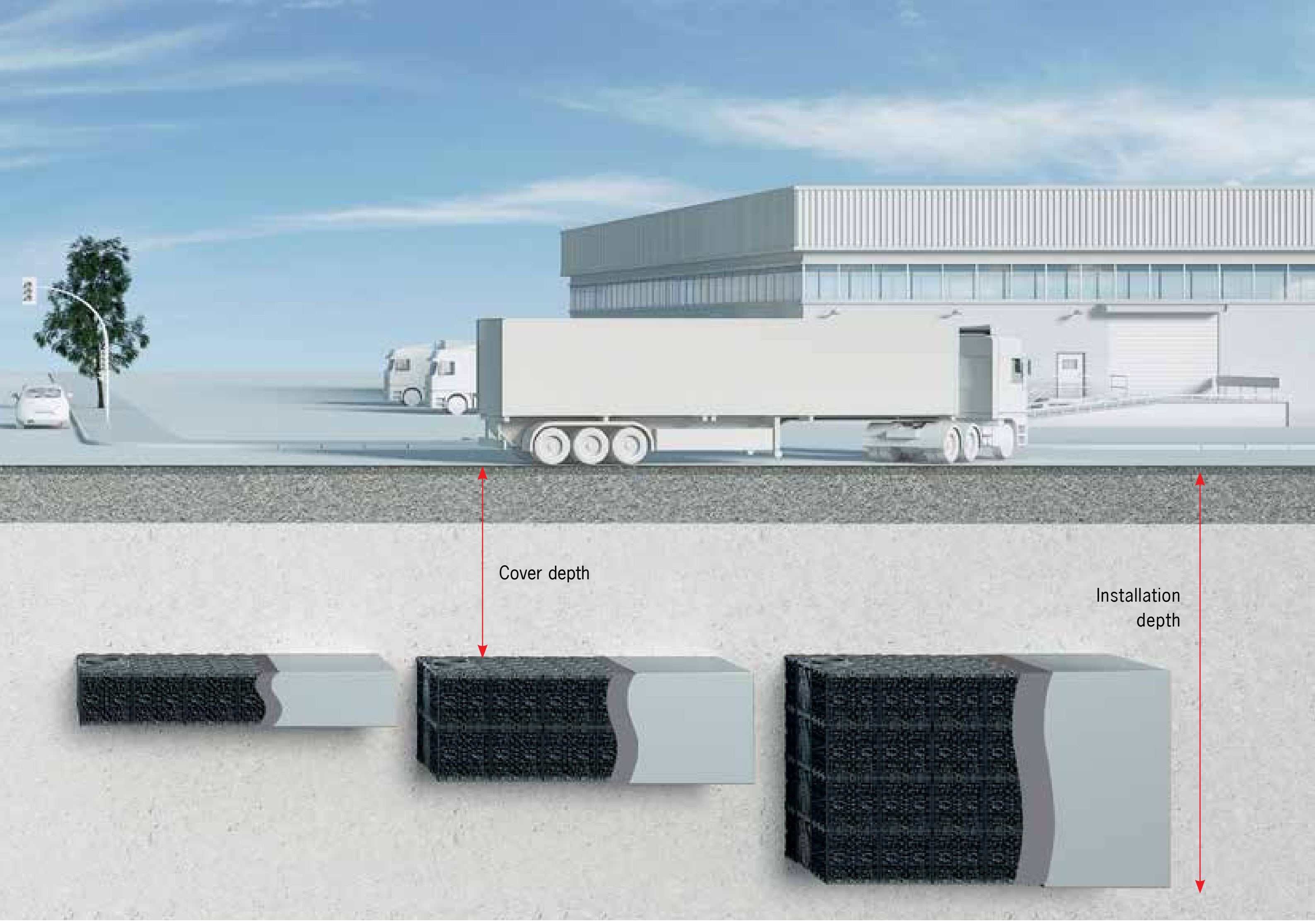
Applications

- Landscaped areas, no vehicles
- Landscaped areas with ride on mowers
- Pedestrian areas
- Driveways, car parks, up to 9 tonne vehicles (solid pavement required)
- For applications with semi-trailers and/or high ground water, contact ACO

StormBrixx® SD unit parameters	
No. of layers*	1-3 layers
Vertical Strength	350 kN/m²
Lateral Strength	70 kN/m²
Design Life	50 years
Minimum Cover – Landscaped	0.5m
Minimum Cover – Car parks	0.6m
Maximum Installation Depth**	4.5m

*Extra layers may be suitable in specific applications, contact ACO
**Ground improvements may be required and ground water has not been taken into account. Seek engineering advice.





StormBrixx® HD
– Heavy Duty

Applications

- Landscaped areas, no vehicles
- Landscaped areas with ride on mowers
- Pedestrian areas
- Driveways, parking lots, up to 9 tonne vehicles (solid pavement required)
- Fire trucks, delivery vehicles, semi-trailers (30 tonnes) (solid pavement required)
- For applications with unusually large loads and/or high ground water, contact ACO

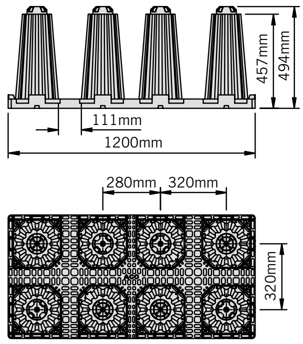
StormBrixx® HD unit parameters	
No. of layers*	1-4 layers
Vertical Strength	455 kN/m²
Lateral Strength	95 kN/m²
Design Life	60 years
Minimum Cover – Landscaped	0.5m
Minimum Cover – Car parks	0.6m
Minimum Cover – Truck traffic	0.8m
Maximum Installation Depth**	6.0m

*Extra layers may be suitable in specific applications, contact ACO
**Ground improvements may be required and ground water has not been taken into account. Seek engineering advice.

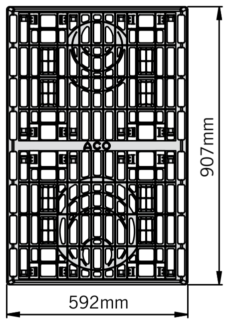
Product details – StormBrixx® SD

Product	Overall Dimensions Length (mm)	Width (mm)	Depth (mm)	Weight (kg)	Part No.
StormBrixx® SD tank half body	1200	600	494	9.5	**314125**
StormBrixx® SD side panels	907	592	104	3.1	**314126**
StormBrixx® SD top cover (set of 4)	550	550	50	0.8	**314127**
StormBrixx® SD layer connectors	53	44	26.5	0.1	**314093**
StormBrixx® SD and StormBrixx® HD access plate	650	650	120	4.7	**314075**

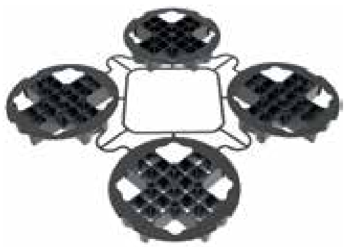
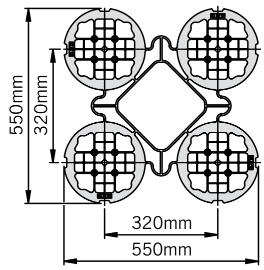
StormBrixx® SD tank half body

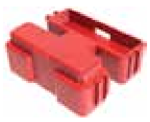
StormBrixx® SD side panels

StormBrixx® SD top cover (set of 4)

StormBrixx® SD layer connectors



StormBrixx® SD and StormBrixx® HD access plate

Clear opening 285mm

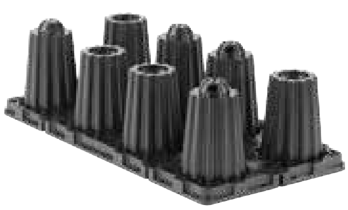
Compatible with StormBrixx® HD

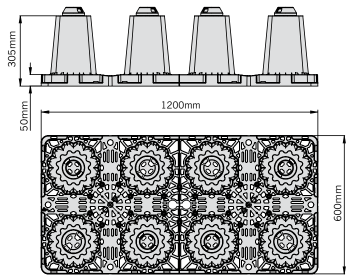
*See page 24 for accessories

Product details – StormBrixx® HD

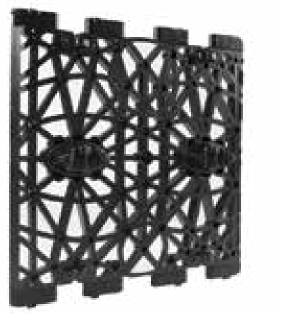
	Overall Dimensions				
	Length (mm)	Width (mm)	Depth (mm)	Weight (kg)	Part No.
StormBrixx® HD tank half body	1200	600	343	10.0	**314020**
StormBrixx® HD side panels	580	578	35	1.6	**314021**
StormBrixx® HD top cover (set of 4)	550	550	43	0.8	**314022**
StormBrixx® HD layer connectors	100	40	46	0.1	**314023**
StormBrixx® HD access chamber	594	594	610	32.0	**27034**

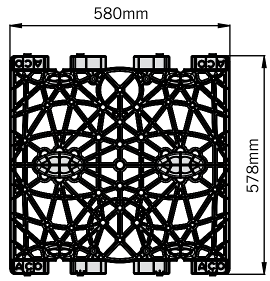
StormBrixx® HD tank half body



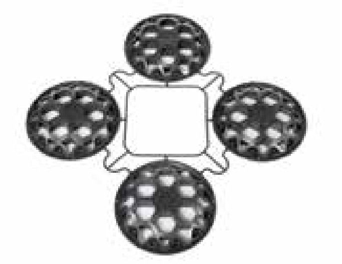


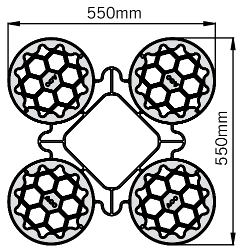
StormBrixx® HD side panels





StormBrixx® HD top cover (set of 4)





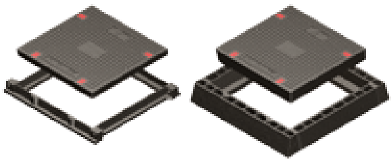
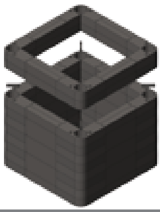
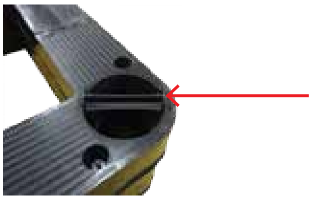
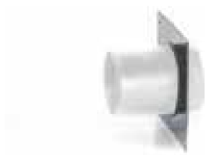
StormBrixx® HD layer connectors

StormBrixx® HD access chamber

Alternative option use access plate, see opposite page

*See page 24 for accessories

Accessories – StormBrixx® SD and StormBrixx® HD

		Overall Dimensions				
		Length (mm)	Width (mm)	Depth (mm)	Weight (kg)	Part No.
Rhinocast square solid top ductile iron access cover and frame						
Clear opening – 450 x 450mm 	Class B	560	600	55	44	**85249**
	Class D	660	660	100	87	**89268**
Rhinocast square recessed ductile iron access cover and frame						
Clear opening – 450 x 450mm 	Class B	560	600	55	47	**85014**
	Class D	665	665	100	85	**89013**
EzyBrixx™ square rising access shaft						
Clear opening – 450 x 450mm 	150mm high shaft	650	650	150	4.9	**142832**
	300mm high shaft	650	650	300	9.8	**142831**
	Connector clips (set of 4)	94	24	26	0.05	**142840**
Circular solid top ductile iron access cover and frame						
Clear opening – 400 diameter 	Class D400	–	Ø528	110	38	**314043**
Circular rising access shaft						
Clear opening – 380 diameter 	300mm high shaft	–	Ø437	350	2.6	**314038**
Pipe connectors with flange						
	DN100	210	210	200	0.6	**142833**
	DN150	260	260	200	1.1	**142834**
	DN225	350	350	200	2.5	**142835**
	DN300	415	415	200	4.0	**142836**
	DN375	500	500	200	6.0	**142837**

Geomembranes and Geotextiles

General information

Geomembrane

Impermeable geomembranes are for retention and detention applications. For 'non sensitive' applications taped joints are usually acceptable. ACO recommends installation by professional lining contractors for environmentally sensitive applications to acheive a geomembrane system with 100% watertight welded joints.

Geotextile

Permeable geotextiles are for use in infiltration applications. They permit the passage of water into and out of the ACO StormBrixx® system. Geotextiles are also used to protect the geomembrane from mechanical damage due to ground and thermal movement. They are placed on the outer side of geomembrane.

Selection guide

Non-sensitive retention/detention	Site-sensitive retention/detention	Infiltration
Geomembrane Geotextile Double sided tape	Welded geomembrane Geotextile Double sided tape for geotextile	Geotextile Double sided tape

Non-sensitive retention/detention

A taped geomembrane system should only be used where ground conditions can accept minor leakages from the tank.

They are not recommended to be used in sensitive applications such as, but not limited to:
- Within 5m of any building line
- Where there is a high groundwater table
- Where land is contaminated or risk of contamination from surface water is high.

Site-sensitive retention/detention

Correct choice of geomembrane is essential to the overall performance of retention/ detention systems. In applications that are site-sensitive, consult a specialist geomembrane supplier, and ensure it is installed by an accredited contractor.

Site sensitive applications include:
- High groundwater table
- Contaminated ground
- Within 5m of any building line
- Where risk of contamination to groundwater from polluted surface waters exists.

Infiltration

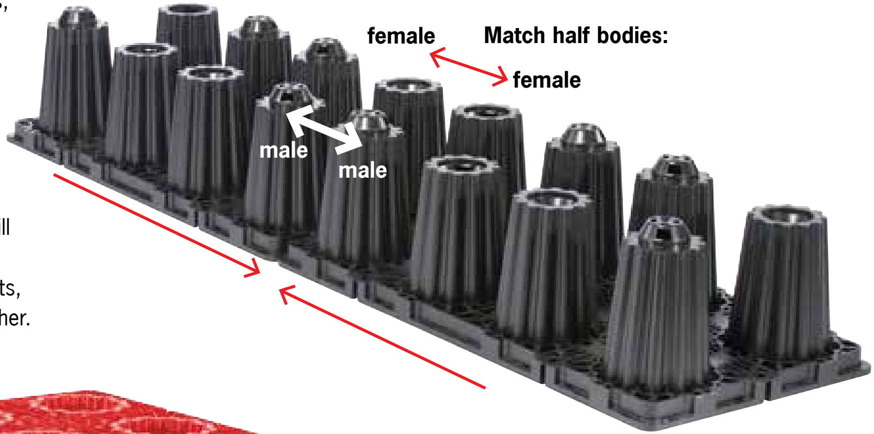
A non-woven geotextile with filtration and drainage properties should be used to minimise sediment build up within an infiltration (soakaway) system. The geotextile should completely wrap the ACO StormBrixx® system.

System configuration – Tank body

Column connections

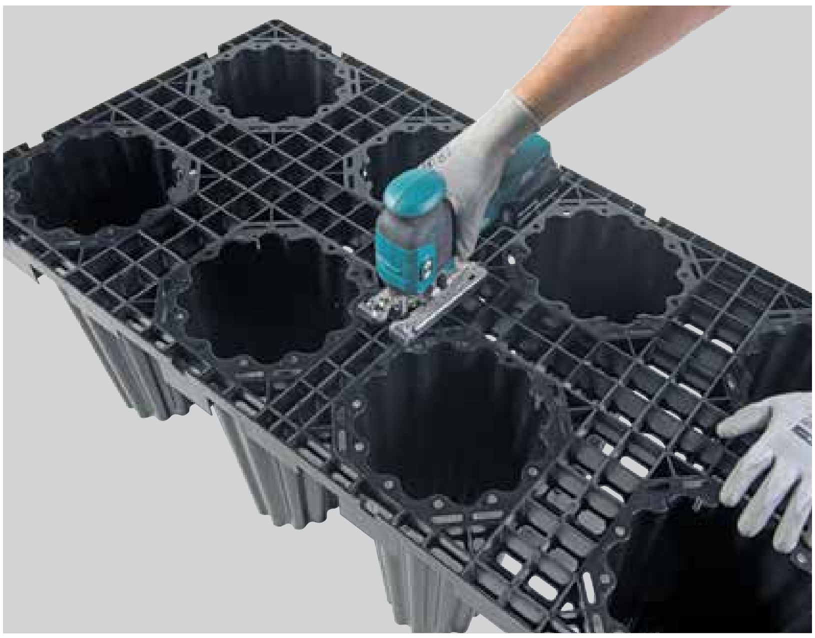
Each half body consists of eight pillars, four male and four female. When installing the half bodies next to each other, (ready for brickbonding), units should be matched to one another.

If the half body finishes with a female connection, the next half body should start with a female connection. This will then allow a further half body piece to be placed on top, bridging the two units, and securely locking the system together.



Cutting the tank body

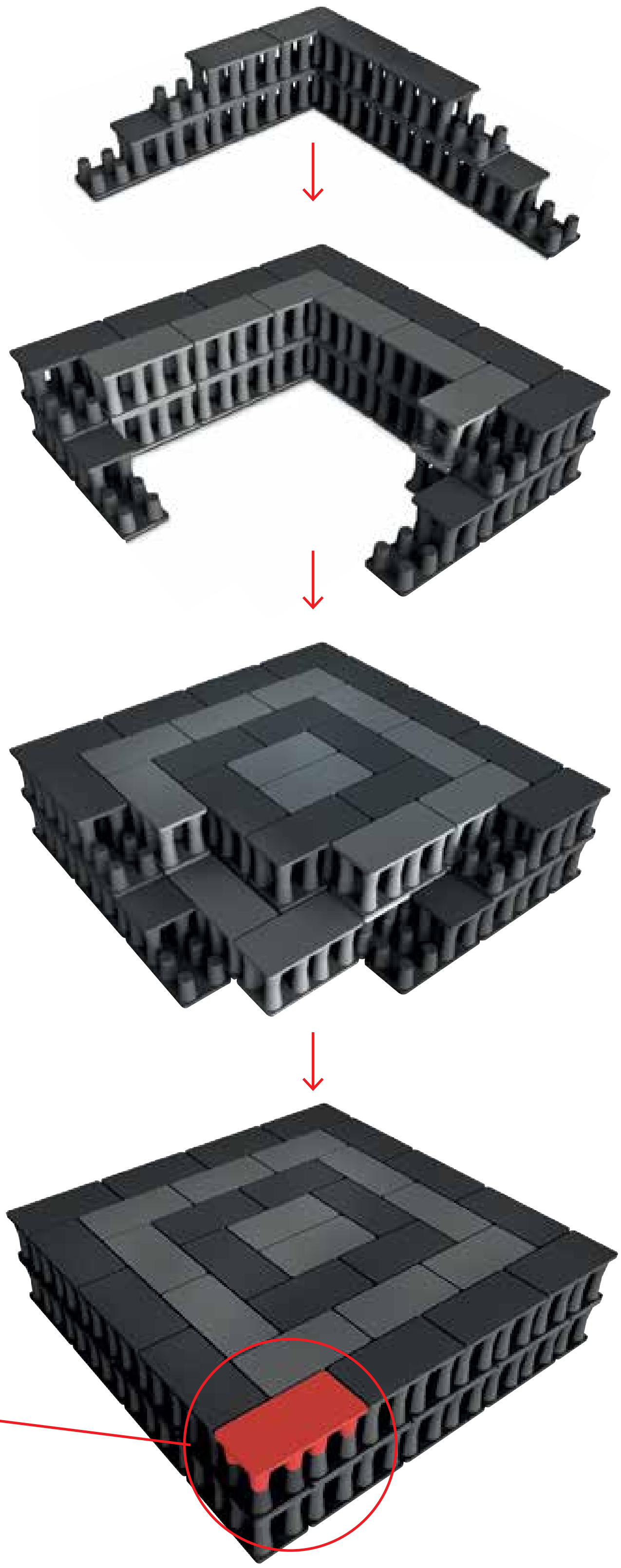
The half body can be cut along the central rib using a handsaw or jigsaw. Each cut piece can be linked to the rest of the system using connectors. Cut surfaces must face into the centre of the tank system to allow side panels to be attached.

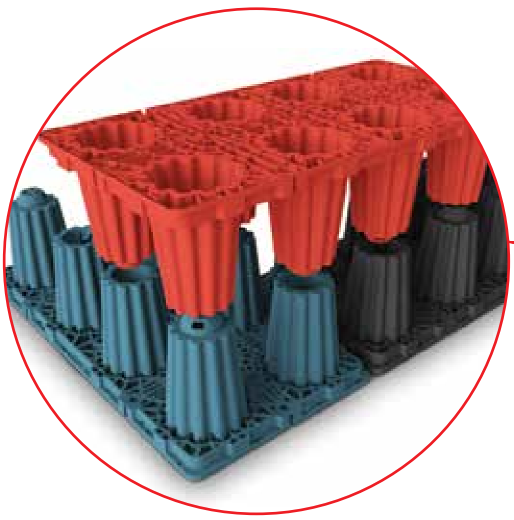


Recommended installation

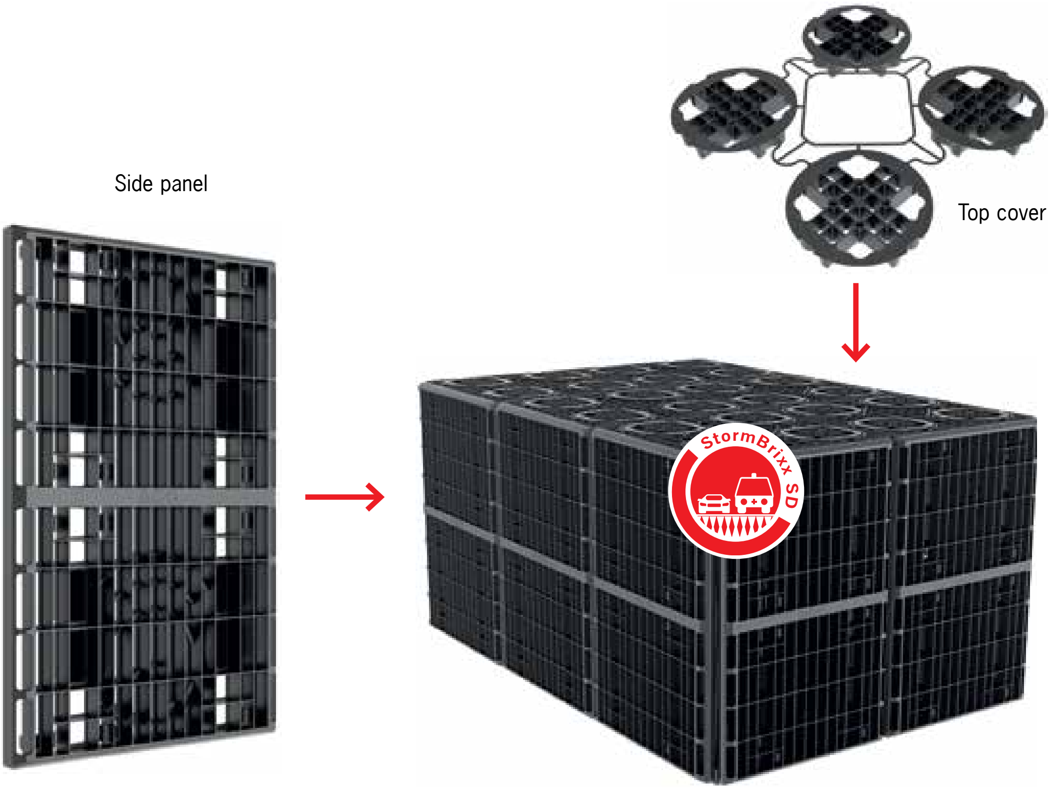
Concentric ring layout

A series of ever decreasing rings converging towards the centre of the system. Place in a brick bonded method. Repeat for subsequent layers using the connectors to bond layers to one another.





Side panel and top cover – StormBrixx® SD



Installing the side panel

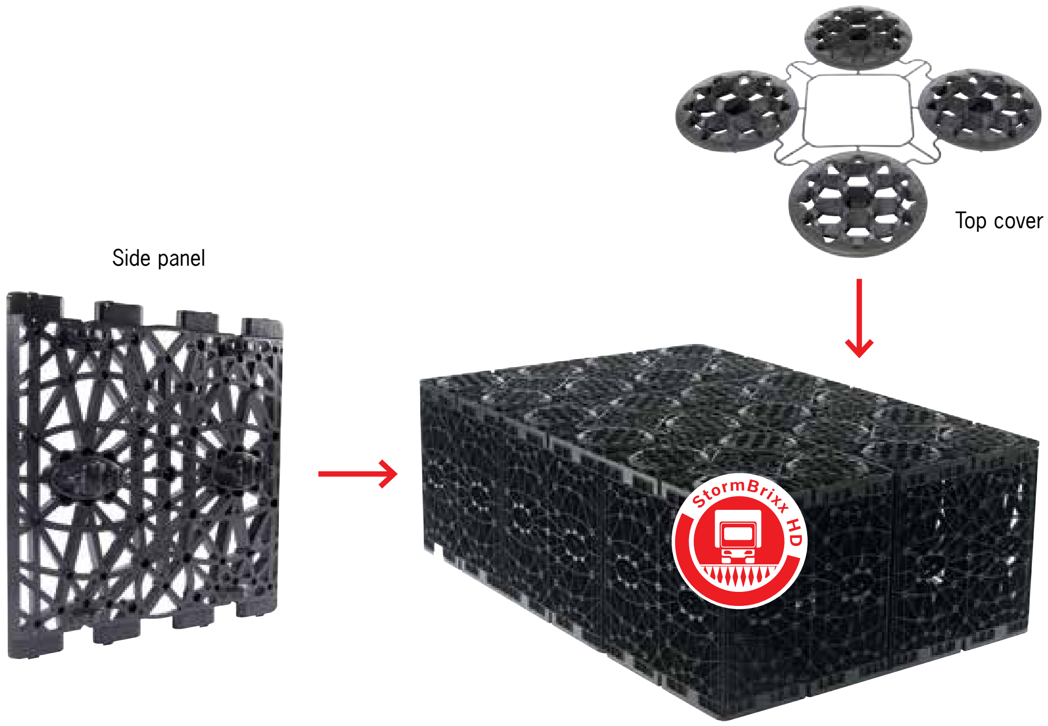
Polypropylene side panels are added to the perimeter of the tank to give lateral support against surrounding soils. The side panels have cutting guides which can be cut out using a jigsaw for the connection of plastic pipes.

Installing the top cover

Polypropylene top covers are added to the top layer of the tank to fill the openings of the pillars and to ensure consistent support for the cover fill material.

Note: Top covers are only placed in the top layer of the tank before the geomembrane and/or geotextile is wrapped around them.

Side panel and top cover – StormBrixx® HD



Installing the side panel

When installing the side panels you must ensure that the positioning tab is inserted into the base of the tank body first.

The outsides of the tank must be covered with side panels that click into place. These are inserted into the openings provided in the tank body elements. The side panels create a perimeter for the entire system offering a consistent surface for the geomembrane or geotextile. If needed, a pipe connection point can be cut out along the cutting guides in locations provided. Side panels have cutting guides for the connection of plastic pipes.

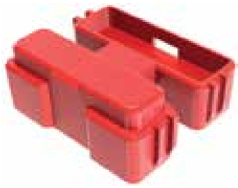
Installing the top cover

A single top cover closes off four pillar openings.

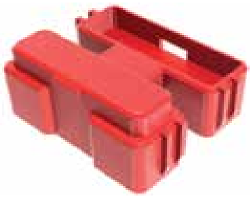
To ensure the geomembrane or geotextile can be wrapped around the tank snugly, covers should only be inserted in the top layer of the ACO StormBrixx® system. They prevent the geomembrane or geotextile being forced into the necks of the pillars during backfilling.

Note: Top covers are only placed in the top layer of the tank before the geomembrane and/or geotextile is wrapped around them.

Layer connectors for multiple layer configuration



Invert connector shown above +



Insert and snap together

StormBrixx® SD layer connector

Each layer requires two connectors per 1.44m^2 (2 modules)

\+ Rounded side forwards

Flattened side forwards and insert together

StormBrixx® HD layer connector

Installing the connectors

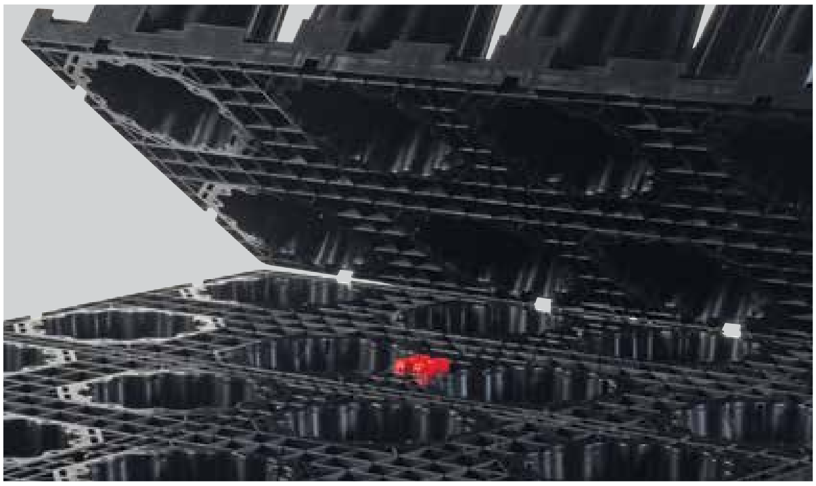
Installation of connectors

When installing a **single layer** of brick bonded tank, connectors are **not an essential requirement**. If the units are fully brick bonded, the structure will not need the connectors to hold the tank together. Connectors are provided as a precaution to give additional stability during installation.

This is unique to ACO StormBrixx® as other stormwater control systems require these units to ensure structure is fully stable during backfill and to ensure their design life can be achieved.

Installing multiple layers

When installing a second layer, connectors will be required. Layer connectors should be installed at the top face close to the outside edge perimeter and randomly throughout the centre. Further connectors should then be installed into the first layer to create locators for the second layer. (see opposite)



Minimise lateral movement

These layer connectors should protrude from the top of the bottom layer by approximately 30 to 50mm, depending on which unit is used (see opposite). These protruding units fit into the base of the layer above and are key to minimising lateral movement during backfill and overall installation.

Access – StormBrixx® SD

Enter via the Access Plate

The Access Plate can be used to allow access to the StormBrixx® SD tank. The plate requires a half body cut piece (4 pillars) to be removed creating the free area within the structure. (See page 26)

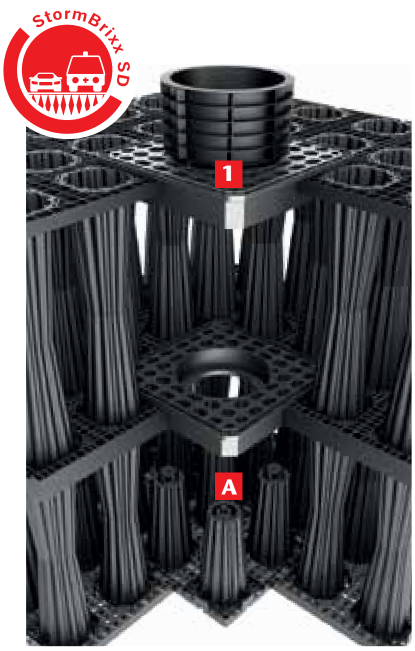
With the Access Plate, an easy installation is possible at any desired position, except along the perimeter.

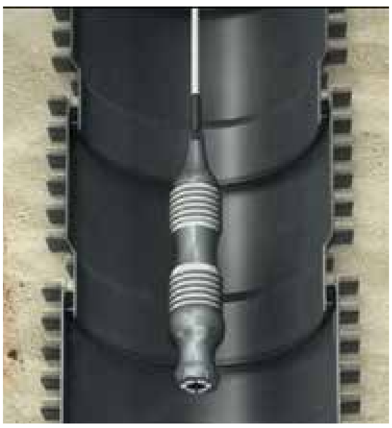
Access Plates (A) are to be connected to circular rising shafts as shown (1) or EzyBrixx square rising shafts.

Caution: Ensure the Access Plate is not installed on the perimeter edge of the tank but at least one unit (4 pillars) away from the edge.

Inspection cameras or jetting heads can be inserted vertically into the access shaft.

The Access Plate can also be used with StormBrixx® HD.





Access – StormBrixx® HD

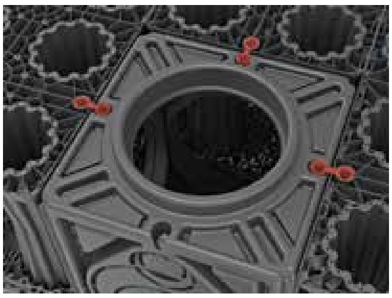
Enter via the Access Chamber

This Access Chamber is only suitable for StormBrixx® HD. Access can be gained to the tank using the Access Chamber (B), or the Access Plate (see opposite). The Access Chamber can be installed both within the structure and along the outer edges. They require half the StormBrixx® cell (4 pillars) to be removed giving full access to the system. (See page 26)

For multi-layer systems, the chambers stack on top of each other and clip to the tank using the connectors. (See below)

Each Access Chamber can be cut out as required to accommodate various sizes of pipe up to DN300. Use a drill to get the saw blade inserted when creating the openings in the lower shaft section.

Access Chambers extend to the surface using circular rising shafts (1) or EzyBrixx square rising shafts.



Cannot be used with StormBrixx® SD

Designing an ACO StormBrixx® system

Consultation should begin with the relevant council or planning authority to determine the requirements surrounding retention, detention and infiltration systems, as this may affect the choice of product required.

These authorities can approve ACO StormBrixx® systems where appropriate.

To design and install ACO StormBrixx®, specifiers need to consider three factors:

1 Hydraulic Design

2 Structural Design

3 Maintenance (See page 38)

1. Hydraulic design

Hydraulic design deals with surface runoff as well as the temporary storage of water in storm events. The objective is to reduce the volume, speed, and frequency of surface water runoff. Factors will be site specific and calculations for hydraulic design may be undertaken using locally accepted and approved methods.

CIRIA C697 offers design guidelines. CIRIA stands for Construction Industry Research and Information Association. It is a non-profit body that provides guidance on the planning, design, construction and maintenance of Water Sensitive Urban Design (WSUD) to assist with effective implementation within developments.

2. Structural design

Structural design considers the load bearing capacity of the ACO StormBrixx® system to ensure it can safely carry the loads it will be subjected to. The initial decision must be made on the type of system required - retention, detention or infiltration and then the design parameters shown below should be considered.

- Soil type
- Vertical loading (including site traffic movement)
- Groundwater
- Depth of cover and total installation depth
- Surface finish
- Horizontal loading

Consideration must be given to the maximum surface deflections allowable for the pavement above the tank. Although excessive deflections may not lead to tank failure, they will cause localised pavement deterioration. ACO can provide structural deflection results for specific live loads. Creep (long term deflections under permanent dead loads) should also be investigated to ensure the durability of the tank.

Structural calculations should be carried out using methodology detailed in CIRIA C680 – "Structural design of modular geocellular drainage tanks". For further advice please contact ACO Technical Services.

Guide to installing ACO StormBrixx® systems

Installation dimensions and methodologies will vary by site. Local ground conditions and council design requirements should be adhered to.

Step 1
Excavate hole, or trench, to required dimensions to accommodate ACO StormBrixx® tank. Allow additional 300mm on all sides for access, necessary pipework and any inspection chamber(s) and/or silt trap(s).

Step 2
Ensure base of excavation is flat, level and capable of withstanding required design loads, angle sides of excavation to prevent collapse, and ensure safe access/conditions for site workers.

Step 3
Lay 100mm compacted bedding layer for retention/detention systems or 100mm coarse sand for infiltration systems.

Step 4
Lay geotextile along the base and sides of the excavation with minimum 300mm overlap at joints.

Step 5
For retention/detention tank lay geomembrane on top of geotextile. Note, infiltration tanks do not require geomembrane.

Step 6
Assemble StormBrixx® units to required size and configuration and place on geotextile or geomembrane. Ensure loose units are fixed together using layer connectors.

Step 7
Form hole(s) in side panels using hole saw/jigsaw to receive pipe (inlet/outlet/inspection/vent pipe as required). Fit side panels and pipe connectors. Ensure top covers are installed on the top layer of the tank.

Step 8
Carefully cut geotextile and/or geomembrane around pipe protrusions. Seal geomembrane around pipe connections. Test joints for leaks.

Step 9
Continue wrapping the tank with geotextile and/or geomembrane.

Step 10
Connect inlet/outlet/vent pipe and access chamber/access plate with rising shafts. Only one DN100 vent pipe is required per 7500m^2.

Step 11
Backfill evenly around excavation sides using sub-base or selected granular material in layers of 150-300mm and compact.

Step 12
Use a 100mm minimum coarse sand protection layer over the top of the tank and then backfill. There should be a minimum 500mm backfill cover before compaction equipment is used.

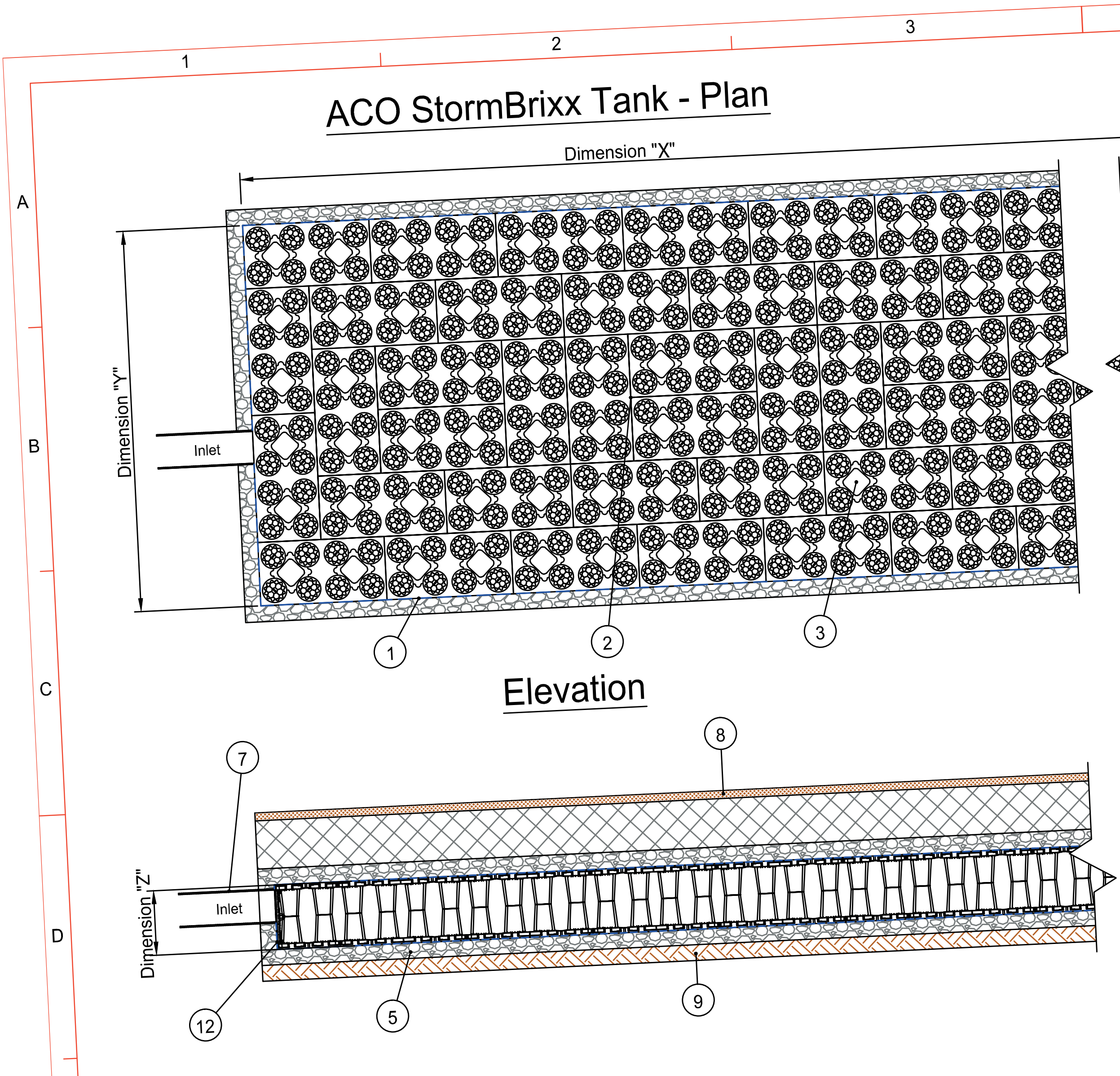
Step 13
The area should then be compacted using suitable compaction equipment.

Step 14
Complete the pavement construction or landscaping over the ACO StormBrixx® tank.

Prior to final surfacing, tank area should be fenced off and traffic prohibited from using the area above the tank. ACO StormBrixx® is not designed to withstand loads from construction traffic.

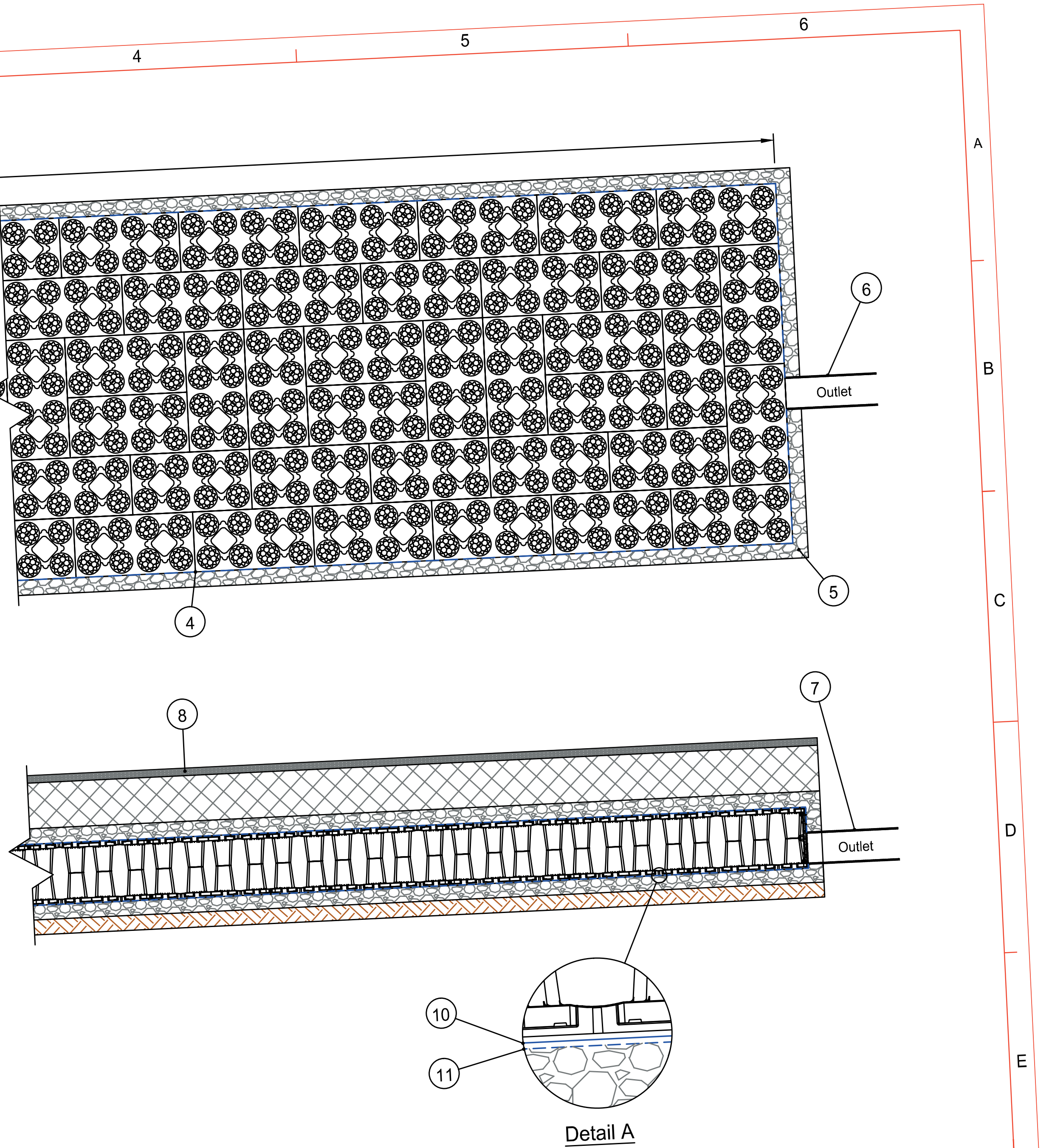
Technical support

ACO will provide general installation drawings, addressing key requirements.



General Notes

1. StormBrixx bodies brick bonded to form a perimeter and optional concentric rings.
2. StormBrixx bodies cross bonded.
3. Top covers to the top layer of the tank to counteract soil pressure.
4. Wraps to entire perimeter of tank, see detail A and notes 11 & 12.
5. 100-150mm of a sharp 6H sand or single size stone to form a protection layer around the tank.
6. Pipe connections to suit anticipated flow rates.
7. Pipe connections formed to suit site requirements where outlet pipes for tanks are laid at the invert to prevent standing water and loss of storage.
8. Surfacing as required by the site (E.G Landscaping or Asphalt).
9. Undisturbed earth base of excavation or made ground with minimum CBR value of 5% and suitable for anticipated load.
10. Impermeable geomembrane taped or welded as appropriate for attenuation tanks to entire of tank.
11. Permeable protection fleece to entire of tank.
12. Side panels to entire perimeter of tank.



			P.J
A	08/08/18	Initial Issue	
Version	Date	Description	Name
		Drawing Number: E1-E01-1108-3	Revision: A
ACO Pty Ltd 134-140 Old Bathurst Rd Emu Plains NSW 2750 Australia		Title: ACO StormBrixx Standard Detail	
Created by: P.J	Released by: L.D	Projection: ISO-A / Units: mm	Format: A3 / Scale: NTS
Created at: 08/08/18	Released at: 08/08/18	Information contained in this drawing is copyright property of ACO Any reproduction in part or whole without written permission of ACO is prohibited	Sheet: 1 of 1
Replacement for: -	Replaced by: -		

Maintenance and inspection guidance

Maintenance procedures

It is important to note that failure to control and remove sediment build-up in stormwater tanks is the largest cause of system failure. Incorporation of a sediment bay in a StormBrixx® infiltration system, or a silt trap in a StormBrixx® retention/ detention system, can ensure the effective management of silt.

The open design of ACO StormBrixx® allows the system to be inspected by remote CCTV either through the inlet connection, access chambers, inspection points or pipes at the sides of the ACO StormBrixx® system. This allows the system to be inspected for sediment build-up and enables collected sediment to be removed from the infiltration system or flushed through a retention/ detention system.

In the event that a sediment bay, or silt trap, has not been incorporated with the ACO StormBrixx® system, please contact ACO Technical Services for further advice.

Infiltration systems

In order to periodically check the effectiveness of the StormBrixx® infiltration system, a percolation test can be carried out on the tank and compared with the original data. If there is a significant decrease in the infiltration rates, the infiltration tank should be filled via the inspection chamber to the invert level of the inlet pipe. It should then be flushed through with water in order to remove sediment and unblock the geotextile.

As sediment has the potential to carry high levels of pollutant, it is important that any sediment removed from the system is disposed of by a licensed contractor and in accordance with local regulations and codes.

Retention/detention systems

In order to clean the ACO StormBrixx® system, if a silt trap has not been incorporated, it will be necessary to block the outflow control device, not the overflow pipe, before filling the tank to the invert of the vent pipe. The tank should be filled and flushed as above and the water effluent removed and disposed of by a suction truck with vacuum pump.

If a silt trap has been installed, lift the access chamber cover and using a suction truck remove all water in the silt trap and jet the sump channel as required to remove all sediment.

The frequency of a maintenance procedure for the tank will be determined by the inspection regime. A recommendation is not less than twice-yearly inspections, and during the first year after every significant storm event.

In order to minimise silt build-up, ACO recommends the use of pretreatment systems upstream of the retention/ detention system.

ACO StormBrixx® Testing

Product performance tests carried out on the ACO StormBrixx® system have been conducted using the methods recommended by CIRIA C680 "Structural design of modular geocellular drainage tanks". Data supplied is supported by qualified third party independent certification.

Ultimate load bearing capacity has been established under laboratory test conditions during short and long term load testing.

Recycled content

ACO aims to incorporate as much recycled material or waste material as is practicable in its products without compromising performance. Typically PP materials can contain up to 50% plus recycled plastic and ductile iron materials contain 40% to 90% recycled iron.

ACO StormBrixx® products are intended for a long life with low maintenance. After its design life, the materials can be recycled or disposed with a low risk of pollution to the environment.

Flow control systems

ACO StormBrixx® represents the 'Hold' element of the ACO System Chain; the final stage is 'Release'. In order to manage the 'Release' stage, ACO has a range of flow control systems that regulate stormwater flow before it discharges into the watercourse or sewer networks. ACO Q-Brake flow controls and ACO Q-Plate orifice plates are capable of regulating any flow for surface water applications and can be used in conjunction with detention systems, such as ACO StormBrixx®, as part of a Water Sensitive Urban Design (WSUD) scheme.

What is an ACO Q-Brake?

ACO Q-Brake is a horizontal vortex flow control unit designed to regulate stormwater flows.

The design of a vortex flow control is based on the fluid mechanics principle of the 'forced vortex', which permits flow regulation without any moving parts.

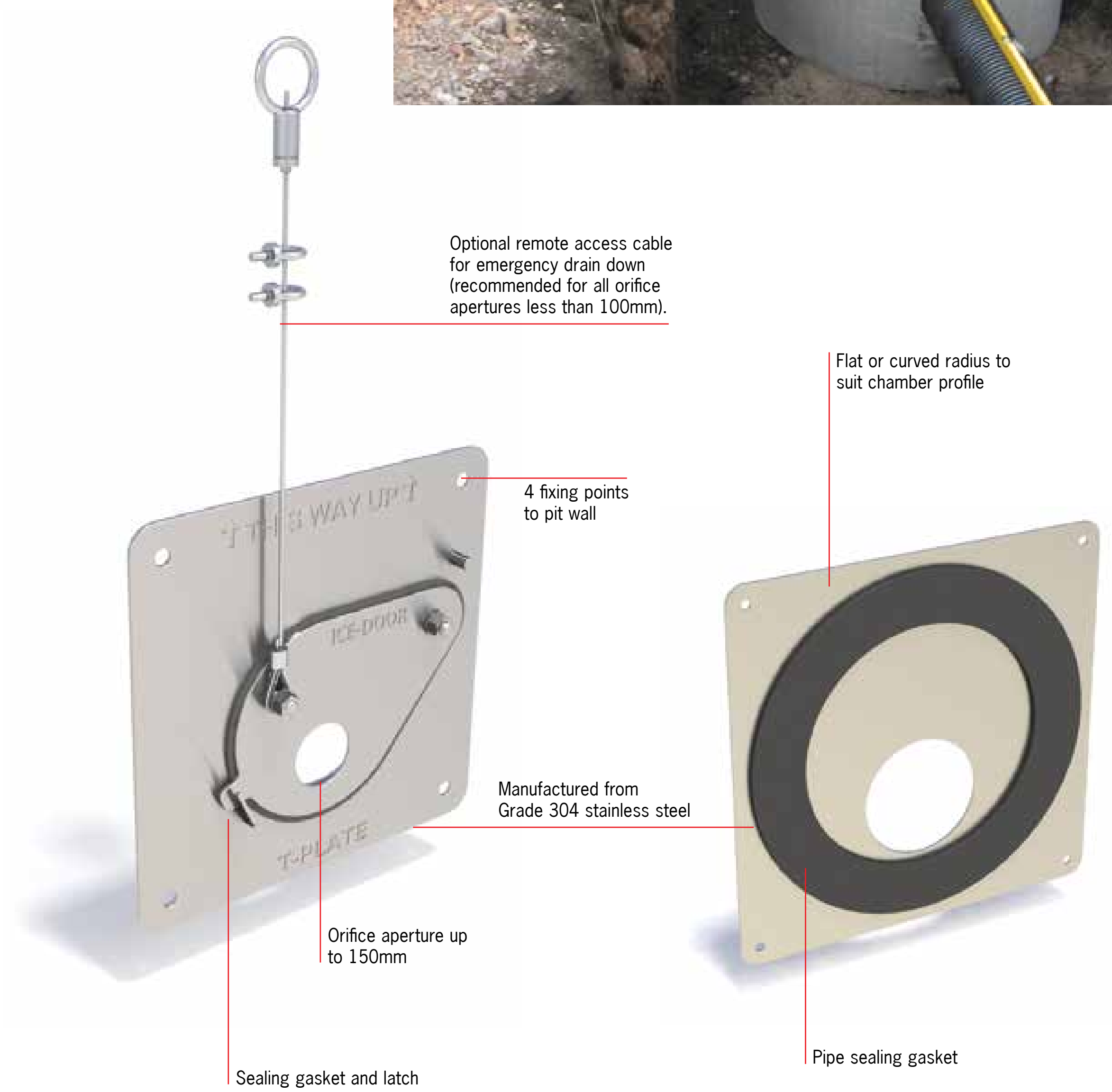
ACO Q-Brake utilises the upstream head and discharge to generate a 'vortex' within the mechanism of the unit. The water is then released at a pre-determined controlled rate preventing downstream flooding.

Unlike conventional products, ACO Q-Brake is less prone to blockage and permits higher flow at a lower head of water. This is because the vortex control allows an equivalent outlet size 4 to 6 times larger in cross-sectional area to be used.

Each ACO Q-Brake Vortex unit is custom built to suit the profile of the chamber. Radius fixing options remove the need for additional benching, simplifying installation and reducing cost.

What is an ACO Q-Plate?

If a more conventional product is required, ACO Q-Plate orifice plates are perfect for all flow rates and can be used for a number of applications. Due to the systems custom construction, any pit size, pipe diameter, orifice opening can be accommodated.



Benefits of using a surface water flow control system

Storage and the controlled release of clean water into the natural environment is an important aspect of managing surface water in the WSUD approach. Councils have overall responsibility to impose, where appropriate, the discharge rate of a surface water flow control system.

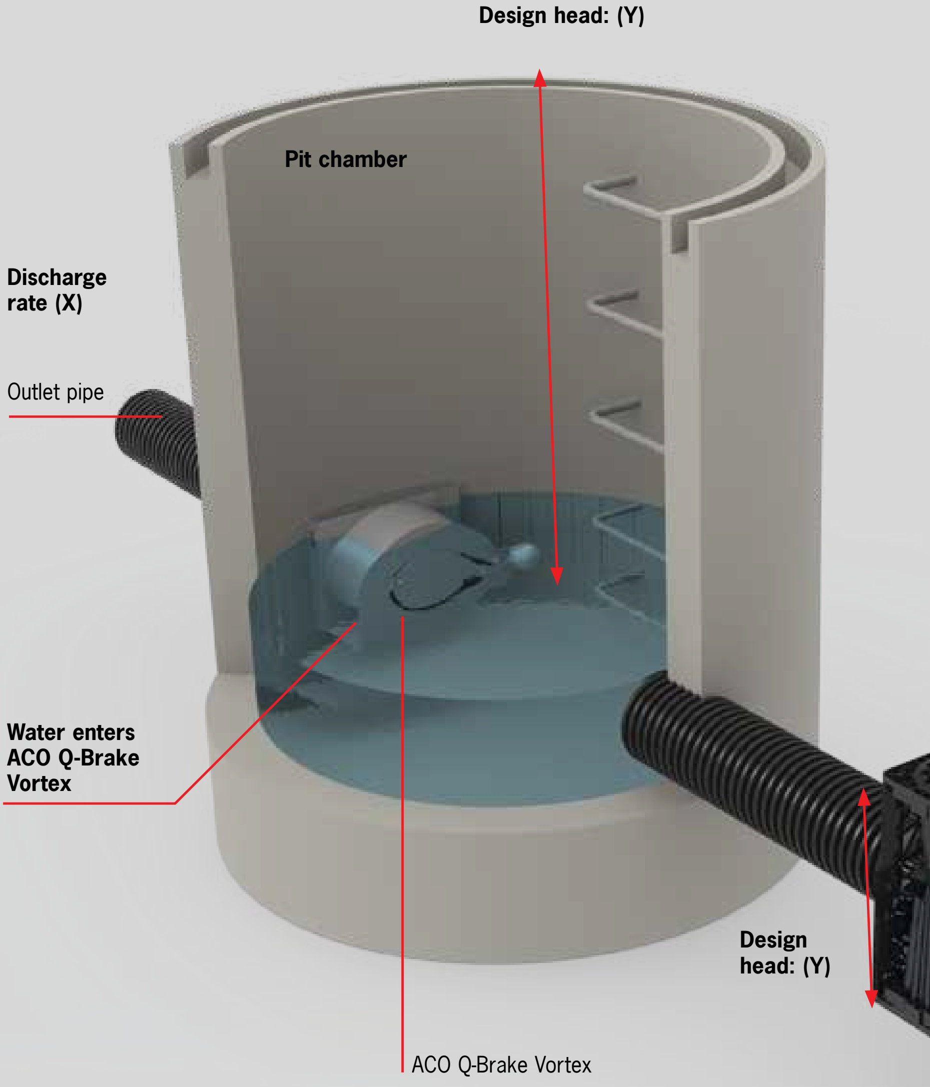
ACO's range of flow control systems can be used in conjunction with ACO StormBrixx®, to provide a fully integrated and compliant solution.

This diagram shows how the ACO StormBrixx® system is used to provide stormwater detention, as the ACO Q-Brake is used to regulate the rate of discharge from the development into the watercourse or stormwater network.

This benefit is best demonstrated in the example opposite, where the upstream storage can be reduced by 32m^3 compared to a traditional flow control system.

Example:

There is a development project with a catchment area of 9,000m^2. The project has predefined design criteria of a 1 in 25 year storm, with a 10% increase in rainfall intensity over the lifetime of a development, due to climate change, and runoff from the site must not exceed 5 L/s at a design head of 1.3m.



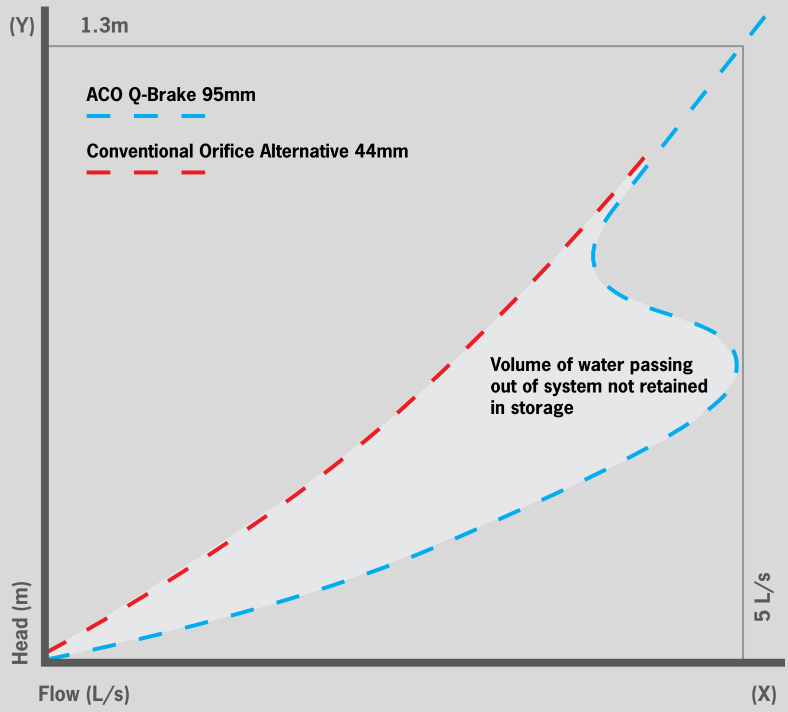
Results:

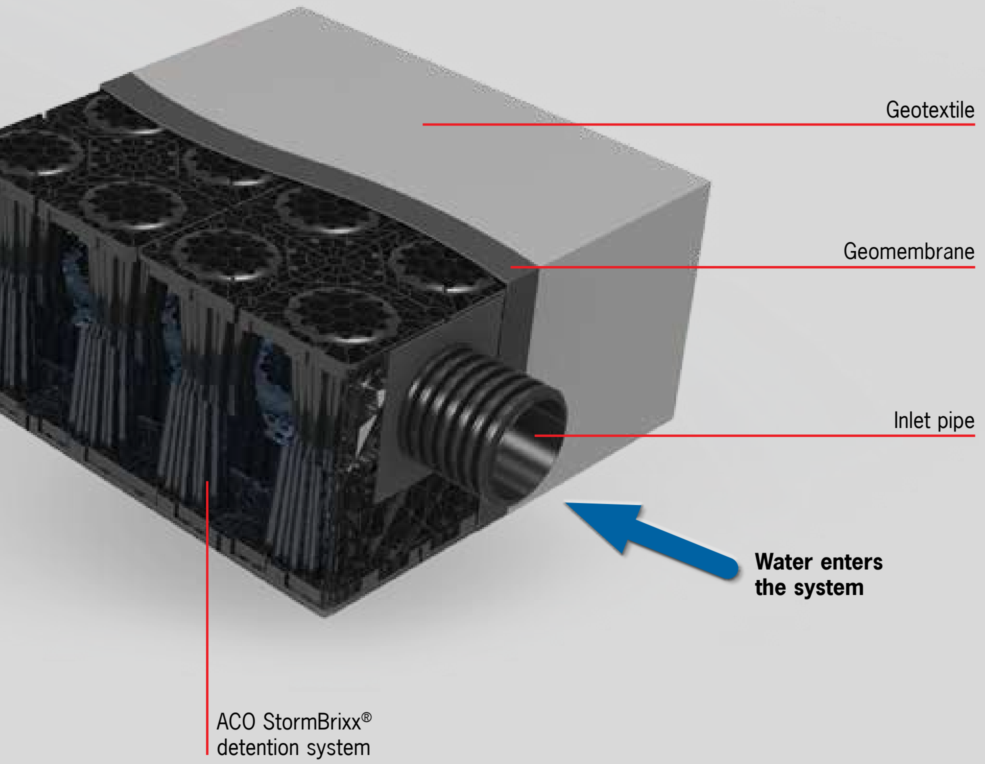
Using drainage software, ACO has identified the potential saving in upstream storage requirements when using a Q-Brake instead of a traditional orifice plate. Results are summarised below:

- An ACO Q-Brake system would require a 95mm diameter orifice to best manage the design head and flow, which lead to 301m³ upstream storage being required.
- An equivalent orifice plate system would require a 44mm diameter orifice and lead to 333m³ upstream storage being required to deliver against the same design criteria.
- ACO Q-Brake would therefore reduce upstream detention requirements by approximately 32m³ relative to a traditional orifice plate system. This equates to a reduction in storage of 10%.

The increased orifice diameter also means the Q-Brake orifice has a cross-sectional area 4.6 times that of the equivalent traditional orifice plate. Therefore, it is less prone to blockage than a traditional orifice plate flow controller.

Discharge characteristics





Other ACO Civil Construction Products

- **ACO Drain**
  A range of grated trench drainage systems and pits made from 'Polycrete' polymer concrete. Grates are available in all materials and finishes.
- **ACO Infrastructure**
  A range of trench drainage systems for roads, ports, airports and rail.
- **ACO Sport**
  A range of surface drainage systems and ancillary products for sports fields, running tracks and stadiums.
- **ACO Self**
  A range of economical domestic drainage products, ideal for homes, gardens and landscaped areas.
- **ACO Access**
  A range of ductile iron, galvanised steel and composite access covers in a wide range of sizes and configurations from single to large multi-parts units.
- **ACO Cablemate**
  A range of electrical, communication cable jointing pits and surface ducting systems.

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