

Barton Willmore
Royal Elm Park
Drainage Design Report

240524-ARP-XX-XX-DR-CD-001

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This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 240524-00

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1 Introduction

Arup have been commissioned by Barton Willmore on behalf of Reading Football Club to undertake the civil engineering design works, in support of a hybrid planning application for a redevelopment of the land surrounding the Madejski Stadium.

2 Local Stakeholders and Operating Authorities

Throughout the design process and development planning there have been a number of key stakeholders and operating authorities that required consultation as part of the development of the proposed site. These are described below:

- Reading Borough Council (RBC) – The council are the Local Planning Authority (LPA) for this application and the Lead Local Flood Authority (LLFA) under the Flood and Water Management Act (FWMA) (2010).
- Thames Water (TW) are the sewerage undertaker and primary supplier of potable water with powers under the Water Industry Act 1991.
- The Environment Agency (EA) – they have wide ranging powers for main rivers and groundwater bodies under the Water Resources Act (1991) and the Environment Act (1995). Under the FWMA they have a responsibility to produce a national strategy towards managing flood risk and are a statutory planning consultee for development and flood risk issues.

Correspondence with these parties is provided in Appendix B.

3 Data Sources

The key data used in compiling this design report and directing the design are listed below:

- Flood Risk Assessment.
- Historic Information including drawings and reports.
- Environment Agency Flood Risk Mapping & Groundwater Mapping.
- Landmark Information Group Envirocheck Report.
- Thames Water asset location plans.
- Survey data supplied by Midland Survey Ltd.
- Consultation with local stakeholders and operating authorities.

4 Existing Drainage Conditions

A description of the existing drainage conditions can be found in Section 3 of the FRA. An outline description of the existing surface water drainage condition can be found in Appendix C.

5 Surface Water Proposed Design

Given the existing car parks and underlying landfill membrane, the Royal Elm Park development does not produce an increase in impermeable area, however the proposed surface water drainage systems are required to meet current regulations for water quality and quantity. This section outlines the proposed surface water drainage strategy.

5.1 Surface Water Management

The surface water management strategy is based on applying sustainable drainage techniques to collect and attenuate rainfall so as not to exceed greenfield runoff rates up to a return period of 100 years plus an allowance of 30% for climate change.

5.2 SuDS Selection

SuDS have been considered an essential part of this scheme in both the outline and detailed planning areas. Due to the development being on landfill, infiltration based drainage is not possible. Any attenuation or surface water features will need to be lined to minimise water reaching the membrane and capping layer.

Utilising landscaping for attenuation, whilst generally preferable for aesthetics, amenity and budget, are of particular importance on this site as they reduce the future maintenance issues associated with the known and anticipated long-term settlement.

Where appropriate the chosen methods of drainage will incorporate adequate protection of the watercourses from pollutants, such as hydrocarbons.

Soakaway

Soakaways are not suitable for this development due to the impermeability of the membrane that caps the landfill beneath. This lack of permeability has driven the SuDS selection to remain positively drained.

Green/Brown/Blue Roofs

Green/brown/blue roofs are not planned to be used on this project due to budgetary constraints and risks associated with waterproofing and loading on the structures. If they are considered in further stages of design development, their effect will be to reduce the below ground storage requirements.

Swales

Swales have not been considered for this scheme due to the restricted space available on the site. Conveyance on the site between SuDS features is facilitated by a pipe network.

Permeable Paving

Where possible permeable paving will be used as a source control in parking areas and in the plaza area to attenuate and provide treatment of surface water. The proposal is generally to use an aggregate with 30% voids to allow for storage, except in areas where the permeable paving also acts as the attenuation element for an adjacent building. In these cases a geocellular tank will be added either below or in place of the sub-base.

Detention Basin

Hybrid detention basins will be used as extended storage for large storm events where below ground geocellular storage is allowed to surcharge into grass lined basins above. Vertical pipes

topped with cowls can be aesthetically hidden on the landscaped banks and will provide the primary hydraulic link between the below ground storage and the basins. The soil matrix on the bottom of the basins will allow for infiltration back into the below ground drainage system as the water levels recede.

These basins aim to provide the required storage for large storm events whilst also maximising the amenity of the area by allowing for use of the space even during smaller rainfall events.

Ponds

Ponds are site/regional controls and are therefore most suited to being at the downstream end of the site. The space required for a suitable pond that could provide attenuation and treatment is not available on this site.

Geocellular/Tanks

Geocellular storage and tanks offer high storage volumes and can be combined well with pervious pavements. Whilst the use of surface SuDS features has been maximised, geocellular tanks are proposed to provide the majority of the required storage volumes. They can be used traditionally as below ground tanks where the depth to the landfill liner allows and elsewhere as sub-base replacement in permeable pavement, effectively forming part of a pavement build up whilst having a significantly higher void ratio than a high void ratio sub-base (~ 95% compared to 30% voids). It is important to utilise a geocellular product that has a strong interlocking capability to transfer shear forces between modules. This will lower the effects of any differential settlement that is likely to occur.

5.3 Design Principals & Assumptions

The design has been developed with the following assumptions:

- The Flood Estimation Handbook (FEH) method has been used over the Flood Studies Report (FSR) method due to it being more onerous for this site.
- Climate change has been factored as 30% on top of the 1 in 100 year storms.
- Catchments are 100% impermeable. This is due to the site being situated on top of a landfill capping membrane. Therefore all surface water is to be positively drained.
- The existing surface water connection to the Foudry Brook to the north of the site is to be used as the primary outfall.
- A new point of discharge will be built in the drainage ditch to the south of the development.
- The existing drainage infrastructure beneath Biscuit Way will be a point of discharge for the access road for the multi-storey car park and the paved circulation surrounding the existing hotel.
- The landfill membrane is assumed at a depth of 1.3m beneath the existing ground surface level.
- Drainage gradients are generous in order to help mitigate the effects of differential settlement.
- The model was built assuming cover levels from Barton Wilmore drawing 24116-RG-M-29A - Hybrid Parameters Plan - Ground Levels.

The surface water scheme has been devised in such a way so that individual catchments or groups of catchments' (see Table 3, Table 4 & Table 5) incident rain water is controlled using source control to remove the requirement of a site control. By controlling the flow to greenfield run off rates into a trunk pipe, the outfall flow rate is the combined total of all of the catchments' controlled flows. This has much to do with the site constraints, including the proposed topography and the existing landfill liner. A site control, such as a pond or other large storage feature, was deemed unfeasible due to both the limited space on the development at the lower elevation as well as the limited depth to the landfill liner, especially considering the sheer storage required for a site that is assumed to be 100% impermeable. By splitting the site into catchment groups, effectively creating multiple internal site outfalls, the greater soil depth and available surface area nearer the upper end of the site allows a more effective use of surface SuDS and creates greater redundancy of storage and control within the drainage system.

Efforts have been made to keep the drainage network above the landfill membrane where possible. Where encroachment into the membrane is most likely is at the northeast end of the site near the Convention Centre and beneath residential blocks 3 & 4. Blocks 3 & 4 have a shared basement car park between them which means that building and courtyard drainage needs to run beneath the basement floor slab to a pumping chamber that lifts the surface water to a receiving tank in the central landscaped area.

In addition to keeping pipe gradients well above the required minimums to avoid undesirable low points, it is proposed that pipe materials are generally plastic. Materials such as uPVC and HDPE will deflect with the ground and maintain stability, whereas rigid materials have a higher chance of failure due to uneven pressure distribution.

5.4 Catchment Areas

A summary of the catchment areas for the proposed development can be found in Table 1 and should be read in conjunction with drawing CD-00104.

Table 1 – Schedule of proposed catchments and areas

Catchments	Area (hectares)
Multi-storey Car Park (MSCP)	0.32
Block 1	0.22
Block 2	0.24
Block 3 & 4	0.61
Block 5	0.33
Block 6	0.33
Block 7	0.43
Park 1	0.13
Park 2	0.11
Park 3	0.20
Park 4	0.20
Park 5	0.13
Park 6	0.27
Stadium Square 1	0.70
Stadium Square 2	0.20
Convention Centre 1	0.28
Convention Centre 2	0.16
Convention Centre 3	0.22
Convention Centre 4	0.16
Convention Centre 5	0.54
Convention Centre 6	0.11
Convention Centre 7	0.25
Convention Centre 8	0.12
Road 1	0.09
Road 2	0.13
Road 3	0.49
Road 4	0.23
Road 5	0.25
Hotel	0.22
MSCP Access	0.17

5.5 Greenfield Runoff

It was advised by Reading Borough Council via e-mail correspondence in July 2015 that as the LLFA, their starting point for surface water discharge rates from proposed developments is as advised in the DEFRA *Non-statutory technical standards for sustainable drainage systems*, Section S3. Namely, the peak runoff rate from developments which were previously developed must be as close as reasonably practicable to the greenfield runoff rates for the 1 in 1 year and the 1 in 100 year rainfall events, and should never exceed the discharge rate from the existing development. The greenfield runoff rates for each catchment group have been calculated using XP Solutions Source Control's calculator for ICP SUDS. This calculator is in accordance with the IH124 method for calculating greenfield runoff. Inputs are shown in Table 2.

Table 2 - ICP SUDS Variables

Variable	Value
SAAR (mm)	640
Soil	0.3
Region	6

The site has been split into several groups of catchments that discharge into one of three outfalls (see Table 3, Table 4 & Table 5). Each catchment group that discharges into the various outfalls have flow control to limit discharges. These are dictated by the ability of the catchment's source control to attenuate the catchment it serves. The site's current condition is deemed to discharge via an outfall on the northern boundary into the Foudry brook, with some surface runoff to the drainage ditch on the southern boundary. The area and circulation surrounding the existing stadium discharge to an outfall to the south of the stadium. The proposed design attempts to maintain existing outfall locations as much as possible and minimise disruption to the embankments.

The largest outfall of the site discharges through an existing outfall to the Foudry Brook. Table 3 outlines the catchments and groups of catchments that are controlled to Greenfield run-off rates or flow rates that are as near as is practicable. In reality it is impractical to limit discharge to these flow rates, as control methods such as orifices and vortex controls have impractically small apertures that would be prone to blockage. Therefore the minimum control flow rate used in the design was set at 3 l/s. This is the lowest recommended flow rate for a vortex control that still maintains a suitable diameter to prevent blockage. Following this proviso to the design flow rate, the proposed 1 in 1 year flow rate is 30 l/s. For 1 in 100 year the flow rate is 36.5 l/s.

The new outfall to be constructed to the south that discharges into the drainage ditch is summarised in Table 4. The rationale for the proposed flow rates being greater than Greenfield is the same as that for the flows into the Foudry Brook. The peak outflow will be 6 l/s for both 1 in 1 year storms and 1 in 100 year storms.

The area surrounding the existing hotel and the access to the multi-storey car park is materially not changing from the existing impermeable area to the proposed impermeable area. To minimise any impact any changes in these areas, the multi-storey car park and hotel forecourt area will be attenuated and their flows will be restricted as shown in Table 5. This restricted flow will discharge at a peak rate of 6 l/s into the existing surface water drainage system that serves the stadium.

It should be noted that the peak discharge rates for all three outfalls are well below the calculated discharge rates for the existing site, as reflected in Appendix C.

Table 3 - Areas contributing to Foudry Brook Outfall

Controlled Catchments	Area (ha)	1 in 1 year Greenfield Runoff Rate (l/s)	1 in 100 year Greenfield Runoff Rate (l/s)	1 in 1 year Flow Rate (l/s)	1 in 100 + 30% CC year Flow Rate (l/s)
Multi-storey Car Park, Park 6	0.59	0.8	3.1	2.4	3.0
Block 7, Stadium Square 2	0.63	0.9	3.3	2.5	3.0
Convention Centre 5 & 8, Road 4	0.89	1.5	5.5	3.1	5.5
Convention Centre 3, 4, 6 & 7	0.74	1.0	3.9	3.0	3.0
Stadium Square 1, Convention Centre 1 & 2	1.14	1.6	6.0	4.6	5.0
Block 3 & 4, Park 1 - 5	1.38	1.9	7.2	4.5	5.0
Block 5	0.33	0.5	1.7	2.2	3.0
Block 6	0.33	0.5	1.7	2.4	3.0
Road 1 - 3	0.71	1.0	3.7	2.5	3.0
Road 5	0.23	0.3	1.2	2.8	3.0
Total	6.97	10	37.3	30	36.5

Table 4 - Areas contributing to drainage ditch on southern edge of site

Controlled Catchments	Area (ha)	1 in 1 year Greenfield Runoff Rate (l/s)	1 in 100 year Greenfield Runoff Rate (l/s)	1 in 1 year Flow Rate (l/s)	1 in 100 + 30% CC year Flow Rate (l/s)
Block 1	0.22	0.3	1.2	2.5	3.0
Block 2	0.24	0.3	1.3	1.4	3.0
Total	0.46	0.6	2.5	3.9	6.0

Table 5 - Areas contributing to existing stadium surface water drainage outfall

Controlled Catchments	Area (ha)	1 in 1 year Greenfield Runoff Rate (l/s)	1 in 100 year Greenfield Runoff Rate (l/s)	1 in 1 year Flow Rate (l/s)	1 in 100 + 30% CC year Flow Rate (l/s)
Hotel	0.20	0.3	1.2	2.9	3.0
MSCP Access	0.17	0.2	0.9	2.1	3.0
Total	0.37	0.5	2.1	5.0	6.0

5.6 Attenuation Systems

The predominant system of attenuation for this site is geocellular storage or high void aggregate pavement sub-base.

A summary of the proposed attenuation systems is provided in Table 6 - Schedule of SuDS. A detailed description of the attenuation systems for the detailed planning application can be found on the Surface Water Manhole Schedule Drawing CD-00102.

Table 6 - Schedule of SuDS

Name	Type	Catchment(s) Served	Flow Control & Design Rate	Storage Volume (m ³)
Block 1 Permeable Paving	Permeable Paving with SuDS Agg sub base	Block 1 car park	Hydrobrake 3 l/s	32
Block 1 Tank	Geocellular attenuation tank	Block 1 Building		95
Block 2 Permeable Paving	Permeable Paving with SuDS Agg sub base	Block 2 car park	Hydrobrake 3 l/s	45
Block 2 Tank	Geocellular attenuation tank	Block 2 Building		95
Block 5 Permeable Paving	Permeable Paving with SuDS Agg sub base	Block 5 car park	Hydrobrake 3 l/s	46
Block 5 Tank	Geocellular attenuation tank	Block 5 Building		180
Block 6 Permeable Paving	Permeable Paving with SuDS Agg sub base	Block 6 car park	Hydrobrake 3 l/s	50
Block 6 Tank	Geocellular attenuation tank	Block 6 Building		180
Basin 1	Detention Basin	Park 1	-	93
Basin 2	Geocellular attenuation tank + detention basin	Park 2, Block 3 & 4	Hydrobrake 35 l/s	434
Basin 3	Geocellular attenuation tank + detention basin	Park 3 + Tank 2	Hydrobrake 25 l/s	300
Basin 4	Geocellular attenuation tank + detention basin	Park 4 + Basin 3	Hydrobrake 10 l/s	606
Basin 5	Geocellular attenuation tank + detention basin	Park 5 + Basin 4	Hydrobrake 5 l/s	475
Car Park Tank	Geocellular attenuation tank	Multi-storey Car Park, Park 6	Hydrobrake 3 l/s	475
Block 7 Tank	Geocellular attenuation tank	Block 7, Stadium Square 2	Hydrobrake 3 l/s	445

Stadium Square Storage 1	Permeable Paving with SuDS Agg sub base	Stadium Square 1	Hydrobrake 5 l/s	45
Stadium Square Storage 2	Permeable Paving with SuDS Agg sub base	Stadium Square 1		250
Convention Centre Storage 1	Permeable Paving with geocellular sub base	Convention Centre 1 & Stadium Square 1		305
Convention Centre Storage 3	Permeable Paving with geocellular attenuation tank + SuDS Agg Sub base	Convention Centre 3, 4, 6 & 7	Hydrobrake 3 l/s	565
Convention Centre Storage 2	Geocellular attenuation tank	Convention Centre 2 & Stadium Square 1	Hydrobrake 5 l/s	190
Convention Centre Storage 4	Geocellular attenuation tank	Convention Centre 5 & 8, Road 4 (and controlled 3l/s flow from Convention Centre Storage 3)	Hydrobrake 8.5 l/s	520
Road Tank 1	Geocellular attenuation tank	Road 1, 2, 3	Hydrobrake 9 l/s	455
Road Tank 2	Geocellular attenuation tank	Road 5	Hydrobrake 3 l/s	91
Hotel Storage 1	Permeable Paving with SuDS Agg sub base	Hotel	Check dams and underdrains	145
Hotel Storage 2	Geocellular attenuation tank	MSCP Access	Hydrobrake 3 l/s	115

5.7 Modelling Results

The drainage system was modelled using XP Solutions Microdrainage 2015.

The whole site's drainage has been modelled, considering both the detailed planning submission and the outline planning area. Modelled information has been taken from this model to produce the design and layout details. The inclusion of the outline planning area in the model was necessary as this area is upstream of the detailed planning area and has the potential to have a knock on effect in the performance of the downstream system. It was also necessary to undertake basic hydraulic modelling for the outline planning area to justify the use of the SuDS attenuation measures and determine basic sizing.

Modelling results can be found in Appendix A. The drainage catchments used in the modelling are shown on drawing CD-00104 (Appendix D).

5.8 Design Details

Details of the design layout, detailed design manhole schedules, standard details and catchments outlined for modelling are listed in Table 8 and can be found in Appendix D.

Table 7 - Drainage Drawings

Design Aspect	Drawing Number
Drainage Layout 1– Outline Planning Area	240524-ARP-XX-XX-DR-CD-00100
Drainage Layout 2 – Detailed Planning Area	240524-ARP-XX-XX-DR-CD-00101
Surface Water Manhole Schedule and SuDS Schedule	240524-ARP-XX-XX-DR-CD-00102
Foul Water Manhole Schedule	240524-ARP-XX-XX-DR-CD-00103
Surface Water Catchment Areas	240524-ARP-XX-XX-DR-CD-00104
Standard Details Sheet 1	240524-ARP-XX-XX-DR-CD-00105
Standard Details Sheet 2	240524-ARP-XX-XX-DR-CD-00106
Surface Water Schematic Overview	240524-ARP-XX-XX-DR-CD-00200
Foul Water Schematic Overview	240524-ARP-XX-XX-DR-CD-00201

5.9 Exceedance of Drainage

Consideration has been given for preventing flooding of buildings in the event of rainfall exceeding the 1 in 100 year + climate change storms.

It is assumed that there will be a fall away from entrances to buildings towards channels and depressions in the hardstanding surfaces. The infrastructure to be put in place will reflect the need to prevent water flowing across the ground in an unregulated way.

Due to the surface profile of the site, surface water will flow off the site via the embankments towards the Foudry Brook or drainage ditch to the south.

6 Foul Water Proposed Design

The proposed Madejski Stadium development is increasing the amount of dwellings and commercial use and therefore the foul discharge from the site will increase. The proposed discharge from the site requires consent from Thames Water as the statutory sewage authority.

6.1.1 Thames Water Consent

Thames Water has been engaged to provide consent for discharge into their foul sewer adjacent to the site. The proposal is to maintain the existing connection that serves the existing stadium and hotel and to discharge the proposed development at the same location. Thames Water is currently undertaking an Impact Study in order to determine the allowable additional discharge from the Madejski Stadium site. Planning consent regarding foul drainage is therefore subject to review once Thames Water's findings are known. This will be after planning is submitted.

6.1.2 General Notes on the Foul Water Management

The worst case design for the foul water has been considered due to the uncertainty of Thames Water's discharge approval. This is to assume that no building can discharge freely, and therefore all new buildings will require foul water storage of 24 hours of effluent in accordance with Building Regulations Approved Document H.

Pending the results of the Thames Water Impact Study, the exact pumping rates from each building may vary. At this time it is assumed that all residential blocks will be allowed to discharge at 3,600 l/unit/day, with an additional 10% flow for infiltration. This is in accordance with the briefing note, *Application of Design Flows when assessing impact of New Development(s)*, which was provided by Thames Water during initial correspondence for this project.

The pumping rates from the commercial and hotel spaces will likely see the greatest difference in agreed rate. In order to provide conservative pipe sizing, it was assumed that the pumping rate would match the estimated peak building discharge rate, although the required 24 hours' storage is provided.

Translating these assumptions into calculations, the current proposed foul discharge rate is 92.7 l/s, an increase of approximately 60 l/s from the currently estimated 31 l/s. Once the exact discharge rate is agreed with Thames Water, the foul water will discharge by gravity to Thames Water manhole 8101 following attenuation and pumping at each building.

It is assumed that it is possible to route the foul water pipes through the basement level to the proposed points of connection. If it is determined during detailed design that the pipes cannot traverse these distances, additional manholes may be required outside the buildings.

As the anticipated differential settlement on site can be particularly problematic for accumulation of solids within the foul drainage network, drainage gradients have been designed well above minimums in order to help mitigate the effects of ground settlement. Solids deposition will also be minimised due to the steady flow rates through the main trunk pipes generated by the building pumping stations. As with the surface water drainage, the pipe materials are proposed to be of a flexible material such as uPVC or HDPE in order to help mitigate pipe failure due to settlement.

6.1.3 Detailed Planning Submission Foul Drainage

The foul water design for Phase 1 (Convention Centre, Block 7 and the Multi Story Car Park) is outlined in this section. This should be read in conjunction with drawing Proposed Drainage Layout 2 – Detailed Planning Area 240524-ARP-XX-XX-DR-CD-00101 and Foul Water Manhole Schedule 240524-ARP-XX-XX-DR-CD-00103.

The foul drainage for the convention centre has been sized assuming the total discharge unit (DU) value from the convention centre and hotel is 1130, and the apartments are allowed an additional 4.3 l/s in accordance with the guidance provided by TW. Efforts have been made to assume the distribution of this flow around the convention centre based on proposed floor plans and usage. The pipe network runs around the northern and western perimeter of the building and connects into a storage tank system adjacent to the northern edge of the building that is capable of storing 550m³ of effluent, which was determined by removing the peaking factor from the peak flow rate and applying the rate over 24 hours. The pumping rate from this storage tank is currently assumed to match the building peak flow rate of 38 l/s and discharges into manhole F00.11 where the pressure head is broken.

Block 7's foul drainage has been sized based on occupancy per the TW guidance. A storage volume beneath the adjacent external car park of 117m³ has been sized for 24 hours' storage for 585 occupants with an average water usage of 200 l/person/day. The pump flow rate has been set at 11 l/s to match the building peak flow rate and discharges into manhole F00.8 where the pressure head is broken.

The multi storey car park foul drainage has been sized assuming a total of 57 DUs. A storage volume beneath the northern end of the structure of 60m³ pumps out at a peak rate of 4.2 l/s into manhole F00.20 where the pressure head is broken. The storage volume was calculated by removing the peaking factor from the peak flow rate and applying the rate over 24 hours.

The existing foul drainage sewer that serves the stadium will be diverted due to it being beneath the footprint of the proposed convention centre. It is anticipated that this will be a like for like diversion without any attenuation storage provided.

6.1.4 Outline Planning Submission Foul Drainage

The foul water design for Phase 2 (Residential Blocks 1-6) is outlined in this section. This should be read in conjunction with drawing Proposed Drainage Layout 1 – Outline Planning Area 240524-ARP-XX-XX-DR-CD-00100.

A summary of the tank sizes and peak flow rates can be found in Table 8. The pumped flow rates were calculated based on occupancy per the TW guidance and the storage volumes were calculated based on an average water usage of 200 l/person/day. The peak flow rates into the storage tanks will be determined during design development.

Table 8 - Phase 2 storage volumes and pumping rates

Residential Block	24 Hour Storage Volume (m ³)	Pumped flow rate (l/s)
1	43	2.8
2	42	2.7
3	44	2.7
4	65	3.8
5	64	3.9
6	65	3.9

7 Utility Coordination

A fully coordinated utility strategy that incorporates the drainage has not been undertaken at this stage of design. Some consideration of the need for utilities in trenches has been considered in the drainage layout. Space has been left in close proximity to the structures on the site and adequate routes between drainage features have been incorporated.

8 Operation and Maintenance Considerations

Operation and maintenance has been considered in the development of this drainage design. There is a particular need when approaching maintenance for SuDS features.

Extended storage detention basins within the park area of the development will require regular maintenance as part of the gardening scheme for the development in the form of grass cutting.

8.1 Settlement Strategies

Several measures are proposed to manage the settlement that is anticipated on this site.

Preliminary assessments of differential settlement due to a large void opening up within the fill have suggested a displacement of up to 120mm over a 12m span i.e. 1%. Additionally, the average tilt due to differential settlement could reach 1 in 12. As this scenario would likely require remedial works for accessibility and visual impact, it is deemed impractical to design the drainage features to be resilient to such large scale settlement. Therefore the drainage has been designed to be resilient to the first scenario and where larger settlements are occur it is recommended that the drainage systems are inspected and replaced as necessary.

8.1.1 Drainage resilience

- Incorporating rocker joints at the interfaces between buildings/manholes and pipes will allow for some movement of the ground to occur without compromising the pipe.

- Attenuation structures are to be formed from products with adequate shear resistance. This will introduce a degree of uniformity to the pavement structure's failure mode if there is settlement. A layer of Tensar Geogrid or similar laid beneath the tanks will provide additional capacity to withstand ground movement.
- All pipes should have an additional 1% gradient beyond the minimum design gradient or at least 300mm fall between manholes.
- Plastic pipes (uPVC or HDPE) will be used as they have the ability to flex with changing ground conditions whilst maintaining structural integrity.
- Where possible, manholes and other drainage structures should be located within soft landscaping in order to minimise impacts of differential settlement and reduce costs of potential future remedial works.

8.1.2 Surface features

- Soft landscaping – gravel or other soft edging around buildings to allow for settlement creep of the surface.
- Transfer slabs at entrances provide a rigid platform at the thresholds to buildings to prevent steps forming. This helps to avoid remedial corrections at building entrances.
- Stairs at building access may have to be extended to cope with changing external surface levels.
- Pavements will require inspection and regular maintenance. Where there is excessive change in surface profile the surface will need to be re-laid.

8.2 Maintenance Strategies

The drainage systems will be specified with suitable access for inspection and maintenance. Table 9 gives an overview of the typical maintenance activities for the drainage systems.

Table 9 - Drainage inspection and maintenance minimum requirements

Drainage Element	Inspection Interval	Maintenance Procedure
Road gullies	Annually	Remove water and captured pollutants by vacuum tanker, rod downstream pipe
Channel drain	Annually	Remove weed growth, identify and replace broken frames/grates, removed water and captured pollutants by vacuum tanker, rod downstream pipe
Manhole chambers	Annually	Observe for downstream blockages, rod or flush downstream pipes as necessary, removed captured

		pollutants by vacuum tanker as necessary
Pipes	Annually	Inspect for blockages, root ingress or any signs of ground movement that may create low points. Where low points exist determine if it is significant enough to justify being re-laid
Park detention basins	Quarterly	Cut back grass (collecting clippings), inspect overflows for blockages
Geocellular attenuation tank*	Annually	Observe any sediment accumulation using inspection camera. Jet out any sediment and collect with vacuum tanker via access chambers
Petrol interceptor*	Annually	Observe sludge accumulation, test oil level alarm and arrange de-sludging by vacuum tanker as necessary.
Vortex flow control*	Twice Annually	Remove water and captured pollutants by vacuum tanker, hose down to remove any debris
Pumps and Pump storage*	Annually	Follow manufacturers' maintenance requirements

* Drainage element is a proprietary product. Refer to manufacturer for maintenance requirements.

Appendix A

Model Results

Ove Arup & Partners International Ltd		Page 1								
The Arup Campus Blyth Gate Solihull B90 8AE										
Date 11/01/2016 09:52 File 240524-ARP-Drainage Model-P1.10.mdx	Designed by james.walley Checked by trevor.mino									
XP Solutions	Network 2015.1									
<u>STORM SEWER DESIGN by the Modified Rational Method</u>										
<u>Design Criteria for Storm</u>										
Pipe Sizes STANDARD Manhole Sizes STANDARD										
FEH Rainfall Model										
Return Period (years)	5	Foul Sewage (l/s/ha) 0.000								
Site Location GB 471200 169400 SU 71200 69400		Volumetric Runoff Coeff. 0.750								
C (1km)	-0.030	Add Flow / Climate Change (%) 0								
D1 (1km)	0.288	Minimum Backdrop Height (m) 0.100								
D2 (1km)	0.292	Maximum Backdrop Height (m) 0.200								
D3 (1km)	0.308	Min Design Depth for Optimisation (m) 1.200								
E (1km)	0.308	Min Vel for Auto Design only (m/s) 1.00								
F (1km)	2.584	Min Slope for Optimisation (1:X) 500								
Maximum Rainfall (mm/hr)	50									
Maximum Time of Concentration (mins)	30									
Designed with Level Soffits										
<u>Network Design Table for Storm</u>										
« - Indicates pipe capacity < flow										
PN	Length	Fall	Slope	I.Area	T.E.	Base	k	HYD	DIA	Auto
(m)	(m)	(1:X)	(ha)	(mins)	Flow (l/s)	(mm)	SECT	(mm)	Design	
<u>Network Results Table</u>										
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<u>Network Design Table for Storm</u>											
PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S2.000	8.302	0.081	102.7	0.126	5.00	0.0	0.600	0	300	
S2.001	6.721	0.567	11.8	0.000	0.00	0.0	0.600	0	300	
S2.002	12.478	0.236	52.9	0.000	0.00	0.0	0.600	0	450	
S2.003	14.157	0.353	40.0	0.722	0.00	0.0	0.600	0	450	
S2.004	21.642	0.324	66.8	0.000	0.00	0.0	0.600	0	300	
S2.005	13.062	0.030	435.9	0.000	0.00	0.0	0.600	0	450	
S2.006	11.633	0.105	110.8	0.200	0.00	0.0	0.600	0	450	
S2.007	2.991	0.050	60.4	0.000	0.00	0.0	0.600	0	300	
S2.008	19.587	0.073	269.9	0.000	0.00	0.0	0.600	0	450	
S2.009	18.111	0.159	113.6	0.196	0.00	0.0	0.600	0	450	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S2.000	50.00	5.09	54.000	0.126	0.0	0.0	0.0	1.55	109.6	17.1
S2.001	50.00	5.11	52.414	0.126	0.0	0.0	0.0	4.59	324.7	17.1
S2.002	50.00	5.19	51.845	0.126	0.0	0.0	0.0	2.80	445.4	17.1
S2.003	50.00	5.26	51.604	0.849	0.0	0.0	0.0	3.22	512.2	114.9
S2.004	50.00	5.45	51.226	0.849	0.0	0.0	0.0	1.93	136.2	114.9
S2.005	50.00	5.67	50.831	0.849	0.0	0.0	0.0	0.97	153.9	114.9
S2.006	50.00	5.77	50.800	1.049	0.0	0.0	0.0	1.93	307.1	142.0
S2.007	50.00	5.80	50.680	1.049	0.0	0.0	0.0	2.03	143.2	142.0
S2.008	50.00	6.06	50.601	1.049	0.0	0.0	0.0	1.23	196.1	142.0
S2.009	50.00	6.22	50.500	1.245	0.0	0.0	0.0	1.91	303.3	168.6

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S2.010	11.186	0.234	47.8	0.000	0.00	0.0	0.600	0	150	
S2.011	10.238	0.105	97.5	0.000	0.00	0.0	0.600	0	450	
S2.012	26.978	0.298	90.6	0.132	0.00	0.0	0.600	0	450	
S2.013	28.598	1.437	19.9	0.000	0.00	0.0	0.600	0	150	
S2.014	20.931	1.805	11.6	0.000	0.00	0.0	0.600	0	150	
S2.015	22.181	0.352	63.0	0.000	0.00	0.0	0.600	0	150	
S3.000	48.827	1.714	28.5	0.092	5.00	0.0	0.600	0	300	
S3.001	31.295	1.663	18.8	0.239	0.00	0.0	0.600	0	450	
S3.002	20.531	0.304	67.5	0.154	0.00	0.0	0.600	0	450	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S2.010	50.00	6.35	50.341	1.245	0.0	0.0	0.0	1.46	25.8«	168.6
S2.011	50.00	6.43	50.105	1.245	0.0	0.0	0.0	2.06	327.5	168.6
S2.012	50.00	6.64	50.000	1.376	0.0	0.0	0.0	2.14	339.8	186.4
S2.013	50.00	6.85	49.686	1.376	0.0	0.0	0.0	2.27	40.1«	186.4
S2.014	50.00	6.97	48.293	1.376	0.0	0.0	0.0	2.98	52.6«	186.4
S2.015	50.00	7.26	46.488	1.376	0.0	0.0	0.0	1.27	22.4«	186.4
S3.000	50.00	5.28	50.214	0.092	0.0	0.0	0.0	2.96	209.0	12.5
S3.001	50.00	5.39	48.350	0.332	0.0	0.0	0.0	4.70	748.1	44.9
S3.002	50.00	5.52	46.687	0.485	0.0	0.0	0.0	2.48	393.9	65.7

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S3.003	11.039	0.185	59.6	0.000	0.00	0.0	0.600	0	300	
S3.004	16.555	0.414	40.0	0.040	0.00	0.0	0.600	0	150	
S2.016	29.756	0.496	60.0	0.000	0.00	0.0	0.600	0	225	
S2.017	18.308	0.594	30.8	0.000	0.00	0.0	0.600	0	225	
S4.000	18.231	0.489	37.3	0.072	5.00	0.0	0.600	0	150	
S4.001	25.018	0.610	41.0	0.000	0.00	0.0	0.600	0	150	
S5.000	6.722	0.197	34.1	0.251	5.00	0.0	0.600	0	225	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S3.003	50.00	5.61	46.417	0.485	0.0	0.0	0.0	2.04	144.2	65.7
S3.004	50.00	5.79	46.234	0.526	0.0	0.0	0.0	1.60	28.2«	71.2
S2.016	50.00	7.55	45.820	1.902	0.0	0.0	0.0	1.69	67.3«	257.6
S2.017	50.00	7.68	45.324	1.902	0.0	0.0	0.0	2.37	94.0«	257.6
S4.000	50.00	5.18	47.313	0.072	0.0	0.0	0.0	1.65	29.2	9.8
S4.001	50.00	5.45	46.824	0.072	0.0	0.0	0.0	1.58	27.9	9.8
S5.000	50.00	5.05	47.021	0.251	0.0	0.0	0.0	2.25	89.4	34.0

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S5.001	33.958	0.675	50.3	0.000	0.00	0.0	0.600	o	150	
S4.002	18.961	0.164	115.6	0.000	0.00	0.0	0.600	o	225	
S6.000	12.776	1.406	9.1	0.436	5.00	0.0	0.600	o	225	
S4.003	21.452	0.186	115.3	0.000	0.00	0.0	0.600	o	225	
S4.004	32.261	0.350	92.2	0.000	0.00	0.0	0.600	o	225	
S7.000	16.696	1.650	10.1	0.372	5.00	0.0	0.600	o	225	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S5.001	50.00	5.45	46.800	0.251	0.0	0.0	0.0	1.42	25.1«	34.0
S4.002	50.00	5.71	46.050	0.323	0.0	0.0	0.0	1.22	48.3	43.8
S6.000	50.00	5.05	47.292	0.436	0.0	0.0	0.0	4.37	173.6	59.1
S4.003	50.00	6.00	45.886	0.760	0.0	0.0	0.0	1.22	48.4«	102.9
S4.004	50.00	6.40	45.700	0.760	0.0	0.0	0.0	1.36	54.2«	102.9
S7.000	50.00	5.07	47.000	0.372	0.0	0.0	0.0	4.14	164.5	50.4

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S4.005	27.509	0.545	50.5	0.000	0.00	0.0	0.600	0	150	
S8.000	33.630	0.897	37.5	0.118	10.00	0.0	0.600	0	300	
S8.001	28.511	0.752	37.9	0.161	0.00	0.0	0.600	0	450	
S8.002	20.100	0.261	77.0	0.145	0.00	0.0	0.600	0	450	
S8.003	15.297	0.300	51.0	0.206	0.00	0.0	0.600	0	450	
S8.004	6.635	0.170	39.0	0.000	0.00	0.0	0.600	0	150	
S2.018	53.804	0.750	71.7	0.000	0.00	0.0	0.600	0	225	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S4.005	50.00	6.72	45.350	1.132	0.0	0.0	0.0	1.42	25.1«	153.2
S8.000	50.00	10.22	48.060	0.118	0.0	0.0	0.0	2.58	182.1	16.0
S8.001	50.00	10.36	47.013	0.280	0.0	0.0	0.0	3.31	526.4	37.9
S8.002	50.00	10.51	46.261	0.425	0.0	0.0	0.0	2.32	368.8	57.5
S8.003	50.00	10.60	46.000	0.631	0.0	0.0	0.0	2.85	453.7	85.4
S8.004	50.00	10.66	45.700	0.631	0.0	0.0	0.0	1.62	28.6«	85.4
S2.018	50.00	11.24	44.730	3.664	0.0	0.0	0.0	1.55	61.5«	496.2



Micro
Drainage

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PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S2.019	12.122	0.170	71.3	0.000	0.00	0.0	0.600	o	225	
S2.020	70.985	1.000	71.0	0.000	0.00	0.0	0.600	o	225	
S2.021	70.985	1.000	71.0	0.000	0.00	0.0	0.600	o	225	
S9.000	61.727	0.882	70.0	0.000	5.00	0.0	0.600	o	225	
S9.001	7.191	0.103	69.8	0.129	0.00	0.0	0.600	o	225	
S9.002	27.486	0.275	100.0	0.000	0.00	0.0	0.600	o	300	
S9.003	41.313	0.380	108.7	0.536	0.00	0.0	0.600	o	300	
S10.000	7.632	0.800	9.5	0.715	5.00	0.0	0.600	o	300	

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S2.019	50.00	11.37	43.980	3.664	0.0	0.0	0.0	1.55	61.7«	496.2
S2.020	50.00	12.14	43.810	3.664	0.0	0.0	0.0	1.55	61.8«	496.2
S2.021	50.00	12.90	42.810	3.664	0.0	0.0	0.0	1.55	61.8«	496.2
S9.000	50.00	5.66	45.618	0.000	0.0	0.0	0.0	1.57	62.2	0.0
S9.001	50.00	5.73	44.736	0.129	0.0	0.0	0.0	1.57	62.3	17.5
S9.002	50.00	6.03	43.850	0.129	0.0	0.0	0.0	1.57	111.1	17.5
S9.003	50.00	6.48	43.575	0.665	0.0	0.0	0.0	1.51	106.6	90.0
S10.000	50.00	5.02	46.300	0.715	0.0	0.0	0.0	5.12	361.9	96.8

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S10.001	39.763	0.612	65.0	0.000	0.00	0.0	0.600	o	300	
S10.002	39.763	0.613	64.9	0.069	0.00	0.0	0.600	o	300	
S10.003	66.009	0.930	71.0	0.066	0.00	0.0	0.600	o	450	
S9.004	14.109	0.235	60.0	0.081	0.00	0.0	0.600	o	150	
S11.000	45.325	1.213	37.4	0.248	10.00	0.0	0.600	o	300	
S12.000	19.334	1.149	16.8	0.083	5.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S10.001	50.00	5.36	45.500	0.715	0.0	0.0	0.0	1.95	138.1	96.8
S10.002	50.00	5.70	44.888	0.784	0.0	0.0	0.0	1.96	138.2	106.2
S10.003	50.00	6.16	44.125	0.850	0.0	0.0	0.0	2.42	384.2	115.2
S9.004	50.00	6.66	43.195	1.596	0.0	0.0	0.0	1.30	23.0«	216.1
S11.000	50.00	10.29	50.747	0.248	0.0	0.0	0.0	2.58	182.4	33.5
S12.000	50.00	5.17	50.803	0.083	0.0	0.0	0.0	1.89	14.9	11.3

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S11.001	4.814	0.103	46.7	0.000	0.00	0.0	0.600	o	225	
S11.002	69.532	1.400	49.7	0.000	0.00	0.0	0.600	o	225	
S13.000	46.390	1.555	29.8	0.252	10.00	0.0	0.600	o	300	
S14.000	19.330	0.488	39.6	0.085	5.00	0.0	0.600	o	100	
S13.001	3.312	0.033	100.4	0.000	0.00	0.0	0.600	o	225	
S13.002	4.533	0.056	80.9	0.000	0.00	0.0	0.600	o	225	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S11.001	50.00	10.33	49.520	0.331	0.0	0.0	0.0	1.92	76.3	44.8
S11.002	50.00	10.96	49.400	0.331	0.0	0.0	0.0	1.86	74.0	44.8
S13.000	50.00	10.27	49.627	0.252	0.0	0.0	0.0	2.89	204.2	34.2
S14.000	50.00	5.26	48.500	0.085	0.0	0.0	0.0	1.23	9.7«	11.5
S13.001	50.00	10.31	48.083	0.337	0.0	0.0	0.0	1.31	51.9	45.6
S13.002	50.00	10.36	48.041	0.337	0.0	0.0	0.0	1.45	57.8	45.6



Micro
Drainage

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PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S11.003	31.305	0.417	75.0	0.127	0.00	0.0	0.600	o	300	
S11.004	41.993	1.781	23.6	0.000	0.00	0.0	0.600	o	300	
S11.005	29.585	0.790	37.4	0.128	0.00	0.0	0.600	o	300	
S11.006	196.770	0.500	393.5	0.000	0.00	0.0	0.600	o	1800	
S11.007	13.489	0.225	60.0	0.452	0.00	0.0	0.600	o	150	
S2.022	73.314	0.915	80.1	0.000	0.00	0.0	0.600	o	300	
S2.023	36.304	0.450	80.7	0.000	0.00	0.0	0.600	o	300	
S15.000	5.803	0.236	24.6	0.155	5.00	0.0	0.600	o	225	

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S11.003	50.00	11.24	47.988	0.795	0.0	0.0	0.0	1.82	128.5	107.7
S11.004	50.00	11.46	47.571	0.795	0.0	0.0	0.0	3.25	229.8	107.7
S11.005	50.00	11.65	45.790	0.923	0.0	0.0	0.0	2.58	182.2	125.0
S11.006	50.00	13.01	45.000	0.923	0.0	0.0	0.0	2.41	6134.1	125.0
S11.007	50.00	13.18	44.500	1.375	0.0	0.0	0.0	1.30	23.0	186.3
S2.022	50.00	13.88	41.735	6.635	0.0	0.0	0.0	1.76	124.3	898.5
S2.023	50.00	14.22	40.820	6.635	0.0	0.0	0.0	1.75	123.8	898.5
S15.000	50.00	5.04	41.386	0.155	0.0	0.0	0.0	2.65	105.4	21.1

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S15.001	7.112	0.180	39.5	0.000	0.00	0.0	0.600	o	150	
S2.024	33.510	0.420	79.8	0.000	0.00	0.0	0.600	o	300	
S2.025	14.909	1.175	12.7	0.000	0.00	0.0	0.600	o	300	
S2.026	7.739	0.050	154.8	0.000	0.00	0.0	0.600	o	600	
S16.000	31.645	0.537	58.9	0.184	10.00	0.0	0.600	o	300	
S17.000	14.326	0.514	27.9	0.056	5.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S15.001	50.00	5.11	41.150	0.155	0.0	0.0	0.0	1.61	28.4	21.1
S2.024	50.00	14.54	40.370	6.791	0.0	0.0	0.0	1.76	124.5<	919.6
S2.025	50.00	14.60	39.950	6.791	0.0	0.0	0.0	4.44	313.6<	919.6
S2.026	50.00	14.66	38.775	6.791	0.0	0.0	0.0	1.96	552.8<	919.6
S16.000	50.00	10.26	51.542	0.184	0.0	0.0	0.0	2.05	145.0	25.0
S17.000	50.00	5.16	51.500	0.056	0.0	0.0	0.0	1.47	11.5	7.6



Micro
Drainage

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Network 2015.1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S16.001	4.822	0.222	21.7	0.000	0.00	0.0	0.600	o	300	
S16.002	61.583	7.317	8.4	0.000	0.00	0.0	0.600	o	150	
S18.000	19.802	0.900	22.0	0.000	10.00	0.0	0.600	o	300	
S19.000	10.423	0.708	14.7	0.046	5.00	0.0	0.600	o	100	
S18.001	4.534	0.189	24.0	0.175	0.00	0.0	0.600	o	300	
S18.002	18.782	0.538	34.9	0.000	0.00	0.0	0.600	o	150	
S18.003	9.439	5.310	1.8	0.000	0.00	0.0	0.600	o	150	

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S16.001	50.00	10.28	50.991	0.241	0.0	0.0	0.0	3.39	239.5	32.6
S16.002	50.00	10.57	50.807	0.241	0.0	0.0	0.0	3.49	61.8	32.6
S18.000	50.00	10.10	49.925	0.000	0.0	0.0	0.0	3.37	238.0	0.0
S19.000	50.00	5.09	50.000	0.046	0.0	0.0	0.0	2.02	15.9	6.3
S18.001	50.00	10.12	49.000	0.222	0.0	0.0	0.0	3.22	227.9	30.0
S18.002	50.00	10.30	48.817	0.222	0.0	0.0	0.0	1.71	30.2	30.0
S18.003	50.00	10.33	48.728	0.222	0.0	0.0	0.0	7.62	134.7	30.0



Micro
Drainage

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Network 2015.1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S16.003	35.346	6.716	5.3	0.000	0.00	0.0	0.600	0	150	
S20.000	52.191	1.704	30.6	0.026	5.00	0.0	0.600	0	150	
S20.001	32.252	1.642	19.6	0.046	0.00	0.0	0.600	0	225	
S20.002	28.271	0.331	85.4	0.108	0.00	0.0	0.600	0	150	
S21.000	3.330	0.048	69.4	0.000	5.00	0.0	0.600	0	100	
S21.001	29.079	0.772	37.7	0.140	0.00	0.0	0.600	0	150	

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S16.003	50.00	10.71	43.402	0.462	0.0	0.0	0.0	4.42	78.2	62.6
S20.000	50.00	5.48	49.300	0.026	0.0	0.0	0.0	1.83	32.3	3.5
S20.001	50.00	5.66	47.521	0.072	0.0	0.0	0.0	2.97	117.9	9.8
S20.002	50.00	6.09	45.500	0.180	0.0	0.0	0.0	1.09	19.2	24.3
S21.000	50.00	5.06	46.843	0.000	0.0	0.0	0.0	0.93	7.3	0.0
S21.001	50.00	5.35	45.997	0.140	0.0	0.0	0.0	1.65	29.1	19.0

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
S20.003	14.681	0.250	58.7	0.000	0.00	0.0	0.600	0	225	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S20.003	50.00	6.23	45.094	0.320	0.0	0.0	0.0	1.71	68.0	43.3

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SBasin 1	54.500	0.500	Open Manhole	1200	S2.000	54.000	300				
S00.1	54.500	2.086	Open Manhole	1200	S2.001	52.414	300	S2.000	53.919	300	1505
S00.2	53.500	1.655	Open Manhole	1350	S2.002	51.845	450	S2.001	51.847	300	
SBasin 2	53.000	1.396	Open Manhole	1350	S2.003	51.604	450	S2.002	51.609	450	5
S00.3	53.000	1.774	Open Manhole	1350	S2.004	51.226	300	S2.003	51.251	450	175
S00.4	52.000	1.169	Open Manhole	1350	S2.005	50.831	450	S2.004	50.902	300	
SBasin 3	52.000	1.200	Open Manhole	1350	S2.006	50.800	450	S2.005	50.801	450	1
S00.5	52.000	1.320	Open Manhole	1350	S2.007	50.680	300	S2.006	50.695	450	165
S00.6	51.500	0.899	Open Manhole	1350	S2.008	50.601	450	S2.007	50.630	300	
SBasin 4	51.500	1.000	Open Manhole	1350	S2.009	50.500	450	S2.008	50.528	450	28
S00.7	51.500	1.159	Open Manhole	1350	S2.010	50.341	150	S2.009	50.341	450	
S00.8	51.000	0.895	Open Manhole	1350	S2.011	50.105	450	S2.010	50.107	150	
SBasin 5	51.000	1.000	Open Manhole	1350	S2.012	50.000	450	S2.011	50.000	450	
S00.9	51.500	1.814	Open Manhole	1350	S2.013	49.686	150	S2.012	49.702	450	316
S00.10	50.000	1.751	Open Manhole	1200	S2.014	48.293	150	S2.013	48.249	150	
S00.11	48.000	1.512	Open Manhole	1200	S2.015	46.488	150	S2.014	46.488	150	
SCP.1	51.500	1.286	Open Manhole	1200	S3.000	50.214	300				
SCP.2	49.700	1.350	Open Manhole	1350	S3.001	48.350	450	S3.000	48.500	300	
SCP.3	48.000	1.313	Open Manhole	1350	S3.002	46.687	450	S3.001	46.687	450	

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SCP Tank	48.000	1.617	Open Manhole	1350	S3.003	46.417	300	S3.002	46.383	450	241
SCP.4	48.000	1.768	Open Manhole	1200	S3.004	46.234	150	S3.003	46.232	300	
S00.12	48.000	2.180	Open Manhole	1200	S2.016	45.820	225	S2.015	46.136	150	
								S3.004	45.820	150	
S00.13	47.500	2.176	Open Manhole	1200	S2.017	45.324	225	S2.016	45.324	225	
SStadSqStorage 1	48.000	0.687	Open Manhole	1200	S4.000	47.313	150				
SP.1	48.000	1.176	Open Manhole	1200	S4.001	46.824	150	S4.000	46.824	150	
SCCStorage2	48.000	0.979	Open Manhole	1200	S5.000	47.021	225				
SP.2a	48.000	1.200	Open Manhole	1200	S5.001	46.800	150	S5.000	46.824	225	99
SP.2	48.000	1.950	Open Manhole		S4.002	46.050	225	S4.001	46.214	150	89
								S5.001	46.125	150	
SStadSqStorage 2	48.000	0.708	Open Manhole		S6.000	47.292	225				
SPP 2 Junction	48.000	2.114	Junction	0	S4.003	45.886	225	S4.002	45.886	225	
								S6.000	45.886	225	
SP.3	48.000	2.300	Open Manhole	1200	S4.004	45.700	225	S4.003	45.700	225	
SCCStorage1	48.000	1.000	Open Manhole	1200	S7.000	47.000	225				
SP.4	48.000	2.650	Open Manhole	1200	S4.005	45.350	150	S4.004	45.350	225	
								S7.000	45.350	225	
SB7.1	49.500	1.440	Open Manhole	1200	S8.000	48.060	300				

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SB7.2	48.270	1.257	Open Manhole	1350	S8.001	47.013	450	S8.000	47.163	300	
SB7.3	47.500	1.239	Open Manhole	1350	S8.002	46.261	450	S8.001	46.261	450	
SB7 Tank	47.500	1.500	Open Manhole	1350	S8.003	46.000	450	S8.002	46.000	450	
SB7.4	47.500	1.800	Open Manhole	1350	S8.004	45.700	150	S8.003	45.700	450	
S00.14	47.500	2.770	Open Manhole	1200	S2.018	44.730	225	S2.017	44.730	225	
								S4.005	44.805	150	
								S8.004	45.530	150	725
S00.15	47.000	3.020	Open Manhole	1200	S2.019	43.980	225	S2.018	43.980	225	
S00.16	46.500	2.690	Open Manhole	1200	S2.020	43.810	225	S2.019	43.810	225	
S00.17	46.500	3.690	Open Manhole	1200	S2.021	42.810	225	S2.020	42.810	225	
SCC.9	47.500	1.882	Open Manhole	1200	S9.000	45.618	225				
SCC.10	47.000	2.264	Open Manhole	1200	S9.001	44.736	225	S9.000	44.736	225	
SCC.11	47.000	3.150	Open Manhole	1200	S9.002	43.850	300	S9.001	44.633	225	708
SCCStorage4	47.000	3.425	Open Manhole	1200	S9.003	43.575	300	S9.002	43.575	300	
SCCStorage3	47.000	0.700	Open Manhole	1200	S10.000	46.300	300				
SCC.1	47.000	1.500	Open Manhole		S10.001	45.500	300	S10.000	45.500	300	
Ignore me 1	47.000	2.112	Junction	0	S10.002	44.888	300	S10.001	44.888	300	
SCC.2	47.000	2.875	Open Manhole	1350	S10.003	44.125	450	S10.002	44.275	300	
SCC.12	47.000	3.805	Open Manhole	1350	S9.004	43.195	150	S9.003	43.195	300	



Micro Drainage

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MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SB5.1	52.500	1.753	Open Manhole	1200	S11.000	50.747	300	S10.003	43.195	450	
SB5 PP	51.500	0.697	Open Manhole	1200	S12.000	50.803	100				
SB5 Tank	51.500	1.980	Open Manhole	1200	S11.001	49.520	225	S11.000	49.534	300	89
								S12.000	49.654	100	9
SB5.2	51.500	2.100	Open Manhole	1200	S11.002	49.400	225	S11.001	49.417	225	17
SB6.1	51.500	1.873	Open Manhole	1200	S13.000	49.627	300				
SB6 PP	49.500	1.000	Open Manhole	1200	S14.000	48.500	100				
SB6 Tank	49.500	1.488	Open Manhole	1200	S13.001	48.083	225	S13.000	48.072	300	
								S14.000	48.012	100	
SB6.2	49.500	1.459	Open Manhole	1200	S13.002	48.041	225	S13.001	48.050	225	9
SB6.3	49.500	1.515	Open Manhole	1200	S11.003	47.988	300	S11.002	48.000	225	
								S13.002	47.985	225	
SB6.4	49.250	1.679	Open Manhole	1200	S11.004	47.571	300	S11.003	47.571	300	
SB6.5	47.500	1.710	Open Manhole	1200	S11.005	45.790	300	S11.004	45.790	300	
SB6.6	47.000	2.000	Open Manhole	2700	S11.006	45.000	1800	S11.005	45.000	300	
SRoad Tank 1	46.500	2.000	Open Manhole	2700	S11.007	44.500	150	S11.006	44.500	1800	
S00.18	46.500	4.765	Open Manhole	1200	S2.022	41.735	300	S2.021	41.810	225	
								S9.004	42.960	150	1075

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S00.19	43.970	3.150	Open Manhole	1200	S2.023	40.820	300	S11.007	44.275	150	2390
SRoad Tank 2	42.500	1.114	Open Manhole	1200	S15.000	41.386	225	S2.022	40.820	300	
S00.20	42.500	1.350	Open Manhole	1200	S15.001	41.150	150	S15.000	41.150	225	
S00.21	42.500	2.130	Open Manhole	1200	S2.024	40.370	300	S2.023	40.370	300	
								S15.001	40.970	150	450
SRebuilt exMH90	42.613	2.663	Open Manhole	1200	S2.025	39.950	300	S2.024	39.950	300	
SexMH18	40.000	1.225	Open Manhole	1500	S2.026	38.775	600	S2.025	38.775	300	
SExisting OF100	40.000	1.275	Open Manhole	0		OUTFALL		S2.026	38.725	600	
SB2.1	53.000	1.458	Open Manhole	1200	S16.000	51.542	300				
SB2 PP	52.500	1.000	Open Manhole	1200	S17.000	51.500	100				
SB2 Tank	52.500	1.514	Open Manhole	1200	S16.001	50.991	300	S16.000	51.005	300	14
								S17.000	50.986	100	
SB2.2	52.500	1.731	Open Manhole	1200	S16.002	50.807	150	S16.001	50.769	300	
SB1.1	51.500	1.575	Open Manhole	1200	S18.000	49.925	300				
SB1 PP	51.000	1.000	Open Manhole	1200	S19.000	50.000	100				
SB1 Tank	51.000	2.000	Open Manhole	1200	S18.001	49.000	300	S18.000	49.025	300	25
								S19.000	49.292	100	92

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SB1.2	51.000	2.189	Open Manhole	1200	S18.002	48.817	150	S18.001	48.811	300	
SB1.3	50.500	2.221	Open Manhole	1200	S18.003	48.728	150	S18.002	48.279	150	
SB1.4	45.000	1.598	Open Manhole	1200	S16.003	43.402	150	S16.002	43.490	150	88
								S18.003	43.418	150	16
SDrainage Ditch	38.000	1.314	Open Manhole	0		OUTFALL		S16.003	36.686	150	
SH.1	50.500	1.200	Open Manhole	1200	S20.000	49.300	150				
SH.2	48.900	1.379	Open Manhole	1200	S20.001	47.521	225	S20.000	47.596	150	
SH.3Storage 2	47.500	2.000	Open Manhole	1200	S20.002	45.500	150	S20.001	45.879	225	454
SDUMMY	47.500	0.657	Open Manhole	1200	S21.000	46.843	100				
SH.4Storage 1	47.400	1.403	Open Manhole	1200	S21.001	45.997	150	S21.000	46.795	100	748
SH.5	47.500	2.406	Open Manhole	1200	S20.003	45.094	225	S20.002	45.169	150	
								S21.001	45.225	150	56
S	47.000	2.156	Open Manhole	0		OUTFALL		S20.003	44.844	225	

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Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D, L (mm)	W (mm)
S2.026	SExisting OF100	40.000	38.725	0.000	0	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D, L (mm)	W (mm)
S16.003	SDrainage Ditch	38.000	36.686	0.000	0	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D, L (mm)	W (mm)
S20.003	S	47.000	44.844	0.000	0	0

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Online Controls for Storm

Hydro-Brake Optimum® Manhole: S00.3, DS/PN: S2.004, Volume (m³): 4.6

Unit Reference MD-SCL-0227-3500-1600-3500	Diameter (mm) 227
Design Head (m) 1.600	Invert Level (m) 51.226
Design Flow (l/s) 35.0	Minimum Outlet Pipe Diameter (mm) 300
Flush-Flo™ Calculated	Suggested Manhole Diameter (mm) 1800
Objective Minimise blockage risk	

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.600	34.9	Kick-Flo®	0.931	27.0
Flush-Flo™	0.367	34.9	Mean Flow over Head Range	-	29.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.4	0.600	33.3	1.600	34.9	2.600	44.0	5.000	60.3	7.500	73.4
0.200	25.0	0.800	30.7	1.800	36.9	3.000	47.1	5.500	63.2	8.000	75.8
0.300	34.6	1.000	27.9	2.000	38.8	3.500	50.8	6.000	65.9	8.500	78.0
0.400	34.8	1.200	30.4	2.200	40.6	4.000	54.2	6.500	68.5	9.000	80.2
0.500	34.2	1.400	32.7	2.400	42.4	4.500	57.3	7.000	71.0	9.500	82.4

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		Designed by james.walley Checked by trevor.mino																																																																										
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<u>Hydro-Brake Optimum® Manhole: S00.5, DS/PN: S2.007, Volume (m³): 3.5</u>																																																																												
Unit Reference MD-SHE-0215-2500-1300-2500																																																																												
Design Head (m)		1.300	Diameter (mm)	215																																																																								
Design Flow (l/s)		25.0	Invert Level (m)	50.680																																																																								
Flush-Flo™		Calculated	Minimum Outlet Pipe Diameter (mm)	300																																																																								
Objective		Minimise upstream storage	Suggested Manhole Diameter (mm)	1800																																																																								
<table><tr><td>Control Points</td><td>Head (m)</td><td>Flow (l/s)</td><td>Control Points</td><td>Head (m)</td><td>Flow (l/s)</td></tr><tr><td>Design Point (Calculated)</td><td>1.300</td><td>25.0</td><td>Kick-Flo®</td><td>0.900</td><td>21.0</td></tr><tr><td>Flush-Flo™</td><td>0.412</td><td>25.0</td><td>Mean Flow over Head Range</td><td>-</td><td>21.3</td></tr></table>					Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)	Design Point (Calculated)	1.300	25.0	Kick-Flo®	0.900	21.0	Flush-Flo™	0.412	25.0	Mean Flow over Head Range	-	21.3																																																						
Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)																																																																							
Design Point (Calculated)	1.300	25.0	Kick-Flo®	0.900	21.0																																																																							
Flush-Flo™	0.412	25.0	Mean Flow over Head Range	-	21.3																																																																							
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated																																																																												
<table><tr><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td></tr><tr><td>0.100</td><td>7.3</td><td>0.600</td><td>24.4</td><td>1.600</td><td>27.6</td><td>2.600</td><td>34.8</td><td>5.000</td><td>47.7</td><td>7.500</td><td>58.1</td></tr><tr><td>0.200</td><td>21.0</td><td>0.800</td><td>22.9</td><td>1.800</td><td>29.2</td><td>3.000</td><td>37.3</td><td>5.500</td><td>50.0</td><td>8.000</td><td>59.9</td></tr><tr><td>0.300</td><td>24.5</td><td>1.000</td><td>22.0</td><td>2.000</td><td>30.7</td><td>3.500</td><td>40.1</td><td>6.000</td><td>52.1</td><td>8.500</td><td>61.7</td></tr><tr><td>0.400</td><td>24.9</td><td>1.200</td><td>24.0</td><td>2.200</td><td>32.1</td><td>4.000</td><td>42.8</td><td>6.500</td><td>54.2</td><td>9.000</td><td>63.4</td></tr><tr><td>0.500</td><td>24.8</td><td>1.400</td><td>25.9</td><td>2.400</td><td>33.5</td><td>4.500</td><td>45.3</td><td>7.000</td><td>56.2</td><td>9.500</td><td>65.1</td></tr></table>					Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	7.3	0.600	24.4	1.600	27.6	2.600	34.8	5.000	47.7	7.500	58.1	0.200	21.0	0.800	22.9	1.800	29.2	3.000	37.3	5.500	50.0	8.000	59.9	0.300	24.5	1.000	22.0	2.000	30.7	3.500	40.1	6.000	52.1	8.500	61.7	0.400	24.9	1.200	24.0	2.200	32.1	4.000	42.8	6.500	54.2	9.000	63.4	0.500	24.8	1.400	25.9	2.400	33.5	4.500	45.3	7.000	56.2	9.500	65.1
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)																																																																	
0.100	7.3	0.600	24.4	1.600	27.6	2.600	34.8	5.000	47.7	7.500	58.1																																																																	
0.200	21.0	0.800	22.9	1.800	29.2	3.000	37.3	5.500	50.0	8.000	59.9																																																																	
0.300	24.5	1.000	22.0	2.000	30.7	3.500	40.1	6.000	52.1	8.500	61.7																																																																	
0.400	24.9	1.200	24.0	2.200	32.1	4.000	42.8	6.500	54.2	9.000	63.4																																																																	
0.500	24.8	1.400	25.9	2.400	33.5	4.500	45.3	7.000	56.2	9.500	65.1																																																																	
<u>Hydro-Brake Optimum® Manhole: S00.7, DS/PN: S2.010, Volume (m³): 4.3</u>																																																																												
Unit Reference MD-SHE-0145-1000-1000-1000																																																																												
Design Head (m)		1.000	Diameter (mm)	145																																																																								
Design Flow (l/s)		10.0	Invert Level (m)	50.341																																																																								
Flush-Flo™		Calculated	Minimum Outlet Pipe Diameter (mm)	225																																																																								
Objective		Minimise upstream storage	Suggested Manhole Diameter (mm)	1200																																																																								
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Hydro-Brake Optimum® Manhole: S00.7, DS/PN: S2.010, Volume (m³): 4.3

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	10.0	Kick-Flo®	0.672	8.3
Flush-Flo™	0.304	9.9	Mean Flow over Head Range	-	8.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.2	0.600	9.1	1.600	12.4	2.600	15.7	5.000	21.4	7.500	26.0
0.200	9.6	0.800	9.0	1.800	13.2	3.000	16.8	5.500	22.4	8.000	26.9
0.300	9.9	1.000	10.0	2.000	13.8	3.500	18.1	6.000	23.4	8.500	27.7
0.400	9.8	1.200	10.9	2.200	14.5	4.000	19.3	6.500	24.3	9.000	28.4
0.500	9.6	1.400	11.7	2.400	15.1	4.500	20.4	7.000	25.2	9.500	29.2

Hydro-Brake Optimum® Manhole: S00.9, DS/PN: S2.013, Volume (m³): 6.7

Unit Reference	MD-SHE-0095-5000-1700-5000	Diameter (mm)	95
Design Head (m)	1.700	Invert Level (m)	49.686
Design Flow (l/s)	5.0	Minimum Outlet Pipe Diameter (mm)	150
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.700	5.0	Kick-Flo®	0.851	3.6
Flush-Flo™	0.417	4.5	Mean Flow over Head Range	-	4.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type

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Hydro-Brake Optimum® Manhole: S00.9, DS/PN: S2.013, Volume (m³): 6.7

of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	0.600	4.4	1.600	4.9	2.600	6.1	5.000	8.3	7.500	10.1
0.200	4.2	0.800	3.9	1.800	5.1	3.000	6.5	5.500	8.7	8.000	10.4
0.300	4.5	1.000	3.9	2.000	5.4	3.500	7.0	6.000	9.0	8.500	10.7
0.400	4.5	1.200	4.3	2.200	5.6	4.000	7.5	6.500	9.4	9.000	11.0
0.500	4.5	1.400	4.6	2.400	5.9	4.500	7.9	7.000	9.7	9.500	11.3

Hydro-Brake Optimum® Manhole: SCP.4, DS/PN: S3.004, Volume (m³): 2.7

Unit Reference MD-SHE-0074-3000-1600-3000	Diameter (mm)	74
Design Head (m)	1.600	Invert Level (m) 46.234
Design Flow (l/s)	3.0	Minimum Outlet Pipe Diameter (mm) 100
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm) 1200
Objective	Minimise upstream storage	

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.600	3.0	Kick-Flo®	0.661	2.0
Flush-Flo™	0.323	2.5	Mean Flow over Head Range	-	2.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	0.200	2.4	0.300	2.5	0.400	2.5	0.500	2.4	0.600	2.2



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Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.800	2.2	1.600	3.0	2.400	3.6	4.000	4.6	6.000	5.6	8.000	6.4
1.000	2.4	1.800	3.2	2.600	3.8	4.500	4.9	6.500	5.8	8.500	6.5
1.200	2.6	2.000	3.3	3.000	4.0	5.000	5.1	7.000	6.0	9.000	6.7
1.400	2.8	2.200	3.5	3.500	4.3	5.500	5.3	7.500	6.2	9.500	6.9

Unit Reference	MD-SHE-0105-5000-1000-5000	Diameter (mm)	105
Design Head (m)	1.000	Invert Level (m)	46.818
Design Flow (l/s)	5.0	Minimum Outlet Pipe Diameter (mm)	150
Flush-Flow™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.0	Kick-Flø®	0.636	4.0
Flush-Flø™	0.295	4.9	Mean Flow over Head Range	-	4.3

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	0.500	4.7	1.200	5.4	2.000	6.9	3.000	8.3	5.000	10.6
0.200	4.8	0.600	4.3	1.400	5.8	2.200	7.2	3.500	8.9	5.500	11.1
0.300	4.9	0.800	4.5	1.600	6.2	2.400	7.5	4.000	9.5	6.000	11.5
0.400	4.9	1.000	5.0	1.800	6.5	2.600	7.8	4.500	10.1	6.500	12.0

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Hydro-Brake Optimum® Manhole: SP.2a, DS/PN: S5.001, Volume (m³): 1.6

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
7.000	12.4	7.500	12.8	8.000	13.2	8.500	13.6	9.000	14.0	9.500	14.4

Hydro-Brake Optimum® Manhole: SP.4, DS/PN: S4.005, Volume (m³): 4.8

Unit Reference	MD-SHE-0087-5000-2500-5000	Diameter (mm)	87
Design Head (m)	2.500	Invert Level (m)	45.350
Design Flow (l/s)	5.0	Minimum Outlet Pipe Diameter (mm)	100
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.500	5.0	Kick-Flo®	0.777	2.9
Flush-Flo™	0.379	3.6	Mean Flow over Head Range	-	3.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.6	0.600	3.5	1.600	4.1	2.600	5.1	5.000	6.9	7.500	8.4
0.200	3.4	0.800	2.9	1.800	4.3	3.000	5.4	5.500	7.2	8.000	8.6
0.300	3.6	1.000	3.3	2.000	4.5	3.500	5.8	6.000	7.5	8.500	8.9
0.400	3.6	1.200	3.6	2.200	4.7	4.000	6.2	6.500	7.8	9.000	9.1
0.500	3.6	1.400	3.8	2.400	4.9	4.500	6.6	7.000	8.1	9.500	9.4

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Hydro-Brake Optimum® Manhole: SB7.4, DS/PN: S8.004, Volume (m³): 4.8

Unit Reference	MD-SHE-0075-3000-1500-3000	Diameter (mm)	75
Design Head (m)	1.500	Invert Level (m)	45.700
Design Flow (l/s)	3.0	Minimum Outlet Pipe Diameter (mm)	100
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	3.0	Kick-Flo®	0.671	2.1
Flush-Flo™	0.329	2.6	Mean Flow over Head Range	-	2.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.1	0.600	2.3	1.600	3.1	2.600	3.9	5.000	5.2	7.500	6.3
0.200	2.5	0.800	2.2	1.800	3.3	3.000	4.1	5.500	5.5	8.000	6.5
0.300	2.6	1.000	2.5	2.000	3.4	3.500	4.4	6.000	5.7	8.500	6.7
0.400	2.6	1.200	2.7	2.200	3.6	4.000	4.7	6.500	5.9	9.000	6.9
0.500	2.5	1.400	2.9	2.400	3.7	4.500	5.0	7.000	6.1	9.500	7.1

Hydro-Brake Optimum® Manhole: SCC.1, DS/PN: S10.001, Volume (m³): 2.2

Unit Reference	MD-SHE-0077-3000-1350-3000	Diameter (mm)	77
Design Head (m)	1.350	Invert Level (m)	45.500
Design Flow (l/s)	3.0	Minimum Outlet Pipe Diameter (mm)	100
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

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Hydro-Brake Optimum® Manhole: SCC.1, DS/PN: S10.001, Volume (m³): 2.2

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.350	3.0	Kick-Flo®	0.689	2.2
Flush-Flo™	0.338	2.7	Mean Flow over Head Range	-	2.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.2	0.600	2.5	1.600	3.2	2.600	4.1	5.000	5.5	7.500	6.7
0.200	2.6	0.800	2.4	1.800	3.4	3.000	4.3	5.500	5.8	8.000	6.9
0.300	2.7	1.000	2.6	2.000	3.6	3.500	4.7	6.000	6.0	8.500	7.1
0.400	2.7	1.200	2.8	2.200	3.8	4.000	5.0	6.500	6.2	9.000	7.3
0.500	2.7	1.400	3.0	2.400	3.9	4.500	5.2	7.000	6.5	9.500	7.5

Hydro-Brake Optimum® Manhole: SCC.12, DS/PN: S9.004, Volume (m³): 18.6

Unit Reference	MD-SHE-0109-8500-3000-8500	Diameter (mm)	109
Design Head (m)	3.000	Invert Level (m)	43.195
Design Flow (l/s)	8.5	Minimum Outlet Pipe Diameter (mm)	150
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	3.000	8.5	Kick-Flo®	0.972	5.0
Flush-Flo™	0.472	6.3	Mean Flow over Head Range	-	6.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type

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Hydro-Brake Optimum® Manhole: SCC.12, DS/PN: S9.004, Volume (m³): 18.6

of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	0.600	6.3	1.600	6.3	2.600	7.9	5.000	10.8	7.500	13.1
0.200	5.6	0.800	5.9	1.800	6.7	3.000	8.5	5.500	11.3	8.000	13.5
0.300	6.1	1.000	5.1	2.000	7.0	3.500	9.1	6.000	11.8	8.500	13.9
0.400	6.3	1.200	5.5	2.200	7.3	4.000	9.7	6.500	12.3	9.000	14.3
0.500	6.3	1.400	5.9	2.400	7.6	4.500	10.3	7.000	12.7	9.500	14.7

Hydro-Brake Optimum® Manhole: SB5 Tank, DS/PN: S11.001, Volume (m³): 5.5

Unit Reference	MD-SHE-0072-3000-1800-3000	Diameter (mm)	72
Design Head (m)	1.800	Invert Level (m)	49.520
Design Flow (l/s)	3.0	Minimum Outlet Pipe Diameter (mm)	100
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.800	3.0	Kick-Flo®	0.646	1.9
Flush-Flo™	0.319	2.3	Mean Flow over Head Range	-	2.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	0.200	2.2	0.300	2.3	0.400	2.3	0.500	2.2	0.600	2.0



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Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.800	2.1	1.600	2.8	2.400	3.4	4.000	4.3	6.000	5.3	8.000	6.0
1.000	2.3	1.800	3.0	2.600	3.6	4.500	4.6	6.500	5.5	8.500	6.2
1.200	2.5	2.000	3.1	3.000	3.8	5.000	4.8	7.000	5.6	9.000	6.4
1.400	2.7	2.200	3.3	3.500	4.1	5.500	5.0	7.500	5.8	9.500	6.5

Unit Reference	MD-SHE-0078-3000-1300-3000	Diameter (mm)	78
Design Head (m)	1.300	Invert Level (m)	48.083
Design Flow (l/s)	3.0	Minimum Outlet Pipe Diameter (mm)	100
Flush-Flow™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.300	3.0	Kick-Flø®	0.695	2.2
Flush-Flø™	0.341	2.8	Mean Flow over Head Range	-	2.5

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.2	0.500	2.7	1.200	2.9	2.000	3.7	3.000	4.4	5.000	5.6
0.200	2.7	0.600	2.6	1.400	3.1	2.200	3.8	3.500	4.7	5.500	5.9
0.300	2.8	0.800	2.4	1.600	3.3	2.400	4.0	4.000	5.0	6.000	6.1
0.400	2.8	1.000	2.7	1.800	3.5	2.600	4.1	4.500	5.3	6.500	6.3

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Hydro-Brake Optimum® Manhole: SB6 Tank, DS/PN: S13.001, Volume (m³): 4.9

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
7.000	6.6	7.500	6.8	8.000	7.0	8.500	7.2	9.000	7.4	9.500	7.6

Hydro-Brake Optimum® Manhole: SRoad Tank 1, DS/PN: S11.007, Volume (m³): 505.3

Unit Reference	MD-SHE-0126-9000-1850-9000	Diameter (mm)	126
Design Head (m)	1.850	Invert Level (m)	44.500
Design Flow (l/s)	9.0	Minimum Outlet Pipe Diameter (mm)	150
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1500
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.850	9.0	Kick-Flo®	1.122	7.1
Flush-Flo™	0.548	9.0	Mean Flow over Head Range	-	7.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.5	0.600	9.0	1.600	8.4	2.600	10.6	5.000	14.4	7.500	17.5
0.200	7.6	0.800	8.7	1.800	8.9	3.000	11.3	5.500	15.1	8.000	18.0
0.300	8.4	1.000	8.0	2.000	9.3	3.500	12.2	6.000	15.7	8.500	18.6
0.400	8.8	1.200	7.3	2.200	9.8	4.000	12.9	6.500	16.3	9.000	19.1
0.500	9.0	1.400	7.9	2.400	10.2	4.500	13.7	7.000	16.9	9.500	19.6

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Hydro-Brake Optimum® Manhole: S00.20, DS/PN: S15.001, Volume (m³): 1.7

Unit Reference	MD-SHE-0079-3000-1200-3000	Diameter (mm)	79
Design Head (m)	1.200	Invert Level (m)	41.150
Design Flow (l/s)	3.0	Minimum Outlet Pipe Diameter (mm)	100
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	3.0	Kick-Flo®	0.707	2.4
Flush-Flo™	0.348	2.9	Mean Flow over Head Range	-	2.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.3	0.600	2.7	1.600	3.4	2.600	4.3	5.000	5.8	7.500	7.0
0.200	2.8	0.800	2.5	1.800	3.6	3.000	4.6	5.500	6.1	8.000	7.3
0.300	2.9	1.000	2.8	2.000	3.8	3.500	4.9	6.000	6.3	8.500	7.5
0.400	2.9	1.200	3.0	2.200	4.0	4.000	5.2	6.500	6.6	9.000	7.7
0.500	2.8	1.400	3.2	2.400	4.1	4.500	5.5	7.000	6.8	9.500	7.9

Hydro-Brake Optimum® Manhole: SB2.2, DS/PN: S16.002, Volume (m³): 2.2

Unit Reference	MD-SHE-0074-3000-1600-3000	Diameter (mm)	74
Design Head (m)	1.600	Invert Level (m)	50.807
Design Flow (l/s)	3.0	Minimum Outlet Pipe Diameter (mm)	100
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

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Hydro-Brake Optimum® Manhole: SB2.2, DS/PN: S16.002, Volume (m³): 2.2

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.600	3.0	Kick-Flo®	0.661	2.0
Flush-Flo™	0.323	2.5	Mean Flow over Head Range	-	2.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	0.600	2.2	1.600	3.0	2.600	3.8	5.000	5.1	7.500	6.2
0.200	2.4	0.800	2.2	1.800	3.2	3.000	4.0	5.500	5.3	8.000	6.4
0.300	2.5	1.000	2.4	2.000	3.3	3.500	4.3	6.000	5.6	8.500	6.5
0.400	2.5	1.200	2.6	2.200	3.5	4.000	4.6	6.500	5.8	9.000	6.7
0.500	2.4	1.400	2.8	2.400	3.6	4.500	4.9	7.000	6.0	9.500	6.9

Hydro-Brake Optimum® Manhole: SB1.2, DS/PN: S18.002, Volume (m³): 2.7

Unit Reference	MD-SHE-0074-3000-1650-3000	Diameter (mm)	74
Design Head (m)	1.650	Invert Level (m)	48.817
Design Flow (l/s)	3.0	Minimum Outlet Pipe Diameter (mm)	100
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.650	3.0	Kick-Flo®	0.657	2.0
Flush-Flo™	0.322	2.4	Mean Flow over Head Range	-	2.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type

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Hydro-Brake Optimum® Manhole: SB1.2, DS/PN: S18.002, Volume (m³): 2.7

of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	0.600	2.2	1.600	3.0	2.600	3.7	5.000	5.0	7.500	6.1
0.200	2.3	0.800	2.2	1.800	3.1	3.000	4.0	5.500	5.2	8.000	6.3
0.300	2.4	1.000	2.4	2.000	3.3	3.500	4.2	6.000	5.5	8.500	6.4
0.400	2.4	1.200	2.6	2.200	3.4	4.000	4.5	6.500	5.7	9.000	6.6
0.500	2.3	1.400	2.8	2.400	3.6	4.500	4.8	7.000	5.9	9.500	6.8

Hydro-Brake Optimum® Manhole: SH.3Storage 2, DS/PN: S20.002, Volume (m³): 3.5

Unit Reference MD-SHE-0072-3000-1800-3000	Diameter (mm)	72
Design Head (m)	1.800	Invert Level (m) 45.500
Design Flow (l/s)	3.0	Minimum Outlet Pipe Diameter (mm) 100
Flush-Flo™	Calculated	Suggested Manhole Diameter (mm) 1200
Objective	Minimise upstream storage	

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.800	3.0	Kick-Flo®	0.646	1.9
Flush-Flo™	0.319	2.3	Mean Flow over Head Range	-	2.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	0.200	2.2	0.300	2.3	0.400	2.3	0.500	2.2	0.600	2.0



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Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.800	2.1	1.600	2.8	2.400	3.4	4.000	4.3	6.000	5.3	8.000	6.0
1.000	2.3	1.800	3.0	2.600	3.6	4.500	4.6	6.500	5.5	8.500	6.2
1.200	2.5	2.000	3.1	3.000	3.8	5.000	4.8	7.000	5.6	9.000	6.4
1.400	2.7	2.200	3.3	3.500	4.1	5.500	5.0	7.500	5.8	9.500	6.5

Unit Reference	MD-SHE-0079-3000-1200-3000	Diameter (mm)	79
Design Head (m)	1.200	Invert Level (m)	45.997
Design Flow (l/s)	3.0	Minimum Outlet Pipe Diameter (mm)	100
Flush-Flow™	Calculated	Suggested Manhole Diameter (mm)	1200
Objective	Minimise upstream storage		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	3.0	Kick-Flo®	0.707	2.4
Flush-Flo™	0.348	2.9	Mean Flow over Head Range	-	2.6

Depth (m)		Flow (l/s)		Depth (m)		Flow (l/s)		Depth (m)		Flow (l/s)		Depth (m)		Flow (l/s)		Depth (m)		Flow (l/s)					
0.100	2.3	0.500	2.8	1.200	3.0	2.000	3.8	3.000	4.6	5.000	5.8	0.200	2.8	0.600	2.7	1.400	3.2	2.200	4.0	3.500	4.9	5.500	6.1
0.300	2.9	0.800	2.5	1.600	3.4	2.400	4.1	4.000	5.2	6.000	6.3	0.400	2.9	1.000	2.8	1.800	3.6	2.600	4.3	4.500	5.5	6.500	6.6



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Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
7.000	6.8	7.500	7.0	8.000	7.3	8.500	7.5	9.000	7.7	9.500	7.9

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Invert Level (m) 50.500

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	700.0	0.400	700.0	0.401	10.0	0.499	10.0	0.500	537.0	1.000	770.0

Invert Level (m) 50.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	570.0	0.300	570.0	0.401	10.0	0.500	391.0
0.100	570.0	0.400	570.0	0.499	10.0	1.000	595.0

Invert Level (m) 46.400 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95

Infiltration Coefficient Base (m/hr) 0.00000

Safety Factor	2.0
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Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	400.0	0.0	0.450	400.0	0.0	0.750	400.0	0.0	1.250	400.0	0.0
0.300	400.0	0.0	0.600	400.0	0.0	1.000	400.0	0.0	1.251	0.0	0.0

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Cellular Storage Manhole: SStadSqStorage 1, DS/PN: S4.000

Invert Level (m) 47.300 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.30
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	250.0	0.0	0.300	250.0	0.0	0.600	250.0	0.0	0.601	0.0	0.0

Cellular Storage Manhole: SCCStorage2, DS/PN: S5.000

Invert Level (m) 47.000 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	250.0	0.0	0.400	250.0	0.0	0.801	0.0	0.0
0.300	250.0	0.0	0.800	250.0	0.0			

Cellular Storage Manhole: SStadSqStorage 2, DS/PN: S6.000

Invert Level (m) 47.300 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.30
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	1400.0	0.0	0.301	1400.0	0.0	0.601	0.0	0.0
0.300	1400.0	0.0	0.600	1400.0	0.0			

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Cellular Storage Manhole: SCCStorage1, DS/PN: S7.000

Invert Level (m) 47.000 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	400.0	0.0	0.400	400.0	0.0	0.800	400.0	0.0
0.300	400.0	0.0	0.600	400.0	0.0	0.801	0.0	0.0

Cellular Storage Manhole: SB7 Tank, DS/PN: S8.003

Invert Level (m) 46.000 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	470.0	0.0	0.500	470.0	0.0	1.000	470.0	0.0	1.001	0.0	0.0

Cellular Storage Manhole: SCCStorage4, DS/PN: S9.003

Invert Level (m) 43.575 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	366.0	0.0	1.000	366.0	0.0	1.501	0.0	0.0
0.500	366.0	0.0	1.500	366.0	0.0			

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<u>Cellular Storage Manhole: SCCStorage3, DS/PN: S10.000</u> Invert Level (m) 46.300 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95 Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr><tr><td>0.000</td><td>1160.0</td><td>0.0</td><td>0.451</td><td>366.0</td><td>0.0</td><td>0.651</td><td>0.0</td><td>0.0</td></tr><tr><td>0.450</td><td>1160.0</td><td>0.0</td><td>0.650</td><td>366.0</td><td>0.0</td><td></td><td></td><td></td></tr></table> <u>Cellular Storage Manhole: SB5 PP, DS/PN: S12.000</u> Invert Level (m) 50.800 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.30 Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr><tr><td>0.000</td><td>260.0</td><td>443.6</td><td>0.301</td><td>260.0</td><td>468.9</td><td>0.601</td><td>0.0</td><td>468.9</td></tr><tr><td>0.300</td><td>260.0</td><td>468.9</td><td>0.600</td><td>260.0</td><td>468.9</td><td></td><td></td><td></td></tr></table> <u>Cellular Storage Manhole: SB5 Tank, DS/PN: S11.001</u> Invert Level (m) 49.520 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95 Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr><tr><td>0.000</td><td>180.0</td><td>0.0</td><td>0.500</td><td>180.0</td><td>0.0</td><td>1.000</td><td>180.0</td><td>0.0</td><td>1.001</td><td>0.0</td><td>0.0</td></tr></table>			Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	0.000	1160.0	0.0	0.451	366.0	0.0	0.651	0.0	0.0	0.450	1160.0	0.0	0.650	366.0	0.0				Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	0.000	260.0	443.6	0.301	260.0	468.9	0.601	0.0	468.9	0.300	260.0	468.9	0.600	260.0	468.9				Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	0.000	180.0	0.0	0.500	180.0	0.0	1.000	180.0	0.0	1.001	0.0	0.0
Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)																																																																								
0.000	1160.0	0.0	0.451	366.0	0.0	0.651	0.0	0.0																																																																								
0.450	1160.0	0.0	0.650	366.0	0.0																																																																											
Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)																																																																								
0.000	260.0	443.6	0.301	260.0	468.9	0.601	0.0	468.9																																																																								
0.300	260.0	468.9	0.600	260.0	468.9																																																																											
Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)																																																																					
0.000	180.0	0.0	0.500	180.0	0.0	1.000	180.0	0.0	1.001	0.0	0.0																																																																					
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The Arup Campus Blyth Gate Solihull B90 8AE																																																																																											
Date 11/01/2016 09:52 File 240524-ARP-Drainage Model-P1.10.mdx		Designed by james.walley Checked by trevor.mino																																																																																									
XP Solutions		Network 2015.1																																																																																									
<u>Cellular Storage Manhole: SB6 PP, DS/PN: S14.000</u> Invert Level (m) 48.500 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.30 Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr><tr><td>0.000</td><td>282.0</td><td>0.0</td><td>0.300</td><td>282.0</td><td>0.0</td><td>0.500</td><td>282.0</td><td>0.0</td></tr><tr><td>0.100</td><td>282.0</td><td>0.0</td><td>0.301</td><td>282.0</td><td>0.0</td><td>0.600</td><td>282.0</td><td>0.0</td></tr><tr><td>0.200</td><td>282.0</td><td>0.0</td><td>0.400</td><td>282.0</td><td>0.0</td><td>0.601</td><td>0.0</td><td>0.0</td></tr></table> <u>Cellular Storage Manhole: SB6 Tank, DS/PN: S13.001</u> Invert Level (m) 48.000 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95 Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr><tr><td>0.000</td><td>180.0</td><td>0.0</td><td>0.500</td><td>180.0</td><td>0.0</td><td>1.000</td><td>180.0</td><td>0.0</td><td>1.001</td><td>0.0</td><td>0.0</td></tr></table> <u>Cellular Storage Manhole: SRoad Tank 2, DS/PN: S15.000</u> Invert Level (m) 41.386 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95 Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr><tr><td>0.000</td><td>120.0</td><td>0.0</td><td>0.400</td><td>120.0</td><td>0.0</td><td>0.800</td><td>120.0</td><td>0.0</td><td>0.801</td><td>0.0</td><td>0.0</td></tr></table>								Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	0.000	282.0	0.0	0.300	282.0	0.0	0.500	282.0	0.0	0.100	282.0	0.0	0.301	282.0	0.0	0.600	282.0	0.0	0.200	282.0	0.0	0.400	282.0	0.0	0.601	0.0	0.0	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	0.000	180.0	0.0	0.500	180.0	0.0	1.000	180.0	0.0	1.001	0.0	0.0	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	0.000	120.0	0.0	0.400	120.0	0.0	0.800	120.0	0.0	0.801	0.0	0.0
Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)																																																																																			
0.000	282.0	0.0	0.300	282.0	0.0	0.500	282.0	0.0																																																																																			
0.100	282.0	0.0	0.301	282.0	0.0	0.600	282.0	0.0																																																																																			
0.200	282.0	0.0	0.400	282.0	0.0	0.601	0.0	0.0																																																																																			
Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)																																																																																
0.000	180.0	0.0	0.500	180.0	0.0	1.000	180.0	0.0	1.001	0.0	0.0																																																																																
Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)																																																																																
0.000	120.0	0.0	0.400	120.0	0.0	0.800	120.0	0.0	0.801	0.0	0.0																																																																																
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Cellular Storage Manhole: SB2 PP, DS/PN: S17.000

Invert Level (m) 51.500 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.30
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	250.0	0.0	0.300	250.0	0.0	0.500	250.0	0.0
0.100	250.0	0.0	0.301	250.0	0.0	0.600	250.0	0.0
0.200	250.0	0.0	0.400	250.0	0.0	0.601	0.0	0.0

Cellular Storage Manhole: SB2 Tank, DS/PN: S16.001

Invert Level (m) 51.000 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	100.0	0.0	0.500	100.0	0.0	1.000	100.0	0.0	1.001	0.0	0.0

Cellular Storage Manhole: SB1 PP, DS/PN: S19.000

Invert Level (m) 50.000 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.30
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	180.0	0.0	0.301	180.0	0.0	0.601	0.0	0.0
0.300	180.0	0.0	0.600	180.0	0.0			

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			Invert Level (m)			49.000	Infiltration Coefficient Side (m/hr)			0.00000	Porosity			0.95
			Infiltration Coefficient Base (m/hr)			0.00000	Safety Factor			2.0				
Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	100.0	0.0	0.500	100.0	0.0	1.000	100.0	0.0	1.001	0.0	0.0			

Invert Level (m)	45.500	Infiltration Coefficient Side (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Base (m/hr)	0.00000	Safety Factor	2.0		

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	120.0	0.0	0.500	120.0	0.0	1.000	120.0	0.0	1.001	0.0	0.0

Invert Level (m)	46.600	Infiltration Coefficient Side (m/hr)	0.00000	Porosity	0.30
Infiltration Coefficient Base (m/hr)	0.00000	Safety Factor	2.0		

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	800.0	0.0	0.300	800.0	0.0	0.600	800.0	0.0	0.601	0.0	0.0



Micro
Drainage

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Checked by trevor.mino

Network 2015.1

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Manhole Headloss Coeff (Global)	0.500	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Foul Sewage per hectare (l/s)	0.000	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Additional Flow - % of Total Flow	0.000	Flow per Person per Day (l/per/day)	0.000

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	18	Number of Storage Structures	24	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model				FEH D2 (1km)	0.292	Cv (Summer)	0.750
Site Location	GB 471200	169400	SU 71200	69400 D3 (1km)	0.308	Cv (Winter)	0.840
C (1km)				-0.030 E (1km)	0.308		
D1 (1km)				0.288 F (1km)	2.584		

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	2.5 Second Increment (Extended)	Inertia Status	ON
DTS Status	OFF		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 100
Climate Change (%)	0, 30

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S2.000	SBasin 1	30 minute 1 year Winter I+0%	54.500	54.054	-0.246	0.000	0.07		5.3	OK

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<u>1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm</u>													
PN	US/MH Name	Event				US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S2.001	S00.1	30 minute	1 year	Winter	I+0%	54.500	52.447	-0.267	0.000	0.03		5.3	OK
S2.002	S00.2	30 minute	1 year	Winter	I+0%	53.500	51.886	-0.409	0.000	0.02		5.3	OK
S2.003	SBasin 2	30 minute	1 year	Winter	I+0%	53.000	51.716	-0.339	0.000	0.13		42.9	OK
S2.004	S00.3	30 minute	1 year	Winter	I+0%	53.000	51.691	0.165	0.000	0.29		34.8	SURCHARGED
S2.005	S00.4	30 minute	1 year	Summer	I+0%	52.000	51.019	-0.262	0.000	0.37		34.8	OK
S2.006	SBasin 3	120 minute	1 year	Winter	I+0%	52.000	50.931	-0.319	0.000	0.12		21.2	OK
S2.007	S00.5	120 minute	1 year	Winter	I+0%	52.000	50.917	-0.063	0.000	0.35		21.2	OK
S2.008	S00.6	120 minute	1 year	Winter	I+0%	51.500	50.710	-0.341	0.000	0.13		21.2	OK
S2.009	SBasin 4	240 minute	1 year	Winter	I+0%	51.500	50.627	-0.323	0.000	0.04		10.1	OK
S2.010	S00.7	240 minute	1 year	Winter	I+0%	51.500	50.623	0.132	0.000	0.43		9.9	SURCHARGED
S2.011	S00.8	720 minute	1 year	Winter	I+0%	51.000	50.232	-0.323	0.000	0.05		9.9	OK
S2.012	SBasin 5	720 minute	1 year	Winter	I+0%	51.000	50.230	-0.220	0.000	0.02		5.5	OK
S2.013	S00.9	720 minute	1 year	Winter	I+0%	51.500	50.229	0.393	0.000	0.12		4.5	SURCHARGED
S2.014	S00.10	960 minute	1 year	Summer	I+0%	50.000	48.323	-0.120	0.000	0.09		4.5	OK
S2.015	S00.11	960 minute	1 year	Winter	I+0%	48.000	46.535	-0.103	0.000	0.21		4.5	OK
S3.000	SCP.1	15 minute	1 year	Winter	I+0%	51.500	50.268	-0.246	0.000	0.07		14.6	OK
S3.001	SCP.2	15 minute	1 year	Winter	I+0%	49.700	48.430	-0.370	0.000	0.07		46.8	OK
S3.002	SCP.3	15 minute	1 year	Winter	I+0%	48.000	46.830	-0.307	0.000	0.22		67.7	OK
S3.003	SCP Tank	360 minute	1 year	Winter	I+0%	48.000	46.568	-0.150	0.000	0.02		2.4	OK
S3.004	SCP.4	360 minute	1 year	Winter	I+0%	48.000	46.566	0.182	0.000	0.09		2.4	SURCHARGED
S2.016	S00.12	360 minute	1 year	Summer	I+0%	48.000	45.869	-0.176	0.000	0.11		6.9	OK
S2.017	S00.13	360 minute	1 year	Summer	I+0%	47.500	45.367	-0.182	0.000	0.08		6.9	OK
S4.000	SStadSqStorage 1	30 minute	1 year	Winter	I+0%	48.000	47.353	-0.110	0.000	0.16		4.2	OK
S4.001	SP.1	30 minute	1 year	Winter	I+0%	48.000	47.343	0.369	0.000	0.13		3.3	SURCHARGED
S5.000	SCCStorage2	360 minute	1 year	Winter	I+0%	48.000	47.208	-0.038	0.000	0.04		2.2	OK
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XP Solutions						Network 2015.1							
<u>1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm</u>													
PN	US/MH Name	Event				US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S5.001	SP.2a	360 minute	1 year	Winter	I+0%	48.000	47.207	0.257	0.000	0.08		1.9	SURCHARGED
S4.002	SP.2	30 minute	1 year	Winter	I+0%	48.000	47.321	1.046	0.000	0.05		2.1	SURCHARGED
S6.000	SStadSqStorage 2	30 minute	1 year	Winter	I+0%	48.000	47.353	-0.164	0.000	0.16		23.8	OK
S4.003	SPP 2 Junction	120 minute	1 year	Winter	I+0%	48.000	46.111	0.000	0.000	0.31		15.1	SURCHARGED*
S4.004	SP.3	30 minute	1 year	Winter	I+0%	48.000	47.290	1.365	0.000	0.34		17.4	SURCHARGED
S7.000	SCCStorage1	360 minute	1 year	Winter	I+0%	48.000	47.179	-0.046	0.000	0.03		4.2	OK
S4.005	SP.4	30 minute	1 year	Winter	I+0%	48.000	47.245	1.745	0.000	0.18		4.4	SURCHARGED
S8.000	SB7.1	15 minute	1 year	Winter	I+0%	49.500	48.115	-0.245	0.000	0.08		12.9	OK
S8.001	SB7.2	15 minute	1 year	Winter	I+0%	48.270	47.095	-0.368	0.000	0.08		34.1	OK
S8.002	SB7.3	15 minute	1 year	Winter	I+0%	47.500	46.393	-0.318	0.000	0.19		53.5	OK
S8.003	SB7 Tank	240 minute	1 year	Winter	I+0%	47.500	46.162	-0.288	0.000	0.01		3.8	OK
S8.004	SB7.4	240 minute	1 year	Winter	I+0%	47.500	46.161	0.311	0.000	0.11		2.6	SURCHARGED
S2.018	S00.14	1440 minute	1 year	Summer	I+0%	47.500	44.803	-0.152	0.000	0.23		13.6	OK
S2.019	S00.15	1440 minute	1 year	Summer	I+0%	47.000	44.057	-0.148	0.000	0.26		13.6	OK
S2.020	S00.16	1440 minute	1 year	Summer	I+0%	46.500	43.882	-0.153	0.000	0.23		13.6	OK
S2.021	S00.17	1440 minute	1 year	Summer	I+0%	46.500	42.882	-0.153	0.000	0.23		13.6	OK
S9.000	SCC.9	120 minute	1 year	Winter	I+0%	47.500	45.618	-0.225	0.000	0.00		0.0	OK
S9.001	SCC.10	15 minute	1 year	Winter	I+0%	47.000	44.834	-0.127	0.000	0.38		17.4	OK
S9.002	SCC.11	15 minute	1 year	Winter	I+0%	47.000	43.935	-0.215	0.000	0.17		17.5	OK
S9.003	SCCStorage4	240 minute	1 year	Winter	I+0%	47.000	43.840	-0.035	0.000	0.05		5.3	OK
S10.000	SCCStorage3	360 minute	1 year	Winter	I+0%	47.000	46.381	-0.219	0.000	0.02		4.0	OK
S10.001	SCC.1	360 minute	1 year	Winter	I+0%	47.000	46.384	0.584	0.000	0.02		2.7	SURCHARGED
S10.002	Signore me 1	15 minute	1 year	Winter	I+0%	47.000	44.947	-0.241	0.000	0.08		11.6	OK*
S10.003	SCC.2	15 minute	1 year	Winter	I+0%	47.000	44.195	-0.380	0.000	0.06		20.4	OK
S9.004	SCC.12	15 minute	1 year	Winter	I+0%	47.000	43.838	0.493	0.000	0.30		6.3	SURCHARGED
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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S11.000	SB5.1	15 minute 1 year Winter I+0%	52.500	50.826	-0.221	0.000	0.16		27.1	OK
S12.000	SB5 PP	15 minute 1 year Winter I+0%	51.500	50.849	-0.054	0.000	0.44		6.3	OK
S11.001	SB5 Tank	240 minute 1 year Winter I+0%	51.500	49.727	-0.018	0.000	0.05		2.2	OK
S11.002	SB5.2	240 minute 1 year Winter I+0%	51.500	49.426	-0.199	0.000	0.03		2.2	OK
S13.000	SB6.1	15 minute 1 year Winter I+0%	51.500	49.702	-0.225	0.000	0.14		27.6	OK
S14.000	SB6 PP	30 minute 1 year Winter I+0%	49.500	48.552	-0.048	0.000	0.52		4.9	OK
S13.001	SB6 Tank	360 minute 1 year Winter I+0%	49.500	48.239	-0.069	0.000	0.08		2.4	OK
S13.002	SB6.2	360 minute 1 year Winter I+0%	49.500	48.080	-0.186	0.000	0.07		2.4	OK
S11.003	SB6.3	15 minute 1 year Winter I+0%	49.500	48.065	-0.223	0.000	0.15		17.3	OK
S11.004	SB6.4	15 minute 1 year Winter I+0%	49.250	47.628	-0.243	0.000	0.08		17.4	OK
S11.005	SB6.5	15 minute 1 year Winter I+0%	47.500	45.883	-0.207	0.000	0.21		34.5	OK
S11.006	SB6.6	15 minute 1 year Winter I+0%	47.000	45.055	-1.745	0.000	0.01		32.0	OK
S11.007	SRoad Tank 1	120 minute 1 year Winter I+0%	46.500	45.034	0.384	0.000	0.43		9.0	SURCHARGED
S2.022	S00.18	60 minute 1 year Winter I+0%	46.500	41.834	-0.201	0.000	0.24		28.5	OK
S2.023	S00.19	60 minute 1 year Winter I+0%	43.970	40.921	-0.199	0.000	0.25		28.5	OK
S15.000	SRoad Tank 2	60 minute 1 year Winter I+0%	42.500	41.474	-0.137	0.000	0.07		4.6	OK
S15.001	S00.20	60 minute 1 year Winter I+0%	42.500	41.471	0.171	0.000	0.12		2.9	SURCHARGED
S2.024	S00.21	480 minute 1 year Summer I+0%	42.500	40.476	-0.194	0.000	0.27		31.3	OK
S2.025	SRebuilt exMH90	480 minute 1 year Summer I+0%	42.613	40.019	-0.231	0.000	0.12		31.3	OK
S2.026	SexMH18	480 minute 1 year Summer I+0%	40.000	38.900	-0.475	0.000	0.10		31.3	OK
S16.000	SB2.1	15 minute 1 year Winter I+0%	53.000	51.620	-0.222	0.000	0.15		20.2	OK
S17.000	SB2 PP	30 minute 1 year Winter I+0%	52.500	51.538	-0.062	0.000	0.31		3.4	OK
S16.001	SB2 Tank	60 minute 1 year Winter I+0%	52.500	51.177	-0.114	0.000	0.03		4.1	OK
S16.002	SB2.2	60 minute 1 year Winter I+0%	52.500	51.185	0.228	0.000	0.04		2.5	SURCHARGED
S18.000	SB1.1	120 minute 1 year Winter I+0%	51.500	49.925	-0.300	0.000	0.00		0.0	OK

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S19.000	SB1 PP	15 minute 1 year Winter I+0%	51.000	50.036	-0.064	0.000	0.28		4.1	OK
S18.001	SB1 Tank	60 minute 1 year Winter I+0%	51.000	49.170	-0.130	0.000	0.04		3.8	OK
S18.002	SB1.2	60 minute 1 year Winter I+0%	51.000	49.175	0.208	0.000	0.09		2.4	SURCHARGED
S18.003	SB1.3	30 minute 1 year Summer I+0%	50.500	48.744	-0.134	0.000	0.02		2.4	OK
S16.003	SB1.4	15 minute 1 year Winter I+0%	45.000	43.427	-0.125	0.000	0.07		4.9	OK
S20.000	SH.1	15 minute 1 year Winter I+0%	50.500	49.336	-0.114	0.000	0.13		4.1	OK
S20.001	SH.2	15 minute 1 year Winter I+0%	48.900	47.567	-0.179	0.000	0.09		10.3	OK
S20.002	SH.3Storage 2	120 minute 1 year Winter I+0%	47.500	45.643	-0.007	0.000	0.11		2.1	OK
S21.000	SDUMMY	120 minute 1 year Winter I+0%	47.500	46.843	-0.100	0.000	0.00		0.0	OK
S21.001	SH.4Storage 1	30 minute 1 year Winter I+0%	47.400	46.625	0.478	0.000	0.10		2.9	SURCHARGED
S20.003	SH.5	240 minute 1 year Winter I+0%	47.500	45.137	-0.182	0.000	0.08		5.0	OK



Micro
Drainage

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Network 2015.1

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Areal Reduction Factor	1.000	Manhole Headloss Coeff (Global)	0.500	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Foul Sewage per hectare (l/s)	0.000	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Additional Flow - % of Total Flow	0.000	Flow per Person per Day (l/per/day)	0.000

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	18	Number of Storage Structures	24	Number of Real Time Controls	0

Rainfall Model										
Site Location	GB	471200	169400	SU	71200	69400	D3 (1km)	0.292	Cv (Summer)	0.750
							D3 (1km)	0.308	Cv (Winter)	0.840
							C (1km)	-0.030	E (1km)	0.308
							D1 (1km)	0.288	F (1km)	2.584

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	2.5 Second Increment (Extended)	Inertia Status	ON
DTS Status	OFF		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 100
Climate Change (%)	0, 30

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S2.000	SBasin 1	15 minute 100 year Winter I+30%	54.500	54.224	-0.076	0.000	0.90		64.4	FLOOD RISK

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm													
PN	US/MH Name	Event				US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S2.001	S00.1	15 minute	100 year	Winter	I+30%	54.500	52.968	0.254	0.000	0.33		62.9	SURCHARGED
S2.002	S00.2	30 minute	100 year	Winter	I+30%	53.500	52.871	0.576	0.000	0.19		51.6	SURCHARGED
S2.003	SBasin 2	60 minute	100 year	Winter	I+30%	53.000	52.834	0.780	0.000	0.14		46.2	FLOOD RISK
S2.004	S00.3	30 minute	100 year	Winter	I+30%	53.000	52.864	1.338	0.000	0.29		34.5	FLOOD RISK
S2.005	S00.4	360 minute	100 year	Winter	I+30%	52.000	51.884	0.604	0.000	0.37		34.8	FLOOD RISK
S2.006	SBasin 3	360 minute	100 year	Winter	I+30%	52.000	51.877	0.627	0.000	0.15		27.0	FLOOD RISK
S2.007	S00.5	360 minute	100 year	Winter	I+30%	52.000	51.875	0.895	0.000	0.41		24.9	FLOOD RISK
S2.008	S00.6	600 minute	100 year	Winter	I+30%	51.500	51.410	0.359	0.000	0.16		24.9	FLOOD RISK
S2.009	SBasin 4	600 minute	100 year	Winter	I+30%	51.500	51.406	0.456	0.000	0.05		10.8	FLOOD RISK
S2.010	S00.7	600 minute	100 year	Winter	I+30%	51.500	51.421	0.930	0.000	0.43		9.9	FLOOD RISK
S2.011	S00.8	1440 minute	100 year	Winter	I+30%	51.000	50.992	0.437	0.000	0.05		9.9	FLOOD RISK
S2.012	SBasin 5	1440 minute	100 year	Winter	I+30%	51.000	50.991	0.541	0.000	0.02		5.1	FLOOD RISK
S2.013	S00.9	1440 minute	100 year	Winter	I+30%	51.500	51.001	1.165	0.000	0.12		4.5	SURCHARGED
S2.014	S00.10	960 minute	100 year	Summer	I+30%	50.000	48.323	-0.120	0.000	0.09		4.5	OK
S2.015	S00.11	960 minute	100 year	Winter	I+30%	48.000	46.535	-0.103	0.000	0.21		4.5	OK
S3.000	SCP.1	15 minute	100 year	Winter	I+30%	51.500	50.363	-0.151	0.000	0.48		95.2	OK
S3.001	SCP.2	15 minute	100 year	Winter	I+30%	49.700	48.591	-0.209	0.000	0.56		359.8	OK
S3.002	SCP.3	15 minute	100 year	Winter	I+30%	48.000	47.708	0.571	0.000	1.70		527.2	FLOOD RISK
S3.003	SCP Tank	480 minute	100 year	Winter	I+30%	48.000	47.339	0.622	0.000	0.03		2.7	SURCHARGED
S3.004	SCP.4	480 minute	100 year	Winter	I+30%	48.000	47.340	0.956	0.000	0.10		2.5	SURCHARGED
S2.016	S00.12	180 minute	100 year	Winter	I+30%	48.000	45.870	-0.175	0.000	0.11		7.0	OK
S2.017	S00.13	180 minute	100 year	Winter	I+30%	47.500	45.367	-0.182	0.000	0.08		7.0	OK
S4.000	SStadSqStorage 1	600 minute	100 year	Winter	I+30%	48.000	47.834	0.371	0.000	0.08		2.3	FLOOD RISK
S4.001	SP.1	600 minute	100 year	Winter	I+30%	48.000	47.833	0.859	0.000	0.08		2.2	FLOOD RISK
S5.000	SCCStorage2	360 minute	100 year	Winter	I+30%	48.000	47.949	0.703	0.000	0.06		3.8	FLOOD RISK
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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S5.001	SP.2a	360 minute 100 year Winter I+30%	48.000	47.945	0.995	0.000	0.15		3.7	FLOOD RISK
S4.002	SP.2	600 minute 100 year Winter I+30%	48.000	47.832	1.557	0.000	0.07		2.8	FLOOD RISK
S6.000	SStadSqStorage 2	600 minute 100 year Winter I+30%	48.000	47.830	0.313	0.000	0.09		12.9	FLOOD RISK
S4.003	SPP 2 Junction	120 minute 100 year Winter I+30%	48.000	46.111	0.000	0.000	0.44		21.1	SURCHARGED*
S4.004	SP.3	600 minute 100 year Winter I+30%	48.000	47.823	1.898	0.000	0.25		12.9	FLOOD RISK
S7.000	SCCStorage1	480 minute 100 year Winter I+30%	48.000	47.825	0.600	0.000	0.03		3.8	FLOOD RISK
S4.005	SP.4	480 minute 100 year Winter I+30%	48.000	47.819	2.319	0.000	0.21		5.0	FLOOD RISK
S8.000	SB7.1	15 minute 100 year Winter I+30%	49.500	48.211	-0.149	0.000	0.50		84.0	OK
S8.001	SB7.2	15 minute 100 year Winter I+30%	48.270	47.258	-0.205	0.000	0.57		254.2	OK
S8.002	SB7.3	15 minute 100 year Winter I+30%	47.500	46.983	0.272	0.000	1.43		411.3	SURCHARGED
S8.003	SB7 Tank	600 minute 100 year Winter I+30%	47.500	46.960	0.510	0.000	0.01		3.6	SURCHARGED
S8.004	SB7.4	600 minute 100 year Winter I+30%	47.500	46.980	1.130	0.000	0.11		2.8	SURCHARGED
S2.018	S00.14	360 minute 100 year Winter I+30%	47.500	44.806	-0.149	0.000	0.25		14.6	OK
S2.019	S00.15	360 minute 100 year Winter I+30%	47.000	44.060	-0.145	0.000	0.28		14.6	OK
S2.020	S00.16	360 minute 100 year Winter I+30%	46.500	43.885	-0.150	0.000	0.24		14.6	OK
S2.021	S00.17	360 minute 100 year Winter I+30%	46.500	42.885	-0.150	0.000	0.24		14.6	OK
S9.000	SCC.9	360 minute 100 year Winter I+30%	47.500	46.994	1.151	0.000	0.01		0.5	SURCHARGED
S9.001	SCC.10	360 minute 100 year Winter I+30%	47.000	46.995	2.034	0.000	0.26		11.8	FLOOD RISK
S9.002	SCC.11	360 minute 100 year Winter I+30%	47.000	46.993	2.843	0.000	0.12		11.5	FLOOD RISK
S9.003	SCCStorage4	360 minute 100 year Winter I+30%	47.000	46.991	3.116	0.000	0.09		9.3	FLOOD RISK
S10.000	SCCStorage3	480 minute 100 year Winter I+30%	47.000	46.801	0.201	0.000	0.02		3.8	FLOOD RISK
S10.001	SCC.1	600 minute 100 year Winter I+30%	47.000	46.821	1.021	0.000	0.02		2.9	FLOOD RISK
S10.002	Signore me 1	180 minute 100 year Winter I+30%	47.000	45.188	0.000	0.000	0.10		14.0	SURCHARGED*
S10.003	SCC.2	360 minute 100 year Winter I+30%	47.000	46.978	2.403	0.000	0.04		14.4	FLOOD RISK
S9.004	SCC.12	360 minute 100 year Winter I+30%	47.000	46.978	3.633	0.000	0.45		9.5	FLOOD RISK

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Event				US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S11.000	SB5.1	240 minute	100 year	Winter	I+30%	52.500	51.409	0.362	0.000	0.19		31.7	SURCHARGED
S12.000	SB5 PP	360 minute	100 year	Winter	I+30%	51.500	51.230	0.327	0.000	0.53		7.5	FLOOD RISK
S11.001	SB5 Tank	240 minute	100 year	Winter	I+30%	51.500	51.396	1.651	0.000	0.07		3.0	FLOOD RISK
S11.002	SB5.2	240 minute	100 year	Winter	I+30%	51.500	49.430	-0.195	0.000	0.04		3.0	OK
S13.000	SB6.1	15 minute	100 year	Winter	I+30%	51.500	49.856	-0.071	0.000	0.94		179.4	OK
S14.000	SB6 PP	360 minute	100 year	Winter	I+30%	49.500	49.054	0.454	0.000	0.59		5.4	SURCHARGED
S13.001	SB6 Tank	240 minute	100 year	Winter	I+30%	49.500	49.079	0.771	0.000	0.09		2.8	SURCHARGED
S13.002	SB6.2	15 minute	100 year	Winter	I+30%	49.500	48.432	0.166	0.000	0.11		3.7	SURCHARGED
S11.003	SB6.3	15 minute	100 year	Winter	I+30%	49.500	48.439	0.151	0.000	1.14		133.5	SURCHARGED
S11.004	SB6.4	15 minute	100 year	Winter	I+30%	49.250	47.911	0.040	0.000	0.62		132.0	SURCHARGED
S11.005	SB6.5	15 minute	100 year	Winter	I+30%	47.500	47.304	1.214	0.000	1.51		249.5	FLOOD RISK
S11.006	SB6.6	360 minute	100 year	Winter	I+30%	47.000	46.255	-0.545	0.000	0.00		26.7	OK
S11.007	SRoad Tank 1	360 minute	100 year	Winter	I+30%	46.500	46.254	1.604	0.000	0.43		9.0	FLOOD RISK
S2.022	S00.18	360 minute	100 year	Winter	I+30%	46.500	41.842	-0.193	0.000	0.28		32.8	OK
S2.023	S00.19	360 minute	100 year	Winter	I+30%	43.970	40.929	-0.191	0.000	0.29		32.8	OK
S15.000	SRoad Tank 2	120 minute	100 year	Winter	I+30%	42.500	42.097	0.486	0.000	0.06		4.1	SURCHARGED
S15.001	S00.20	120 minute	100 year	Winter	I+30%	42.500	42.101	0.801	0.000	0.12		2.9	SURCHARGED
S2.024	S00.21	360 minute	100 year	Winter	I+30%	42.500	40.484	-0.186	0.000	0.31		35.4	OK
S2.025	SRebuilt exMH90	360 minute	100 year	Winter	I+30%	42.613	40.023	-0.227	0.000	0.13		35.4	OK
S2.026	SexMH18	360 minute	100 year	Winter	I+30%	40.000	38.907	-0.468	0.000	0.11		35.4	OK
S16.000	SB2.1	120 minute	100 year	Winter	I+30%	53.000	52.099	0.257	0.000	0.31		41.3	SURCHARGED
S17.000	SB2 PP	180 minute	100 year	Winter	I+30%	52.500	52.038	0.438	0.000	0.58		6.3	SURCHARGED
S16.001	SB2 Tank	120 minute	100 year	Winter	I+30%	52.500	52.092	0.801	0.000	0.03		4.0	SURCHARGED
S16.002	SB2.2	120 minute	100 year	Winter	I+30%	52.500	52.092	1.135	0.000	0.04		2.7	SURCHARGED
S18.000	SB1.1	120 minute	100 year	Winter	I+30%	51.500	50.596	0.371	0.000	0.00		0.4	SURCHARGED

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Event				US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S19.000	SB1 PP	180 minute	100 year	Winter	I+30%	51.000	50.465	0.365	0.000	0.50		7.5	SURCHARGED
S18.001	SB1 Tank	120 minute	100 year	Winter	I+30%	51.000	50.596	1.296	0.000	0.06		6.5	SURCHARGED
S18.002	SB1.2	120 minute	100 year	Winter	I+30%	51.000	50.595	1.628	0.000	0.11		3.1	SURCHARGED
S18.003	SB1.3	120 minute	100 year	Winter	I+30%	50.500	48.744	-0.134	0.000	0.03		3.1	OK
S16.003	SB1.4	120 minute	100 year	Winter	I+30%	45.000	43.429	-0.123	0.000	0.08		5.7	OK
S20.000	SH.1	15 minute	100 year	Winter	I+30%	50.500	49.409	-0.041	0.000	0.85		26.6	OK
S20.001	SH.2	15 minute	100 year	Winter	I+30%	48.900	47.661	-0.085	0.000	0.70		77.0	OK
S20.002	SH.3Storage 2	180 minute	100 year	Winter	I+30%	47.500	46.421	0.771	0.000	0.12		2.2	SURCHARGED
S21.000	SDUMMY	120 minute	100 year	Winter	I+30%	47.500	46.897	-0.046	0.000	0.00		0.0	OK
S21.001	SH.4Storage 1	120 minute	100 year	Winter	I+30%	47.400	46.897	0.750	0.000	0.10		2.9	SURCHARGED
S20.003	SH.5	600 minute	100 year	Winter	I+30%	47.500	45.138	-0.181	0.000	0.09		5.1	OK

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FOUL SEWERAGE DESIGN

Design Criteria for Foul - Total Site

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Domestic (l/s/ha)	0.00	Maximum Backdrop Height (m)	1.500
Industrial Peak Flow Factor	0.00	Domestic Peak Flow Factor	6.00	Min Design Depth for Optimisation (m)	1.200
Calculation Method	EN 752	Add Flow / Climate Change (%)	0	Min Vel for Auto Design only (m/s)	0.75
Frequency Factor	1.00	Minimum Backdrop Height (m)	0.200	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul - Total Site

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
F00.2.000	46.273	1.851	25.0	0.000	0.0	2.7	1.500	0	150	
F00.2.001	69.134	1.536	45.0	0.000	0.0	2.7	1.500	0	150	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F00.2.000	53.500	0.000	2.7	0.0	0.0	30	1.07	1.76	31.0	2.7
F00.2.001	51.649	0.000	5.4	0.0	0.0	49	1.07	1.31	23.1	5.4

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Network Design Table for Foul - Total Site

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
F00.2.002	18.488	0.507	36.5	0.000	0.0	2.8	1.500	o	150	
F00.3.000	50.695	1.690	30.0	0.000	0.0	3.8	1.500	o	150	
F00.3.001	70.936	1.182	60.0	0.000	0.0	3.9	1.500	o	150	
F00.3.002	37.294	0.622	60.0	0.000	0.0	3.9	1.500	o	150	
F00.2.003	93.248	2.664	35.0	0.000	0.0	0.0	1.500	o	150	
F00.4.000	18.836	0.471	40.0	0.000	0.0	4.2	1.500	o	150	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F00.2.002	50.113	0.000	8.2	0.0	0.0	58	1.29	1.45	25.7	8.2
F00.3.000	53.100	0.000	3.8	0.0	0.0	37	1.11	1.60	28.3	3.8
F00.3.001	51.410	0.000	7.7	0.0	0.0	65	1.06	1.13	20.0	7.7
F00.3.002	50.228	0.000	11.6	0.0	0.0	82	1.17	1.13	20.0	11.6
F00.2.003	49.606	0.000	19.8	0.0	0.0	97	1.63	1.48	26.2	19.8
F00.4.000	46.750	0.000	4.2	0.0	0.0	42	1.03	1.39	24.5	4.2

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Network Design Table for Foul - Total Site

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
F00.2.004	48.275	0.644	75.0	0.000	0.0	0.0	1.500	0	225	
F00.2.005	69.458	0.926	75.0	0.000	0.0	0.0	1.500	0	225	
F00.2.006	25.602	0.394	65.0	0.000	0.0	11.0	1.500	0	225	
F00.2.007	57.969	0.892	65.0	0.000	0.0	0.0	1.500	0	225	
F00.2.008	57.969	0.892	65.0	0.000	0.0	0.0	1.500	0	225	
F00.2.009	81.431	1.253	65.0	0.000	1360.0	4.3	1.500	0	300	
F00.2.010	31.850	0.490	65.0	0.000	0.0	0.0	1.500	0	300	
F00.5.000	113.608	5.386	21.1	0.000	1494.0	0.0	1.500	0	225	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F00.2.004	46.204	0.000	24.0	0.0	0.0	106	1.30	1.33	52.7	24.0
F00.2.005	45.560	0.000	24.0	0.0	0.0	106	1.30	1.33	52.7	24.0
F00.2.006	44.634	0.000	35.0	0.0	0.0	128	1.50	1.43	56.7	35.0
F00.2.007	44.240	0.000	35.0	0.0	0.0	128	1.50	1.43	56.7	35.0
F00.2.008	43.349	0.000	35.0	0.0	0.0	128	1.50	1.43	56.7	35.0
F00.2.009	42.382	0.000	39.3	1360.0	0.0	172	1.82	1.72	121.7	76.2
F00.2.010	41.129	0.000	39.3	1360.0	0.0	172	1.82	1.72	121.7	76.2
F00.5.000	46.100	0.000	0.0	1494.0	0.0	97	2.35	2.51	99.6	38.7

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Network Design Table for Foul - Total Site

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
F00.2.011	63.424	1.268	50.0	0.000	0.0	0.0	1.500	o	300	
F00.2.012	37.716	0.754	50.0	0.000	0.0	0.0	1.500	o	300	
F00.2.013	48.185	0.964	50.0	0.000	0.0	0.0	1.500	o	300	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F00.2.011	40.639	0.000	39.3	2854.0	0.0	179	2.10	1.96	138.8	92.7
F00.2.012	39.370	0.000	39.3	2854.0	0.0	179	2.10	1.96	138.8	92.7
F00.2.013	38.616	0.000	39.3	2854.0	0.0	179	2.10	1.96	138.8	92.7



Designed by james.walley

Checked by trevor.mino

Network 2015.1

Manhole Schedules for Foul - Total Site

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
F00.15	54.846	1.346	Open Manhole	1200	F00.2.000	53.500	150				
F00.16	53.000	1.351	Open Manhole	1200	F00.2.001	51.649	150	F00.2.000	51.649	150	
F00.17	51.500	1.387	Open Manhole	1200	F00.2.002	50.113	150	F00.2.001	50.113	150	
F00.1	54.212	1.112	Open Manhole	1200	F00.3.000	53.100	150				
F00.2	52.500	1.090	Open Manhole	1200	F00.3.001	51.410	150	F00.3.000	51.410	150	
F00.3	51.500	1.272	Open Manhole	1200	F00.3.002	50.228	150	F00.3.001	50.228	150	
F00.18	51.500	1.894	Open Manhole	1200	F00.2.003	49.606	150	F00.2.002	49.606	150	
								F00.3.002	49.606	150	
F00.20	47.760	1.010	Open Manhole	1200	F00.4.000	46.750	150				
F00.19	48.000	1.796	Open Manhole	1200	F00.2.004	46.204	225	F00.2.003	46.942	150	663
								F00.4.000	46.279	150	
F00.7	48.000	2.440	Open Manhole	1200	F00.2.005	45.560	225	F00.2.004	45.560	225	
F00.8	47.376	2.742	Open Manhole	1200	F00.2.006	44.634	225	F00.2.005	44.634	225	
F00.9	46.892	2.652	Open Manhole	1200	F00.2.007	44.240	225	F00.2.006	44.240	225	
F00.10	46.692	3.343	Open Manhole	1200	F00.2.008	43.349	225	F00.2.007	43.349	225	
F00.11	46.717	4.335	Open Manhole	1200	F00.2.009	42.382	300	F00.2.008	42.457	225	
F00.12	46.669	5.540	Open Manhole	1200	F00.2.010	41.129	300	F00.2.009	41.129	300	
F00.X1	47.473	1.373	Open Manhole	1200	F00.5.000	46.100	225				
F00.X2	43.100	2.461	Open Manhole	1200	F00.2.011	40.639	300	F00.2.010	40.639	300	

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Manhole Schedules for Foul - Total Site

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
F00.13	41.940	2.570	Open Manhole	1200	F00.2.012	39.370	300	F00.5.000	40.714	225	
F00.14	42.277	3.661	Open Manhole	1200	F00.2.013	38.616	300	F00.2.011	39.370	300	
F00.	41.430	3.778	Open Manhole	0		OUTFALL		F00.2.012	38.616	300	
								F00.2.013	37.652	300	

Appendix B

Correspondence with Approvals Bodies

Reading Borough Council (Lead Local Flood Authority)

Trevor Mino

From: Cook, Darren <Darren.Cook@reading.gov.uk>
Sent: 23 November 2015 13:04
To: James Walley
Cc: McMurray, Alistair
Subject: FW: LLFA & SuDS approval for planning

Hi James,

I have been forwarded your email below regarding the SUDS requirements for the proposed development at Madejski Stadium. I can confirm that we have no other formal application process in addition to that required through the planning submission.

I hope this information is of use to you.

Kind regards,

Darren Cook
Transport Development Control Advisor
Transport | Directorate of Environment and Neighbourhood Services (DENS)

Reading Borough Council
Civic Offices
Bridge Street
Reading
RG1 2LU

0118 937 2612 (72612)

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From: James Walley [<mailto:James.Walley@arup.com>]
Sent: 19 November 2015 11:04
To: Butler, Cris
Cc: Trevor Mino
Subject: LLFA & SuDS approval for planning

Dear Cris,

I have been pointed in your direction by way of Chris Saunder's autoreply email...

I am wrapping up our surface water strategy for planning for the Madejski redevelopment and wanted to know, as LLFA do you have any formal application requirements for consent as a separate process from the rest of the planning submission process?

If you could direct me to these or send over the required forms (if there are any) it would be much appreciated.

Kind regards,

James

James Walley

Graduate Engineer | Civil Engineering

Arup

Arup Campus, Blythe Valley Park, Solihull, B90 8AE United Kingdom

d: +44 12 1213 3098

www.arup.com

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From: James Walley

Sent: 19 November 2015 10:54

To: 'Saunders, Chris'

Cc: Trevor Mino; 'alison.amoah@reading.gov.uk'; 'Giorgio.framalicco@reading.gov.uk'

Subject: RE: Madejski Stadium Surface Water Strategy - Initial Query [Filed 19 Nov 2015 10:54]

Good Morning Chris,

I am wrapping up our surface water strategy for planning for the Madejski redevelopment and wanted to know, as LLFA do you have any formal application requirements for consent as a separate process from the rest of the planning submission process?

If you could direct me to these or send over the required forms (if there are any) it would be much appreciated.

Kind regards,

James

James Walley

Graduate Engineer | Civil Engineering

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From: Saunders, Chris [<mailto:Chris.Saunders@reading.gov.uk>]

Sent: 10 July 2015 10:18

To: James Walley

Cc: Amoah, Alison; Framalicco, Giorgio

Subject: Madejski Stadium Surface Water Strategy - Initial Query [Filed 10 Jul 2015 10:23]

Dear James

I refer to the email below to my planning colleague regarding the surface water strategy for the Madjeski Stadium and to the questions you raise, I comment as follows

- We propose to offer a 20% betterment on calculated existing flows. Is this acceptable? - Our starting point is in accordance with the Defra document on Technical Standards for Sustainable Drainage systems and specifically the following paragraphs which state

“S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

S7 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

S8 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

S9 The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.”

Your proposals of only a 20% betterment do not meet these requirements but while the standards do allow relaxations there is a proviso that the discharge must not adversely affect flood risk. Therefore if a 20% betterment is only being achieved detailed evidence will be required to determine why the Greenfield rates cannot be achieved and to show flood risk will not be affected.

- Can we discharge surface water at multiple locations (i.e. on either side of the development to different watercourses or at multiple points along one watercourse) into the watercourse(s) to suit the outfall rate calculated in the first bullet point? - Yes you will be able to discharge at various points but specific calculations will be required at each discharge point to determine that flood risk is not affected.
- Are there any other considerations that we need to be made aware of with regard to the outfall design into the brook? - The brook is designated as a main river course so any outfalls and discharge into this will need acceptance and approval from the Environment Agency.

If you require any further questions please let me know.

Kind Regards

Chris Saunders IEng, FIHE
Transport Development Control Manager
Transport

Reading Borough Council
Civic Offices
Bridge Street
RG1 2LU

[Website](#) | [Facebook](#) | [Twitter](#) | [YouTube](#)



From: James Walley [<mailto:James.Walley@arup.com>]
Sent: 08 July 2015 10:35
To: Amoah, Alison
Cc: Framallicco, Giorgio; David Kent
Subject: RE: Planning meeting for Madejski Stadium Surface Water Strategy

Good Morning Alison,

Here are some of our initial questions for you and your team:

- We propose to offer a 20% betterment on calculated existing flows. Is this acceptable?
- Can we discharge surface water at multiple locations (i.e. on either side of the development to different watercourses or at multiple points along one watercourse) into the watercourse(s) to suit the outfall rate calculated in the first bullet point?
- Are there any other considerations that we need to be made aware of with regard to the outfall design into the brook?

I look forward to your responses.

Kind regards,

James

James Walley
Graduate Engineer | Civil Engineering

Arup
t +44 121 213 3098

From: Amoah, Alison [<mailto:Alison.Amoah@reading.gov.uk>]
Sent: 06 July 2015 15:13
To: James Walley
Cc: David Kent; Framallicco, Giorgio
Subject: RE: Planning meeting for Madejski Stadium Surface Water Strategy

Dear James,

As just discussed please send me some initial bullet point questions of the key matters you are seeking guidance on at this pre, pre-app stage. We can then provide an appropriate response/sign post you.

Regards,

Alison

Alison Amoah

Principal Planner

Planning, Development and Regulatory Services/ Environment and Neighbourhood Services

Reading Borough Council

Civic Centre

Bridge Street

Reading RG1 2LU

0118 937 2286 (72286)

This Council will implement its Community Infrastructure Levy (CIL) on 1st April 2015. Planning applications which are decided on or after 1st April 2015 may be liable to pay the levy. For more information please visit our website at <http://beta.reading.gov.uk/readingldf>

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From: James Walley [<mailto:James.Walley@arup.com>]

Sent: 06 July 2015 14:14

To: Framallicco, Giorgio; Amoah, Alison

Cc: David Kent

Subject: RE: Planning meeting for Madejski Stadium Surface Water Strategy

Good Afternoon,

I was just wondering if you have considered my previous email with regard to organising a pre-application meeting to discuss the surface water drainage strategy for Madejski?
My telephone number is 0121 213 3098, please feel free to call me.

Kind regards,

James

James Walley

Graduate Engineer | Civil Engineering

Arup

t +44 121 213 3098

From: James Walley

Sent: 30 June 2015 16:06

To: 'Giorgio.framallicco@reading.gov.uk'; 'Alison.amoah@reading.gov.uk'

Cc: David Kent; Damian Friel; Robert Nield; 'gemma.care@bartonwillmore.co.uk'

Subject: Planning meeting for Madejski Stadium Surface Water Strategy [Filed 30 Jun 2015 16:05]

Good Afternoon Giorgio and Alison,

I'm working on the new Madejski stadium redevelopment alongside Barton Wilmore Architects with whom I understand you have been providing useful advice. Part of Arup's role on this project is to provide a drainage strategy for both the foul and surface water. I understand that you are the Lead Local Flood Authority for this area

and therefore, before we progress too far, I would like to set up a pre-application meeting with yourselves to discuss our proposals for the surface water drainage strategy for the site. Could you tell me what we must do to organise this meeting?

Kind regards,

James

James Walley

Graduate Engineer | Civil Engineering

Arup

The Arup Campus Blythe Gate Blythe Valley Park
Solihull West Midlands B90 8AE United Kingdom

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Record of Verbal Communication

ARUP

Project title Royal Elm Park

Job number
240524-00

Communication from Trevor Mino

File reference
6-05

Organisation Arup

Telephone no 0121 213 3894

Date of communication
23 September 2015

Communication to Melanie Ward

Organisation Environment Agency

Telephone no 0118 953 5797

Copy to

Record of communication

The intent of the phone call was to discuss the Environment Agency's (EA) role in reviewing and approving discharge points and flow rates to the Foudry Brook. The understanding from the discussion is as follows:

- The EA is a consultee for the Planning application, but since the site is not within a Flood Zone 3 the discharge rates are the responsibility of the local Council (as the lead local flood authority)
- A Flood Defence Consent application needs to be submitted for all works within 8m of a main watercourse.
- The Flood Defence Consent application can be submitted at any time, however it is recommended that it is not submitted until after Planning approval has been granted. If anything changes (location, size, type, etc) the application needs to be re-submitted.
- If temporary works are required to facilitate construction of the permanent structures, these should be included with the consent application, else they will require their own applications.
- The EA has 2 months to review the consent applications, and approval remains active for 3 years.
- The EA will review for ecological impact if the development is within 20m of a main watercourse.

Trevor Mino

From: West Thames Consents <WestThamesConsents@environment-agency.gov.uk>
Sent: 22 September 2015 14:44
To: Trevor Mino
Cc: Robert Nield; David Kent; James Walley; Kidd, Michelle; Planning-Wallingford
Subject: RE: Flood Defence Consent (FDC) Application Forms

Dear Trevor,

I have been asked to reply to your enquiry below regarding outfalls into the Foudry Brook.

There are a few things that I need clarifying in order to respond to your enquiry. I think it would be easier if we discuss this on the telephone. Could I ask you to call me on 01189 535797?

Kind regards

Melanie

Melanie Ward
Partnerships and Strategic Overview Team –Berkshire & Buckinghamshire
Flood and Coastal Risk Management
West Thames Area
[Environment Agency](#)

✉ Kings Meadow House, Kings meadow Road, Reading, RG1 8DQ.

ARE YOU PREPARED?



www.gov.uk/floodsdestroy

From: Trevor Mino [mailto:Trevor.Mino@arup.com]
Sent: 18 September 2015 12:27
To: West Thames Consents
Cc: Robert Nield; David Kent; James Walley; Kidd, Michelle; Planning-Wallingford
Subject: RE: Flood Defence Consent (FDC) Application Forms

Hi Alston,

Thank you for your e-mail below. The Flood Defence Consent application appears to be for a detailed design / pre-construction stage, whereas we are only at Planning. What we are hoping to glean from you at this stage is if the Environment Agency has any specific requirements on discharge rate or locations/types of outfalls.

In order to meet Reading Borough Council's requirements, we will be attenuating to greenfield runoff rate and have currently been showing an additional 3 outfalls to Foudry Brook. After some recent findings regarding the existing surface water drainage, we are considering combining these outfalls to utilise the existing outfall instead, however we would be very grateful for the Environment Agency's preference in this regard.

Is there any general guidance you can provide, or is there anything we can provide to you for perhaps an outline approval? As I mentioned, unless we have misunderstood the Flood Defence Consent, we do not seem to be at the appropriate design stage for this application.

Thanks,
Trevor

Trevor Mino
Senior Civil Engineer

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d: +44 121 213 3894
www.arup.com

From: Ponde-Silcott, Alston [<mailto:Alston.Ponde-Silcott@environment-agency.gov.uk>] **On Behalf Of** West Thames Consents
Sent: 07 August 2015 11:58
To: Robert Nield
Subject: Flood Defence Consent (FDC) Application Forms

Dear Robert,

Thank you for your query, based on the works you intend to carry out you would need to submit an application for Flood Defence Consent for any structure in, over, or within 8m of a main river. I have attached the relevant forms with guidance below.

Please contact us at westthamesconsents@environment-agency.gov.uk should you have any further questions.

**WATER RESOURCES ACT 1991
THAMES WATER AUTHORITY LAND DRAINAGE BYELAWS 1981
LAND DRAINAGE ACT 1991
CONSENT FOR WORKS AFFECTING WATERCOURSES AND/OR FLOOD DEFENCES**

Please find attached a Flood Defence Consent (FDC) application form and associated guidance notes.

We ask for a location plan of the works, design drawings and an appropriate method statement describing how you intend to complete the works, including any pollution prevention measures. The method statement should consider flood risk, biodiversity, ecology and pollution prevention including disposal of any waste arising from the work. It should consider both permanent and temporary works.

The Flood Defence Consents needs to included the following information:

- Location plan of the works
- Design drawings
- Appropriate method statement – this needs to describe how you intend to complete the work and include the following aspects:
 - o Flood risk
 - o Biodiversity
 - o Ecology
 - o Pollution preventions measures
 - o Disposal of any waste arising from the works
 - o Both permanent works and temporary works need to be addressed

Please ensure that each of documents is dated and that all drawings have a reference number.

Once completed please send the forms, plans and method statement to westthamesconsents@environment-agency.gov.uk.

If however your drawings or plans are larger than A3 and are only available in hard copy, please send two copies to:

Partnerships & Strategic Overview Team
Red Kite House
Howbery Park
Crowmarsh Gifford
Wallingford
Oxon
OX10 8BD

Please note that a £50 fee is applicable **per structure** in, over or under a main river. The fee applies for all structures whether **temporary** or **permanent**. This fee can be paid by cheque to 'Environment Agency' at the above address or by payment card. To pay by card please state your desire to do so on the application form, further details will be sent to you with your acknowledgement. We advise that you do not submit payment until you receive an acknowledgement e-mail.

We have two months from the date of receipt of the **complete application including payment** to determine the application. Every effort will be made to process them as quickly as possible, but you are reminded that work **should not start** until consent is granted.

Please note that applicants should be aware that the following species are often associated with watercourses and are protected from disturbance by current UK and/or European legislation. Their disturbance may constitute an offence unless appropriate mitigation and/or licensing is in place before works commence:

Water-voles (and their burrows), bats (and their roosts), otters (and their holts and resting sites), spawning fish (and their eggs and spawning habitat) and nesting birds.

Please note this list is not exhaustive and applicants are advised to consult a suitably experienced ecologist for further information and advice to ensure that an offence is not committed. The Environment Agency's Conservation Team or staff from Natural England are also available to give you further advice on protected species and legislation if needed.

Please be aware that we also offer a free pre-application enquiry service relating to FDC proposals prior to formally submitting an application. If you would like to discuss your proposals prior to submitting an application please submit further information to: westthamesconsents@environment-agency.gov.uk.

If you have any questions please contact us.

Kind regards,

Alston Ponde-Silcott

Partnerships and Strategic Overview Team – Berkshire & Buckinghamshire
Flood and Coastal Risk Management
West Thames Area
[Environment Agency](#)

✉ Kings Meadow House, Kings meadow Road, Reading, RG1 8DQ.

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Thames Water

Trevor Mino

From: James Walley
Sent: 19 November 2015 12:28
To: Siva Sivarajan
Cc: Trevor Mino
Subject: RE: EMAIL SENT ON 17TH SEPT

Good Afternoon Siva,

Following our discussion on the phone this morning I am emailing to confirm that we have instructed a cheque to be sent for payment for this scheme.

Additionally I have a clarification to make to the scheme - "A proposed pumped connection point has been identified as manhole SU70708101." This is incorrect. To clarify, this connection will be a gravity connection. The reference to pumping is to do with the drainage on the site involving several pumping stations that feed into a "trunk" gravity sewer on the site that we intend to connect to the Thames Water asset.

Kind regards,

James

James Walley
Graduate Engineer | Civil Engineering

d: +44 12 1213 3098

From: Siva Sivarajan [mailto:Siva.Sivarajan@thameswater.co.uk]
Sent: 20 October 2015 12:09
To: James Walley
Cc: Trevor Mino
Subject: FW: EMAIL SENT ON 17TH SEPT [Filed 20 Oct 2015 13:48]

James,

The below email was sent to Trevor who is away I believe; as such I am forwarding same to you in his absence to deal with if required

Regds

Siva

From: Siva Sivarajan
Sent: 20 October 2015 11:55
To: 'Trevor Mino'
Subject: RE: EMAIL SENT ON 17TH SEPT

Trevor,

Apologies for the slight delay in coming back with the scoping report. I have attached the report herewith for your perusal and consideration. By the way the scheme reference is IR 1013193475 & 50071613.

Regds,

Siva Sivarajan
Senior Adoptions Engineer (TW)

Thames Water Utilities Ltd
Clearwater Court
Vastern Road
Reading, RG1 8DB

From: Trevor Mino [<mailto:Trevor.Mino@arup.com>]
Sent: 01 October 2015 09:17
To: Siva Sivarajan
Subject: RE: EMAIL SENT ON 17TH SEPT

Hi Siva,

Can you please provide an update on the scoping study? Do you have an estimate on when we can expect a response? Do you need anything else?

The project is the Madejski Stadium Park, and I believe the TW ref is 1013047943.

Many thanks,
Trevor

Trevor Mino
Senior Civil Engineer

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The Arup Campus Blythe Gate Blythe Valley Park Solihull B90 8AE United Kingdom
d: +44 121 213 3894
www.arup.com

From: Siva Sivarajan [<mailto:Siva.Sivarajan@thameswater.co.uk>]
Sent: 18 September 2015 11:30
To: Trevor Mino
Subject: FW: EMAIL SENT ON 17TH SEPT

Trevor,

Ignore the below email ; I have managed without you having to send it;

Apologies for the trouble

Regds

Siva

From: Siva Sivarajan
Sent: 18 September 2015 11:22
To: 'trevor.mino@arup.com'
Subject: EMAIL SENT ON 17TH SEPT

Trevor,

Would it be possible to resend that email you sent me on 17th with attachments ; would appreciate it;

Regds

Siva

0203 5777752

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Trevor Mino

From: Trevor Mino
Sent: 17 September 2015 12:08
To: 'Siva Sivarajan'
Cc: James Walley
Subject: RE: Madejski Stadium- Impact Study
Attachments: 240524-ARP-XX-XX-SK-C-013.pdf; 20150917 Stadium Park Foul Calcs.pdf

Hi Siva,

Apologies for the delay in getting back to you. I have attached the requested information. These include a revised site plan sketch showing the relevant development and hydraulic information for each building, and calculation sheets for the foul discharge from the proposed development.

Please note:

- We have identified existing building which are to be removed and have estimated their peak foul flow rate.
- We have revised the residential peak flow calculations in accordance with the document you provided. It is our assumption at this time due to both the Thames Water sewer capacity and various site constraints that each building will be attenuated and pumped. Therefore the highlighted value is for the pumped connection. We have also provided calculations based on approximate discharge units for the current architectural layouts and as this total flow rate is slightly larger we ask that you bear this in mind in your review.
- The total site discharge rate identified on the sketch is the summation of the highlighted values in the sketch. These are (1) the residential units calculated using the document you provided, (2) the office units calculated by discharge units and (3) the convention centre and stadium calculated by combined discharge units. We believe this is a reasonable approach given the different development types.

If there is any other information I can provide at this time, please let me know.

Regards,
Trevor

Trevor Mino
Senior Civil Engineer

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From: Siva Sivarajan [mailto:Siva.Sivarajan@thameswater.co.uk]
Sent: 11 September 2015 12:50
To: Trevor Mino
Subject: FW: Madejski Stadium- Impact Study

Trevor,

I sent the email below and James has auto replied stating that he is not back till 28th sept; can my queries below in email dated 8th sept wait till he comes back or ?; can you respond?;

Regds,

Siva Sivarajan
Senior Adoptions Engineer (TW)

Thames Water Utilities Ltd
Clearwater Court
Vastern Road
Reading, RG1 8DB

From: Siva Sivarajan
Sent: 11 September 2015 12:05
To: 'james.walley@arup.com'
Subject: FW: Madejski Stadium- Impact Study

James,

Have you had a chance to answer the below queries as discussed; then I will be able to give our modellers a better idea of your proposals and they can produce a 'Scope & Cost for the impact study

Regds

Siva

From: Siva Sivarajan
Sent: 08 September 2015 11:41
To: 'james.walley@arup.com'
Cc: 'trevor.mino@arup.com'
Subject: Madejski Stadium- Impact Study

James ,

I refer to our tele discussion this morning; as requested could you endeavour to provide the following info so that I can forward same to the Asset Planning team / Modellers who will be reviewing the proposals and preparing the 'scope & cost' for the Impact Study;

- Details of existing building (and their discharge rates) that are being demolished and replaced at your proposed site; ie any flows that are being taken off
- Proposed development details and the flow rates
- Any other info that you consider useful for the asset planners
- Provide the above info preferably on calculation sheet so tht we can pass it to the asset planners/modellers
- I have also attached notes that I discussed with you

I will await your response before passing the info to Modelling team;

Regds,

Siva Sivarajan
Senior Adoptions Engineer (TW)

Thames Water Utilities Ltd
Clearwater Court

Vastern Road
Reading, RG1 8DB

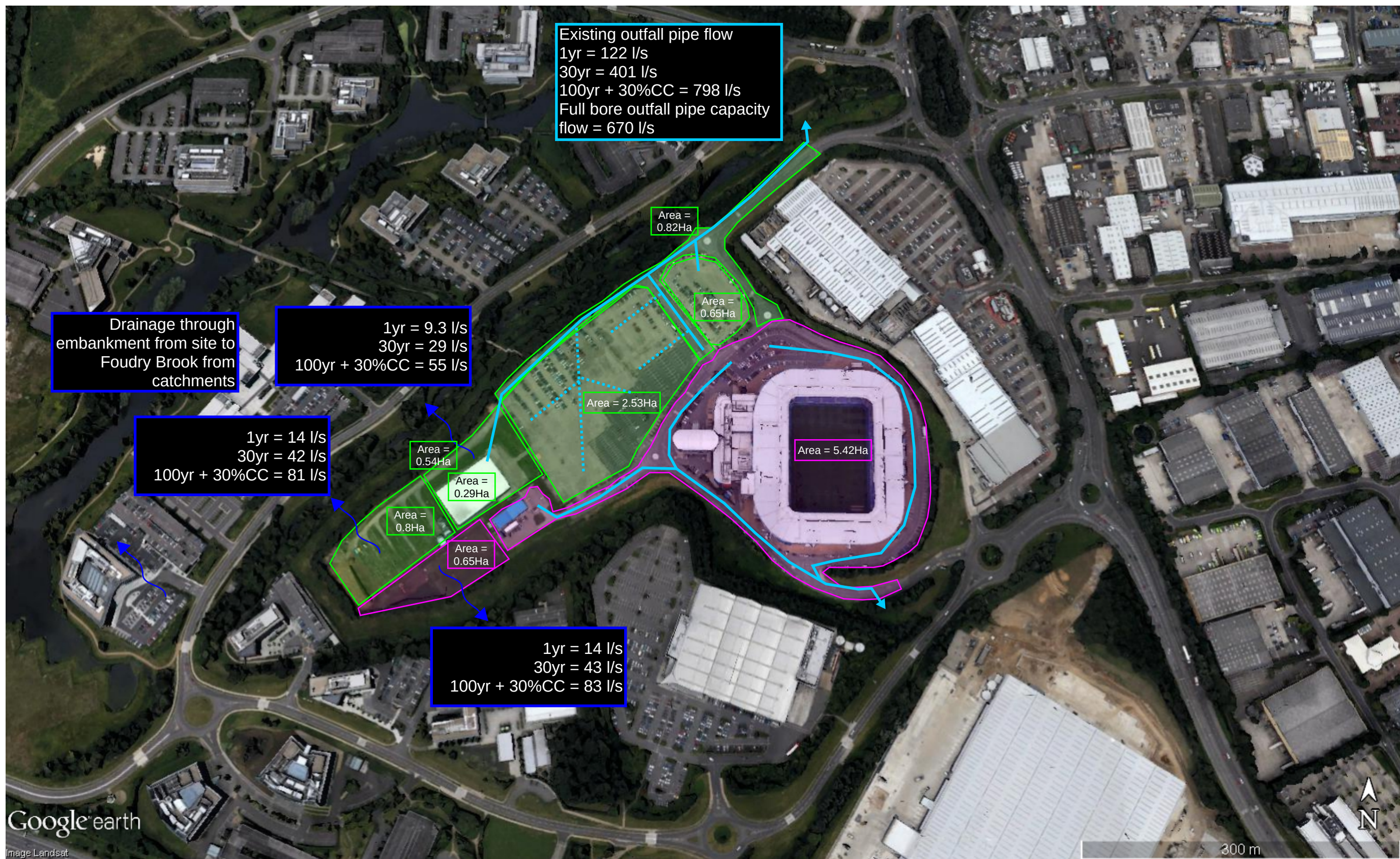
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Appendix C

Existing Surface Water Hydrology



Assumptions behind this assessment:

- Storm are calculated using FEH values for 1, 30 and 100 year + 30% Climate Change. Average intensities were used.
- To mimic the attenuating effect on the runoff that is not collected by gullies etc. a 30minute storm was applied to relevant catchments. A 15 minute storm was applied to hard standing surfaces that are drained with gullies etc.
- The rational method was used to calculate the storm flows ($Q=CiA$).
- Assuming that the majority of rainfall incident on the hard standing site is collected by gullies/filter drains, a C Value of 0.8 was used.
- Catchment areas for determining flow rates are approximate

Existing Surface Water Hydrology

Madejski Stadium Park (240524)

04 September 2015 | For Information

240524-ARP-XX-XX-SK-C-010

ARUP

Appendix D

Design Drawings



Notes

- 1. This drawing is to be read in conjunction with the manhole schedules 240524-ARP-XX-XX-DR-CD-00102 & 00103 and standard details 240524-ARP-XX-XX-DR-CD-00105 & 00106.
- 2. Existing sewers are shown based on available survey and record drawings. Although every effort has been taken to check survey/site information used on this drawing, Arup is not responsible for its accuracy.
- 3. Existing sewer depths are not known at the time of this drawing being made. Prior to detailed design a utilities survey, including a CCTV survey of the existing drainage condition, shall be procured to verify the levels and positions of existing drainage and underground services.
- 4. The minimum pipe size for below ground foul and surface water drainage shall be 150mmØ.
- 5. Pipes less than 300mmØ are to be uPVC. Pipes 300mmØ and larger are to be HDPE.
- 6. Drainage laid beneath roads and car parks with less than 1200mm of cover shall be encased in 150mm concrete with the provision for movement at joints. All other drainage with less than 900mm cover shall be similarly treated.
- 7. It is assumed that where possible the foul and rain water downpipes will be routed through the basement level to the proposed points of connection. If it is determined during detailed design that the pipes cannot traverse these distances, additional manholes may be required outside the buildings. The quantity of manholes is subject to change due to coordination with underground services and other site elements during detailed design.
- 8. Thames Water is currently conducting an Impact Study for the proposed foul water connection to the public sewer. Storage tanks have been provided for all buildings to accommodate 24 hours of storage in accordance with Buildings Regulations Approved Document H. The exact pumping rate from each building is to be determined based on the result of the Impact Study, however it is assumed at this time that the allowable discharge rate will require replacing the existing sewer with a 300mmØ sewer.
- 9. All disused drains to be grouted up or removed.
- 10. All gullies are shown indicatively. Exact location and means of collection, i.e. gullies vs channels, to be coordinated during detailed design. Runoff from roads shall pass through an appropriate means of hydrocarbon separation (permeable paving, Biomat, etc) prior to entering the below ground drainage system.
- 11. Geocellular tank products shall have interlocking capability for high horizontal shear strength. Subgrade preparation shall be per manufacturer's requirements and shall incorporate Tensar geogrid for additional stability.
- 12. Similar proprietary products may be submitted to Engineer for approval in lieu of those shown herein.

Refer to drawing CD-00101 for continuation

P01	11/01/16	JW	TM	DK
Issue for Planning Application				
Issue	Date	By	Chkd	Appld

ARUP

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Client
Reading Football Club

Job Title
Royal Elm Park
(Land at Madejski Stadium)

Drawing Title
Proposed Drainage Layout
for Outline Planning Application

Scale at A1 1:500
Discipline Civil

Drawing Status
For Planning Application

Job No	Drawing No	Issue
240524-00	CD-00100	P01