NW Bicester

An application for the exemplar phase of the
NW Bicester Eco Development proposals submitted by
P3Eco (Bicester) Limited and the A2Dominion Group

Drainage Strategy

Hyder

P3Eco Ltd a2dominion

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Appendices

1 INTRODUCTION

1.1 Terms of Reference

Hyder Consulting (UK) Ltd. (Hyder) has been instructed by A2Dominion Group (A2Dominion) and P3Eco (Bicester) Ltd. (P3Eco) to provide engineering and infrastructure design in support of the masterplanning and planning for the proposed new eco development on the north-western periphery of the town of Bicester, Oxfordshire. The proposed eco development site will comprise approximately 5,000 homes with supporting employment and education infrastructure. The Exemplar Site is the first phase of the development, located at the north eastern end.

The NW Bicester development is identified in the Planning Policy Statement PPS 1 supplement as one of four eco-towns which have received support from central government. The scheme is also supported locally by Cherwell District Council and Oxfordshire County Council, and is identified as a strategic allocation within CDC draft Core Strategy. The NW Bicester development is proposed to comprise some 5000 homes, a secondary school, a number of primary schools, retail and commercial space along with health care and other community facilities. 40% of the overall site will be green open space, including sports playing fields, semi private and public open space. The development will meet the requirements of the PPS 1 supplement on Eco Towns; which sets out the key sustainability principles.

The first phase of the NW Bicester eco development, the Exemplar Site, will comprise 394 homes, a primary school, nursery and local retail centre, and areas of commercial offices.

This report contains details of the drainage strategy proposed to manage surface water runoff and foul water generated by the Exemplar Site development only. The remainder of the NW Bicester eco development will be covered within a separate drainage strategy.

1.2 Location

The town of Bicester lies approximately 24km to the north east of Oxford and 28km to the south east of Banbury. The M40 motorway lies 2km to the south west, with established access to the town from Junction 9.

The eco development will be situated on the north-western periphery of Bicester, beyond the A4095 (which forms part of the Bicester Ring Road), approximately 1.5km from the town centre.

The Exemplar Site is situated at the northeast end of the development and covers an area of approximately 21.1ha of Grade 3 agricultural land. To the west of the Exemplar Site is the village of Bucknell, with Caversfield located on the north-eastern Exemplar Site boundary, beyond the B4100 highway.

The locations of the eco development and Exemplar Site are presented on drawing 7006 within Appendix A.

2 EXISTING SITE

2.1 Topography

A topographical survey has been completed for the Exemplar Site. Ordnance Survey DTM (Digital Terrain Model) data and Mastermap have been used to provide ground profile and mapping information respectively for the remainder of the surrounding area.

Drawing 7013 (Appendix A) shows contours and topological details of the Exemplar Site produced from the topographical survey.

The existing topography of the Exemplar Site falls by approximately 4m from the north-western boundary to the south-eastern boundary (from ~92m AOD to ~88m AOD), with watercourses lying in central depressions reaching a depth of 82.5m AOD.

2.2 Ground Conditions

Ground conditions have been assessed within a desk study (Phase 1 Desk Study, document 2501-UA001881) and a factual report summarising the findings of onsite ground investigation (Exemplar Site Factual Report, document 2504-UA001881).

In summary, the investigations indicate that the site comprises stratum of sand and gravel overlying clay bands and limestone.

No significant contamination issues or risks have been identified within the reports and it is considered that ground contamination will not impact on the potential for drainage and ground infiltration.

2.3 Local Hydraulic Conditions

Drainage and Water Features

Within the eco development there are several water features: the Bure and its associated tributaries, field drains, ponds and springs. The Bure (a main river) flows in a southerly direction from Caversfield House to a culvert beneath the A4095. Downstream from this it flows in an open channel between Lucerine Avenue and Purslane Drive. There is a tributary flowing in an easterly direction from Bucknell which converges with the Bure downstream of Home Farm. The Langford Brook (an ordinary watercourse) flows in an easterly direction from Crowmarsh Farm, which converges with the Bure at the A4095 culvert. There is a field drain south of Gowell Farm flowing in a southerly direction to a culvert under the A4095 and the downstream urban area. There are several ponds within the boundary of the eco development, most notably at Crowmarsh Farm and south of Himley Farm and a spring is shown to present east of Himley Farm.

In addition to these prominent water features, it is likely that a number of ditches and other smaller features drain individual fields and feed in to the network. The existing water features are identified on Drawing 7019 within Appendix A.

Isolated properties across the eco development are likely to discharge runoff from roofs and paved areas to ditches or piped networks discharging to the watercourses. Roads crossing and adjacent to the site shed surface water to their grassed verges, from where it infiltrates the ground.

Mapping obtained from Thames Water Utilities indicates that urban areas surrounding the eco development are drained by a positive drainage network of surface water pipes and manholes which discharge to nearby watercourses, and a network of foul sewers discharging by both gravity and pump to Bicester Treatment Works.

Existing Drainage Mechanism

Rainfall on the Site discharges predominantly through the following mechanisms:

- Ground Infiltration - water seeps into the ground
- Surface Water Runoff – water discharges along the surface of the ground forming surface water features such as streams, rivers and ponds
- Evaporation and Transpiration – water evaporates from the surface of the ground or is taken up by plants

During large rainfall events, surface water runoff from the Site will contribute to flow in the watercourses, both on Site and further downstream, directly via surface water runoff and indirectly via ground infiltration, by flowing along impermeable stratum and seeping into watercourses.

Assessment of the hydrological conditions provides information regarding the proportion of water discharging by these mechanisms.

Greenfield Runoff Rates

The proportion of rainfall discharging as surface water runoff across the surface of the pre-development site to watercourses has been estimated. These results are expressed as greenfield runoff rates and have been agreed with the Environment Agency. The results are shown within Table 2.1 below.

The IoH124 method has been used to derive these figures, as recommended by the Environment Agency and set out within the SuDS Manual for sites up to 200ha. Further details of their derivation are provided within the Flood Risk Assessment (document 3501-UA001881).

Return Period	(l/s/ha)
Mean Annual Flood	2.29
1 in 30 year	5.12
1 in 100 year	7.29

Table 2.1 Calculated Greenfield runoff rates for the predevelopment site

Ground Infiltration Rates

Desk study of the hydrological conditions at the site indicates that the eco development has relatively low surface water runoff rates, with 1ha of land typically producing a peak discharge of only 7.29l/s. The results indicate that the majority of rainfall discharges from the surface via ground infiltration and therefore infiltration rates at the site are considered to be moderate to good. Ground infiltration methods are therefore considered to be viable as part of the drainage strategy.

Surveyed data on site provides further evidence of the potential to discharge surface water from the development via ground infiltration. Tests were undertaken and completed in accordance with the requirements of BRE365 (Soakaway Design, March 2007, Building Research Establishment) and used to derive ground infiltration rates across this drainage strategy. To achieve ground infiltration rates that reflect the likely depth of soakaway features, the soakaway tests were conducted at depths of approximately 1m below ground level. The results indicate that ground infiltration is feasible within the superficial deposits and that soakage will also be feasible between depths of 1-2m below ground level. Table 2.2 sets out the ground infiltration rates derived which are of relevance to the Exemplar Site and Table 2.3 provides additional ground infiltration information from subsequent testing. Appendix B contains the soakaway test results and test locations. The results reinforce the hydrological assessment and indicate moderate ground infiltration rates.

Discharge of surface water runoff via ground infiltration is considered feasible at the site. However, it is anticipated that some areas of site may not be practical or feasible to discharge via ground infiltration due to the presence of shallow impermeable stratum.

Trial Pit	Infiltration Rate (mm/hr)	Stratum Tested
SP1	180	Slightly clayey sandy limestone GRAVEL
SP2	56	Slightly clayey gravelly SAND
SP3	64	Gravelly CLAY

Table 2.2 Ground infiltration rates

Trial Pit	Infiltration Rate (mm/hr)
SA1	78
SA2	12.2
SA3	66
SA4	131
SA5	-
SA6	54

Table 2.3 Additional ground infiltration rates

2.4 Planning Context

2.4.1 Cherwell District Draft Core Strategy

The vision for the Core Strategy is to achieve a sustainable balance between water supplies and demand. Policies are being developed through the draft Core Strategy to make sure development:

- Addresses issues of water supply and sewage disposal;
- Reduces the consumption of energy and water, minimizes the production of pollution and waste and incorporates facilities for recycling water and waste; and
- Reduces flood risk – Cherwell District Council will seek to allocate development beyond the floodplain. Flood risk assessments will be required for appropriate sites and management sought.

2.4.2 PPS 1

The supplement to Planning Policy Statement 1 states that Eco-towns should:

a Incorporate measures for improving water quality and managing surface water, groundwater and local watercourses to prevent surface water flooding from those sources;

b incorporate sustainable drainage systems (SuDS) and, except where this is not feasible, as identified within a relevant Surface Water Management Plan, avoid connection of surface water run-off into sewers;

c include a strategy at planning stage for the long term maintenance, management and adoption of the SuDS; and

d reduce and avoid flood risk wherever practicable through consideration of the location, layout and construction, whilst not increasing the risk of flooding elsewhere and using opportunities to address and reduce existing flooding problems.

3 SURFACE WATER DRAINAGE STRATEGY

3.1 Principles

The aim of the drainage strategy is to demonstrate that it would be feasible to develop detailed drainage proposals for the development that meet the flood risk requirements of the Environment Agency and the requirements for Eco-towns as set out within PPS1, and requirements to achieve level 5 of the Code for Sustainable Homes (CSH).

The drainage strategy is based on the masterplan submission and site investigation, and sets out proposals for key drainage features and the principles in line with which detailed design should be carried out, based on currently available information. At detailed design stage further site investigations would be conducted providing additional detail of ground conditions and the findings used in conjunction with the drainage strategy to develop a detailed design.

The strategy includes proposals for a surface water drainage system based on Sustainable Drainage System (SuDS) principles, ensuring that following large rainfall events the developed site presents no greater flood risk to the surrounding area than the predevelopment site.

Residential property would be designed in accordance with the requirements of the CSH, whilst non-residential property such as schools and commercial premises are likely to be specified in accordance with and assessed using BREEAM (BRE Environmental Assessment Method). BREEAM sets targets for flood risk depending on type of property and awards credits against the level achieved for other drainage criteria. For example, for educational establishments, credits can be achieved for the following:

- Rainwater and greywater recycling
- Use of SUDS to minimise flood risk

The non-residential property would be expected to meet very similar criteria to residential property and therefore, for the purposes of the drainage strategy, a common set of criteria based on CSH has been used.

Mandatory requirements are set out within CSH for the management of peak runoff rates and the volume of runoff, which can be met by ensuring that:

1 the peak rate of runoff into watercourses is no greater for the developed site than it was for the pre-development site for rainfall events having return periods ranging between 1 and 100 years.

2 the additional predicted volume of rainwater discharge caused by the new development, for a 1 in 100 year event of 6 hour duration, including an allowance for climate change, is entirely reduced using infiltration or rainwater harvesting/recycling. Where conditions make these two options infeasible, the peak discharge rate to watercourses from the entire site should be substantially reduced to a defined minimal level.

Two credits are available under CSH for the management of surface water run-off by ensuring that:

1 no discharge to the watercourse occurs for rainfall depths up to 5mm.

OR

2 agreements are established for the ownership, long term operation and maintenance of all sustainable drainage elements used.

CSH supports the drainage hierarchy which is also encouraged within other guidance documents such as the SuDS Manual and the Building Regulations, through which infiltration is to be used as far as is practicably feasible. Where it is not feasible, surface water is to be discharged in a controlled manner to nearby watercourses.

PPS25 states that an allowance for climate change should be incorporated within SuDS proposals, applied by increasing rainfall intensity within calculations. The rate recommended depends on the anticipated lifespan of the proposals in question. A value of 30% is recommended by PPS25 for the period 2085-2115, reflecting building lifespans of 75years and over. This would be appropriate for the majority of development being considered as residential property typically has a lifespan of 100years and commercial property of 75 years. Therefore, across the site an allowance for climate change of 30% has been made within calculations.

The drainage strategy has been designed to meet the requirements set out above and to prove that such a scheme is feasible, based on the currently available information.

3.2 SuDS Strategy

The development has been designed to mitigate flood risk from surface water through use of SuDS, comprising a system of devices designed to manage both the quality and quantity of surface water runoff. The system would be used in conjunction with effective site management to prevent flooding and pollution.

The SuDS strategy is primarily based on discharge via ground infiltration, in accordance with the drainage hierarchy, minimising surface water discharges to nearby watercourses and the risk of flooding due to surface water. Ground conditions are suitable for use of ground infiltration methods as outlined in Section 2.3. Soakaways and site drainage infrastructure would be designed to minimal depths to allow a broad range of SuDS techniques to be applied and which suit the site ground conditions. A conservative approach has been adopted and appropriate spaces have been set aside for open attenuation features within the site layout. Further ground infiltration investigations would be completed at the specific locations of soakaway features in future design phases.

The watercourses crossing the site are generally dry or have minimal flow. The Langford Brook and River Bure are considered “at risk” of failing WFD standards principally because of high phosphate and nitrate concentrations. These are nutrients which can feed algal growth (leading to de-oxygenation and smothering of aquatic plants) and come from both sewage effluent and agricultural runoff. The eco development would lead to a reduction in agricultural runoff to the watercourses, reducing the phosphate and nitrate concentrations, whilst presenting opportunities to increase the regularity and quantity of flows within the watercourses on site, and therefore offers the potential to improve the status of these waterbodies by reducing nutrient release and increasing dilution. These measures will be developed further at detailed design stage in line with Environment Agency requirements.

Direct discharges would be required to the watercourses at controlled rates for the purpose of enhancing the flow regime of watercourses crossing the site and would also be used as a contingency for areas not being feasible for use of ground infiltration methods.

PPS25 advises that a key component of SuDS is that drainage infrastructure should be spread across a site and discharge close to the source of runoff, mimicking the natural diffuse nature of greenfield site drainage (source control). A variety of forms of soakaway have therefore been proposed across the site as appropriate and to suit the particular location requirements. Each of these would collect and discharge surface water from nearby buildings and paved areas.

SuDS can be formed from many potential components, each having a variety of attributes and strengths which make them suitable or unsuitable for use in differing situations. SuDS systems often comprise chains of linked SuDS components which complement one another and can be combined to form the optimal solution for each situation, often referred to as treatment trains.

The critical requirements of the SuDS system are to control water quantity and improve water quality. A number of treatment trains that meet the criteria are proposed and described within Sections 3.2.3 and 3.2.4. Each treatment train has been assessed hydraulically using WinDES to model their control of water quantity, with further details provided within Section 3.2.9. The treatment trains have been assessed in terms of water quality using a matrix to ensure that the best water quality is achieved through feasible and practical proposals, as set out within Section 3.2.6.

The strategic layout for surface water drainage infrastructure is shown on Drawings 7060 and 7061 within Appendix A. Key elements of the strategy are outlined further in this section.

3.2.1 Soakaways

During large rainfall events, hard paved areas would discharge surface water to soakaways at a greater rate than it is possible to discharge to the ground. Storage volumes are therefore required to store accumulating surface water whilst it steadily discharges to ground.

Storage is generally provided integral with the soakaway but it can take a number of forms, including surface features, such as basins, ponds or swales, or subsurface features, such as tanks, cellular units and permeable pavements, with incoming water filling the soakaway and gradually discharging to the ground through the base and sides. It is likely that a range of forms would be constructed at the site depending on factors local to the soakaway, including the depth of incoming drainage, water treatment requirements, land use and adoption requirements. Wherever feasible, soakaways will be designed which offer benefits beyond surface water control, such as wildlife habitat and public amenity.

As key elements of the strategy set out, each indicative soakaway has been designed and modelled to support the feasibility of the proposal principles, specifically the use of ground infiltration on site. Further details of each type of soakaway proposed are set out in Sections 3.2.3 and 3.2.4.

3.2.2 Controlled Discharge to Watercourse

Discharge Rate

The controlled discharge of surface water to watercourses would be required where inflow to watercourses is desirable and ground infiltration and soakaways are not likely to be feasible. Discharge control would be provided by a flow control device restricting discharges to the mean annual greenfield runoff for the site for all rainfall events up to the 100 year event (including 30% allowance for climate change). During large rainfall events, surface water would enter the drainage system at a greater rate than can be discharged, requiring storage to accommodate the resulting volume of water.

The mean annual greenfield runoff rate has been derived using the IH124 methodology, as outlined in Section 2.3. The whole site comprises areas affected by the proposals and those which remain unaffected/undeveloped, such as the green corridor adjacent the watercourses. The areas affected by the proposals account for 17.5ha of the development and have been used to establish greenfield runoff rates for the developed areas, as shown in Table 3.1.

Total discharges from the developed areas to watercourses would be limited to the mean annual greenfield runoff rate of 40.1l/s, to significantly reduce flood risk as outlined in Section 3.2.7.

Areas containing storage structures such as basins would be landscaped and hydraulically designed to achieve an integrated layout suitable to the spatial requirements of both uses, meeting the functional and maintenance requirements of the soakaways and the aesthetic and amenity requirements of landscaping.

Return Period	Greenfield Runoff	
	(l/s/ha)	(l/s)
Mean Annual	2.29	40.1
1 in 30 year	5.12	89.6
1 in 100 year	7.29	127.6

Table 3.1 Greenfield runoff rates for the predevelopment site

Discharge Volume

As set out in Section 3.1, CSH encourages SuDS to be designed such that the volume of surface water discharged during a 100 year rainfall event is not increased following development, through use of soakaways and rainwater harvesting. CSH recognises that many sites cannot achieve due to unsuitable ground conditions and other overriding issues. In such cases, CSH recommends that the increased risk of flooding that increased volumetric discharge presents, is mitigated through additional restrictions on site discharge rates.

The existing site discharges approximately 1,270m^3 of surface water during the 1 in 100 year event of 6 hour duration. This existing discharge volume is the equivalent to approximately 2.5ha of impermeable area. Calculations of this volume are provided within Appendix D.

Soakaways and ground infiltration are to be used at the eco development wherever feasible, which will combine with extensive rainwater harvesting and recycling to minimise the volume of water discharged to watercourses. However, it is not possible in advance of detailed design to determine the quantity of impermeable developed area that will require discharge to watercourses, particularly due to the unknown requirements of deliberately discharging some areas to watercourses to provide an improved flow regime, as outlined on Section 3.2. Therefore, in anticipation that the discharge volume could potentially exceed the greenfield volume, to mitigate the risk of flooding caused by this increase, discharges to the watercourses during the large rainfall events that might cause flooding will be restricted to the peak rate of the mean annual runoff, in accordance with best practice and the Code for Sustainable Homes. Table 3.1 shows that the peak discharge rate for a 100 year rainfall event (plus 30% allowance for climate change) would be substantially lowered from 127.6l/s for the predevelopment site to 40.1l/s from the eco development.

Discharge Summary

The eco development has the potential to discharge a total volume of water less than or equal to the existing discharge volume. If not feasible, due to the considerations outlined above, the peak discharge rate has been significantly reduced to mitigate any increase in flood risk, as set out in Table 3.2.

	Pre-development	Post-development
6hour duration 1 in 100 year discharge volume (m^3)	1,270	1,270[1]
1 in 100 year peak discharge rate (l/s)	127.6	40.1

1. Target figure for detailed design stage.

Table 3.2 Pre-development and post-development discharge

3.2.3 Roads, Paved and Parking Areas

Adopted roads within the site would drain via a mixture of permeable and impermeable paving. Permeable block paving would be used extensively across site allowing infiltration to the ground. Areas adjacent to some SuDS features will use impermeable surfaces to provide regular inflow to encourage desirable wetland habitat and to feed ponds with fresh water. Private roads, parking, driveways and other areas of paving would drain surface water via permeable block paving and soakaways within the private plot.

Permeable Block-Paving

Permeable block paving are designed systems comprising block paviors underlain by a permeable sub-base. The block paving is spaced with permeable joining medium such as sand which allows rainfall to infiltrate and enter the sub-base, in which it is stored as it slowly infiltrates the ground beneath. A typical detail of permeable block paving is provided on drawing 7163 within Appendix A.

Should an area not be suitable for the use of permeable paving discharging via ground infiltration, the paving can be used to percolate water, slowly conveying water to a nearby swale, pond or basin.

During normal rainfall events, areas of permeable paving would discharge via ground infiltration alone, as described above. During exceptionally large rainfall events, beyond normal design horizons, and in the event of blockages and other such failures, water would overflow and flow to adjacent areas of permeable paving or flow overland following roads to a nearby channel, swale, pond or basin.

Permeable paving provides a high level of treatment of runoff, with filtration trapping and biologically breaking-down particles and pollutants such as suspended solids and hydrocarbons.

Swales

Swales are linear, vegetated depressions which store and infiltrate or slowly convey surface water to other SuDS features.

Swales are proposed to be used across the site within suitable areas of open ground, soaking wherever feasible and conveying surplus water to other nearby features such as ponds and basins.

Swales can provide excellent habitat through creation of marshy and wetland conditions within the swale.

Ponds

Ponds would be incorporated as permanent water features in some areas. Ponds would be supplied with water from the nearby road network and would incorporate an element of attenuation storage.

Excess water would be discharged by ground infiltration through the fringes of the pond or to a nearby SuDS feature such as a basin or swale.

Basins

Following large rainfall events, basins located around the site would receive and store surface water runoff from other SuDS features, discharging by ground infiltration. The basins would be designed to incorporate small areas for relatively frequent inundation allowing the creation of wetlands, and larger and less frequently inundated areas which would provide additional storage volume during less frequent, very large rainfall events. It is anticipated that during such events the basins would typically discharge all water within a maximum of 12 hours. The basins would be modelled in detail at detailed design stages, but it may be possible to achieve a frequency of inundation of 12 hours once every two years for the area less frequently inundated, allowing use of the area for amenity.

Basins would be designed to form a part of the landscaping, shaped to allow their safe use as amenity areas and preventing the build up of unsafe volumes and depths of water.

Infiltration SuDS Feature

Infiltration trenches are proposed to be located adjacent the primary roads within the site and comprise an excavation with permeable base, backfilled with granular filter and plant bedding material. A typical detail of one option for this feature is provided on drawing 7163 within Appendix A, though the final design and details would be finalised at detailed design stage through consultation with OCC.

By incorporating a flat vegetated verge between the road and infiltration trench, particles can be trapped and removed by filtration as the water passes through the vegetation and then percolates down through the bedding medium or granular filter material. Surface water would discharge directly to ground, infiltrating the base and sides of the trench, with infiltration trapping and biologically break-down particles and pollutants such as suspended solids and hydrocarbons.

Village Street SuDS Feature

The commercial hub of the Exemplar site is the village High Street. A SuDS feature incorporating attractive planting would serve this area. A narrow, relatively deep and vertically faced channel could be formed within the paved area, backfilled with planting and filter medium. A grill near the surface would provide a resilient surface through which would protrude vegetation, such as reeds planted in the base. A typical detail is provided on drawing 7163 within Appendix A, though the final design and details would be finalised at detailed design stage through consultation with OCC to ensure that the feature is safe and practical to maintain.

Surface water would run off the surrounding paved area over the edge of the channel from where it would be filtered by the vegetation and planting medium, stored and treated, whilst slowly being discharged by ground infiltration. Particles would be trapped by the vegetation or drawn into the plants thus improving the water quality, whilst filtration in the planting medium would trap and biologically break-down particles and pollutants such as suspended solids and hydrocarbons.

3.2.4 Property

Surface water runoff from the roofs and paved areas of residential and commercial property would be discharged via soakaways within the curtilage of the property or to nearby SuDS features.

Each residential property would incorporate a combined rainwater harvesting and soakaway system within the back garden. Rainfall would be retained within the rainwater harvesting tank, ready for future reuse within the property. Excess rainwater would discharge to a soakaway structure within the garden should the tank capacity be exceeded. Smaller properties with shared courtyards for parking have the potential to incorporate shared soakaways beneath the courtyards.

Affordable housing and flats may benefit by allowing a number of properties to discharge to shared soakaway and rainwater harvesting features, allowing substantial volumes of water to be stored for reuse.

Commercial property, the school and other areas would be served by separate private drainage systems incorporating basins, ponds and other soakaways within open areas of the property boundary. Many forms of soakaway could be used and the selection would be made to suit each property, varying in form to suit land availability and the quality of the runoff water. Rainwater harvesting would also be incorporated.

Rainwater Harvesting

The development is in an area subject to water stress. Rainwater harvesting allows reuse of collected rainwater within the home to supply toilets and washing machines, and for use in gardens and landscaped areas, reducing demand on water supply infrastructure.

Rainwater would run off a roof into guttering, protected by a leaf guard, and discharge via downpipes to a subsurface rainwater harvesting tank. The water would be filtered on entry to remove sediments and stored within the body of the tank. A small submersible pump would supply water to the property as required. When the tank is at capacity, additional rainwater would be discharged via a pipe to a soakaway.

When the rainwater harvesting tank is empty, the water supply would revert to the potable (Water Authority) network. The Water Cycle Study considers the demand for potable water in further detail (document 5003-UA001881, Hyder, March 2011). A typical detail is provided on drawing 7163 within Appendix A.

Overflow Soakaways

Should a rainwater harvesting tank exceed capacity during periods of consistent heavy rainfall, an overflow pipe would discharge excess water to a percolation tunnel, lined soakaway or similar structure within the property curtilage. A typical detail is provided on drawing 7163 within Appendix A.

Overflow Structures, Swales, Basins and Wetlands

Should it not be feasible to locate a soakaway within a property curtilage, overflow water from rainwater harvesting systems would be directed to nearby SuDS features located around the site, including swales, basins, ponds and wetlands, as outlined in Section 3.2.3. The depth and level of an overflow would be minimised and pipework avoided where possible to allow discharge to nearby areas of impermeable paving or shallow channels to convey runoff to the SuDS features.

Online Storage

During design development, some locations may become highly constrained and the provision of surface storage structures such as basins, ponds and wetlands may not be feasible to accommodate the entire storage volume required. Should such an occasion occur, online storage would be used to supplement the preferred surface storage structures. A variety of methods are available, including oversized pipes and cellular storage. Such methods would be employed only where other alternatives have been proven as impractical or infeasible and preference should always be given to open surface structures.

Should online storage be required, discharge to watercourse would be through a wetland area to provide additional enhancement to water quality. Such areas would be expected to receive regular inflow and would provide valuable wetland habitat.

3.2.5 Adoption and Maintenance

Soakaways on site would be adopted and maintained by a variety of parties. It is likely that soakaways serving residential and commercial properties would become the responsibility of property owners or the private maintenance company proposed to manage other shared facilities on the site, with residents and occupiers paying a maintenance fee. Community facilities such as schools would also be responsible for the drainage features within the property

Highway drainage, local and regional controls such as swales, basins and ponds, and any associated pipework and structures would be offered for adoption by OCC.

Whilst proposals have been set out for features across the site, the final design and details of all adopted features would be finalised at detailed design stage through consultation with OCC, to ensure that their requirements are met. For example, ponds and basins would incorporate banks not steeper than 1 in 3, maintenance strips and access roads to facilitate maintenance, and appropriate easement allowed for.

3.2.6 Water Quality and Treatment Trains

The proposed SuDS system has been formed using a broad range of components, each having a variety of attributes and strengths which make them suitable or unsuitable for use in differing situations. The SuDS system proposed comprises chains of linked SuDS components which complement one another and have been combined to form a treatment train.

The SuDS Manual provides advice on the relative merits of different components using ratings of Low, Medium and High. The treatment trains described within Sections 3.2.3 and 3.2.4 have been assessed in terms of water quality using the ratings of the SuDS Manual to ensure that the best water quality is achieved through feasible and practical proposals.

Where the major SuDS features would be unlikely to provide the required level of water quality treatment, pre-treatment methods would be used to supplement the treatment trains. Pre-treatment are components not subject to water treatment ratings within the SuDS Manual and include systems for water treatment such as bypass separators (petrol interceptors) to remove hydrocarbons, catchpits to remove sediments and vortex separators for sediment and pollutant removal.

It is important to consider the quality of runoff to be discharged when considering the treatment required. For example, relatively clean runoff from a roof would be likely to require less rigorous treatment than runoff from a road. Therefore, where it may be acceptable to treat roof runoff with SuDS features having low to moderate water quality treatment characteristics, it would be more desirable for road runoff to be treated by a SuDS feature having medium or high treatment characteristics for the appropriate contaminants.

Runoff from parking areas and roads would require some form of pollutant removal due to the presence of to remove hydrocarbons and other similar pollutants associated with motor vehicles. Treatment would be by filtration within SuDS features as it runs through vegetation and percolates through the surface stratum and via percolation through layers of filtration material such as grit within permeable paving. Bypass separators (petrol interceptors) or vortex separators could be used for discharges where space is insufficient for a suitable SuDS feature. Catchpits would be used within any piped networks to capture sediments.

The naturally high quality and unpolluted nature of runoff from roofs and paved areas is likely to require minimal treatment. Filtration and settlement of any solids and pollutants would naturally occur within soakaways, further improving the water quality.

It is important to also consider the treatment trains in the context of their function. Where structure perform vital SuDS functions but have low water treatment characteristics, such as detention basins providing storage, such features have been combined with complimentary features to provide suitable water treatment.

The treatment trains have been assessed and the findings presented within Appendix C.

3.2.7 Overland Flowpaths

The Code for Sustainable Homes requires that the site should be designed to accommodate all runoff for events up to the 100 year rainfall event (plus 30% allowance for climate change), with an appropriate allowance for climate change. The ponds, basins and other structures discharging directly to the watercourse would be designed to ensure this criterion is met and to ensure that surface water in excess of this event is discharged safely away from property to a watercourse via overland flowpaths. Such flow paths would include the local road network in some locations and direct overflow to watercourses in others.

Individual drainage features would be designed to accommodate a variety of specific maximum rainfall events depending on the requirements of legislation, the adopting party and constraints local to the feature. Typically, drainage features would be designed to accommodate the 100 year rainfall event, including 30% allowance for climate change. However, where size prohibits the use of certain features to this standard, such as a soakaway in a garden, the 30 year rainfall event will be used instead. In such cases, surface water in excess of the design event could result in overland flows which would be directed to local SuDS features such as swales and basins, which would be designed to accommodate such flows, and permeable paving which would be likely to contain significant surplus storage within its substructure. Anticipated overland flowpaths have been shown on Drawings 7160 and 7161 in Appendix A.

3.2.8 Hydraulic Modelling

Key elements of the drainage strategy set out above have been modelled to demonstrate the feasibility of the proposals, specifically the ability of the site to discharge by ground infiltration and to accommodate suitable basins, swales and ponds. Typical elements have been modelled as the final designs would be determined at detailed design stage in consideration of the final site layout and additional information.

Modelling of the drainage network has been undertaken using industry standard software, MicroDrainage WinDES. WinDES uses the Modified Rational Method to analyse pipe networks, soakaways and other drainage features, running a suite of design storms through the system to comprehensively test a network or SuDS feature.

Each element has been designed at a strategic level to meet a variety of requirements including flood risk, adoption and health and safety, with amenity and habitat features incorporated where feasible. SuDS have been hydraulically tested as groups to provide a total storage volume required for a specific catchment using the appropriate protection (e.g. 100 years plus 30% for climate change) for a range of rainfall events with storm durations varying between 15 minutes and 10 days. The SuDS for each catchment would be broken down into smaller components if necessary, capable of providing the required storage within the context of the masterplan. Typical details are shown on Drawing 7163 within Appendix A, and calculations provided within Appendix D. Details of the proposed SuDS features to drain each catchment are provided within Table 3.3.

Site investigation indicates that the site would be able to discharge predominantly via ground infiltration extensively using private soakaways and permeable paving. Despite this, in some locations it is likely that ground infiltration will not be practical or feasible and therefore SuDS features have been proposed and designed throughout the eco development to accommodate runoff from such areas. Additionally, to provide regular inflows which would encourage development of valuable marshy and wetland habitat, impermeable surfacing would be used at some locations to feed adjacent or nearby SuDS. Each SuDS feature therefore has a defined catchment based on topography, comprising an area of adjacent impermeable paving and a proportion of the remainder of the topographical catchment. The topographical catchment has been assumed to contribute runoff from 20% of its area to the SuDS feature. Considering that each catchment area comprises landscape and garden areas, as well as permeable paving, this contribution of 20% is considered to be closer to 50% of the remaining impermeable areas. The catchments are shown on Drawings 7160 and 7161 within Appendix A.

Catchment	SuDS Type	Storage Volume (m^3)
1	Dry swale, swale, pond, basin	250
2	Swale, pond, basin	245
3	Roadside swale	120
4	Swale, pond, basin	190
5	Site edge swale	165
6	Basin, pond	55 - 590[1]
7	Pond, wetland scrape	135
8	Wetland scrapes, online storage	175
9	Roadside swales, Village Street SuDS, wetland scrape, online storage	405

1. Regional control with limited direct paved area catchment, size will vary depending on flow passed forward from other SuDS features (i.e. if upstream SuDS infiltrate to ground, storage requirement is 55m^3)

Table 3.3 SuDS Feature Design Summary

Rainwater harvesting would provide storage within the system. However, this storage has not been included within calculations as a worst-case scenario has been assumed in which the rainwater harvesting tanks are already at capacity when rainfall events begin.

The surface water drainage strategy on Drawings 7060 and 7061 in Appendix A shows a network of SuDS designed to discharge via ground infiltration and to accommodate anticipated runoff from the site. Each has been designed using the typical infiltration rate encountered during site investigation of 56mm/hr, as set out in Section 2.3. Modelling results are provided within Appendix D for each component.

As a contingency for some areas having lower infiltration rates than encountered during the site investigation, or being impractical for the use of ground infiltration methods, the network and individual components have also been tested to indicate how the system could discharge at controlled rates to the watercourses. In this assessment flow control devices have been assumed to be used at local SuDS features to ensure that storage is provided throughout the site, with regional and local SuDS features close to the watercourses discharging to watercourses at a combined rate that does not exceed the allowed discharge rate determined in Section 3.2.2. Modelling results are provided within Appendix D.

Ground infiltration rates from onsite assessment (see Section 2.3) indicate that all areas of the site are suitable for ground infiltration methods, excepting the area of a proposed regional pond/basin feature within Catchment 6 (indicated on drawing 7160 within Appendix A). This location is likely to require a discharge to a watercourse.

4 FOUL WATER DRAINAGE STRATEGY

4.1 Principles

Waste (foul) water at the Exemplar Site would discharge to a manhole on the existing nearby Thames Water network for treatment within Bicester Sewage Treatment Works. A pumping station would be located on site to pump foul flows via a rising main up to the level of the connection point.

A significant reduction in discharges would be achieved through the implementation of water efficient measures, when compared to regular developments.

Due to the phased nature of the development, key elements of the foul drainage strategy, such as the pumping station, would need to be constructed at an early stage.

During future stages of the wider NW Bicester eco development, it may be possible and desirable to treat foul water on site. Foul water from the Exemplar site could be disconnected from the Thames Water network and redirected via the pumping station to a centrally located treatment plant, if this is found to be the most suitable option.

The foul water drainage strategy is shown on drawing 7162 within Appendix A.

4.2 Foul Loading

A breakdown of the types of property within the masterplan has been used to assess foul water discharges. Accommodation and non-residential building schedules have been provided within Appendix E. These figures were used to calculate the preliminary flow estimate based on the number of occupants for each dwelling, the number of end-users/floor plan area for non-residential property and typical usage rates provided by Thames Water (Thames Water Guidelines for Undertaking Sewerage Modelling (November 2005)). The peak foul water loading has been assessed based on the Thames Water rates as being 49l/s.

The Thames Water rates are conservative and actual discharges from site will be reduced by use of water efficient appliances, and potentially greywater recycling, which would offset potential increases due to retro-fitting of property with less efficient devices by home owners. The rates have been assessed and reduce the peak discharge to 28l/s.

4.3 Liaison with Thames Water

An extensive foul water network serves Bicester. Thames Water has advised that modifications to or extension of their network may be required to allow connection of the Exemplar Site and that further investigation by them would be necessary to identify the exact works required.

Thames Water have agreed (see correspondence in Appendix F) that the foul water connection could be conditioned on the understanding that discharge to the existing network would be feasible, subject to agreement of a set of works to be defined at detailed design stage.

5 CONCLUSION

A drainage strategy is set out that provides a framework for development of both foul and surface water management systems for the Exemplar Site and ensures that the requirements of level 5 of the Code for Sustainable Homes are achieved.

In summary:

- Ground conditions indicate an existing rainfall discharge mechanism based on ground infiltration, with low surface runoff rates (see Section 2);
- A SuDs network is proposed comprising shallow soakaways and ground infiltration features, mitigating flood risk, protecting the supply to local aquifers and providing valuable habitat and amenity areas (see Section 3);
- The eco development has potential to reduce the volumes of surface water discharged during large rainfall events to below predevelopment levels (see Section 3.2);
- Discharge to onsite watercourses may be required to allow for local conditions which may prohibit use of ground infiltration, and may be desirable to improve their flow regime and water quality (see Section 3.2);
- Peak discharges to watercourses would be reduced from 127.6 l/s to 40.1 l/s following development of the site during the 100 year rainfall event (including allowance for climate change) to mitigate against the potential for increased discharge volumes (see Section 3.2.2);
- The SuDS network proposed utilises permeable paving, swales, ponds and basins (see Sections 3.2.3 and 3.2.4);
- Online storage such as oversized pipes are not generally proposed but may be required as a final resort should some local areas not be feasible for locating open SuDS features due to additional constraints arising at detailed design stage;
- SuDS features have been designed to accommodate 100 year events, including a 30% allowance for climate change, and to discharge via ground infiltration alone, but have also been sized to allow for discharge to watercourses if required (see Section 3.2.8);
- Rainwater harvesting is proposed across the site, reducing discharges further (see Section 3.2.4);
- Treatment trains are proposed which provide appropriate treatment of runoff (see Section 3.2.6);
- Rainfall events beyond normal design consideration are likely to exceed the capacity of the SuDS network. The site will be developed to ensure that such flows are directed away from property onsite to safely discharge to watercourses;
- Foul water is to be discharged offsite through a piped system which connects to the local sewer network (see Section 4);
- A significant reduction in foul water discharge is to be achieved through the implementation of water efficient measures (see Section 4);
- The wider eco development offers the potential to redirect foul water arising from the Exemplar Site to a treatment area within the eco development, further reducing foul water discharges to the local sewer network and Bicester Treatment Works (see Section 4).

The widespread use of Sustainable Drainage Systems and rainwater harvesting would provide sustainable storm water management and create a sustainable resource from rainfall, whilst ensuring that flood risk is reduced for areas downstream and benefitting the local area. Ground infiltration would be used extensively throughout the Exemplar Site to ensure that discharge volumes to watercourses are kept to a minimum and that ground water resources continue to be recharged by the site, whilst attenuation features will ensure that discharge rates to watercourses are reduced during large rainfall events to far below existing rates, offsetting historical development within Bicester which would have increased surface water discharge rates to the local watercourses and consequently increased flood risk.

The use of SuDS would allow the creation of new wildlife spaces incorporating wetlands, ponds and a variety of vegetation, creating valuable open amenity areas whilst enhancing the local water environment.

The eco development would promote excellent water quality standards, enhancing the local environmental water quality where possible and improving the flow regime of the watercourses within the eco development. SuDS would be used to remove any polluted runoff from diffuse sources providing at source treatment prior to discharge into watercourses.

Appendix A

DRAWINGS

7006-UA001881 – Site Location & Boundary

7013-UA001881 – Exemplar Area

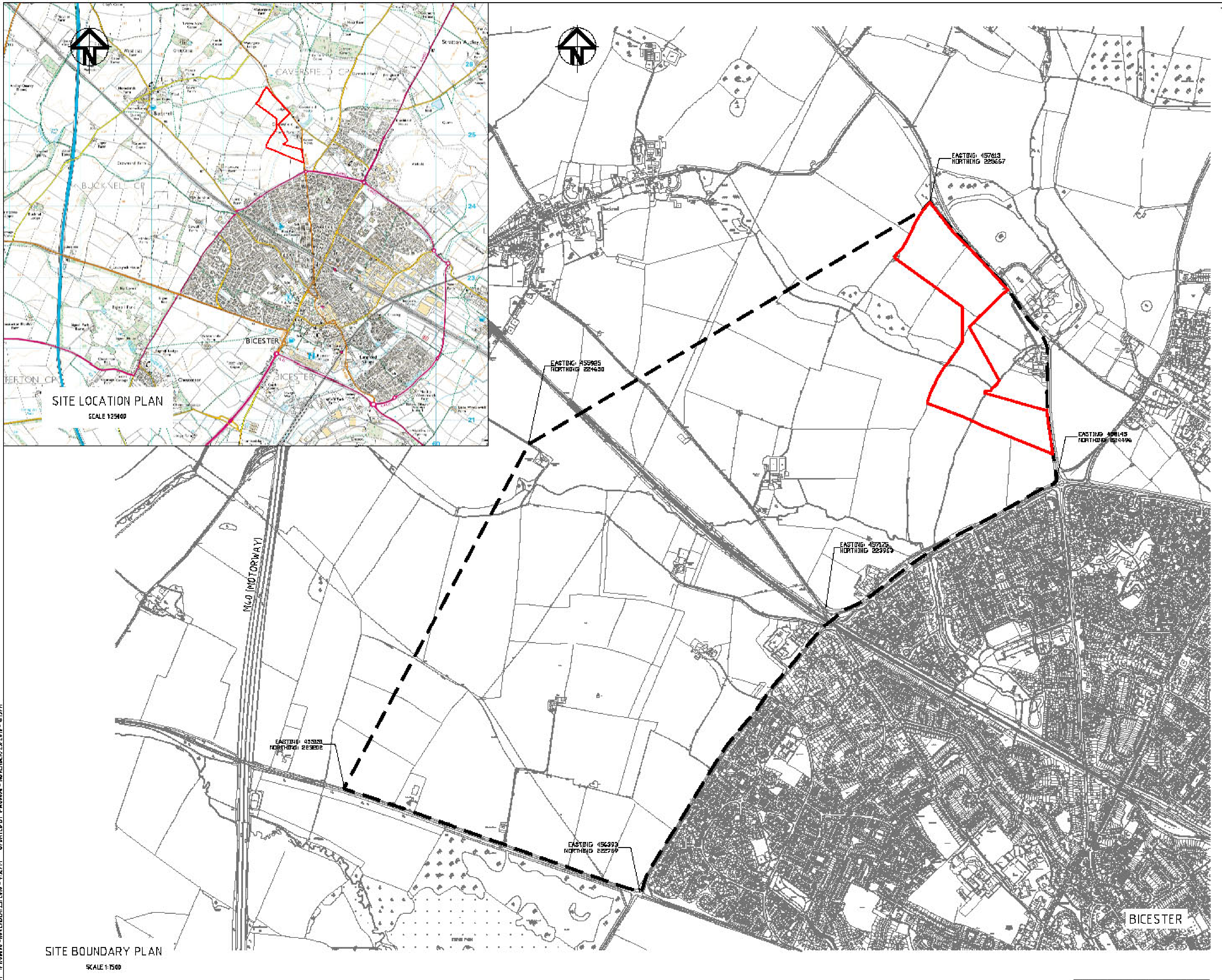
7019-UA001881 – Existing Water Features

7160–UA001881 – Surface Water Drainage Layout 1 of 2

7161–UA001881 – Surface Water Drainage Layout 2 of 2

7162–UA001881 – Foul Water Drainage Layout

7163-UA001881 – Drainage Details



KEY

ECO DEVELOPMENT BOUNDARY

EXEMPLAR SITE BOUNDARY

Issue	Description	Date
05	MINOR REVISIONS	24/11/10

Status

Scales	AS SHOWN	Author S. JONES
Original Size	A1	Checker D. BRAITHWAITE
Height Datum	-	Approver S.A. DAVIES
Grid	O.S.	© Copyright reserved

File: UA001881-UP210-05-SITE LOCATION PLAN (SERVICES CHECK).DWG

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Project

BICESTER
ECO DEVELOPMENT

Title

SITE LOCATION
AND BOUNDARY PLAN

Drawing No.	Project No.	Issue
7006	UA001881	05

CAD FILE : K:\UA001881_BicesterEco\E-OurDrawings\7006-UA001881-UP210-05-SITE LOCATION PLAN (SERVICES CHECK).dwg
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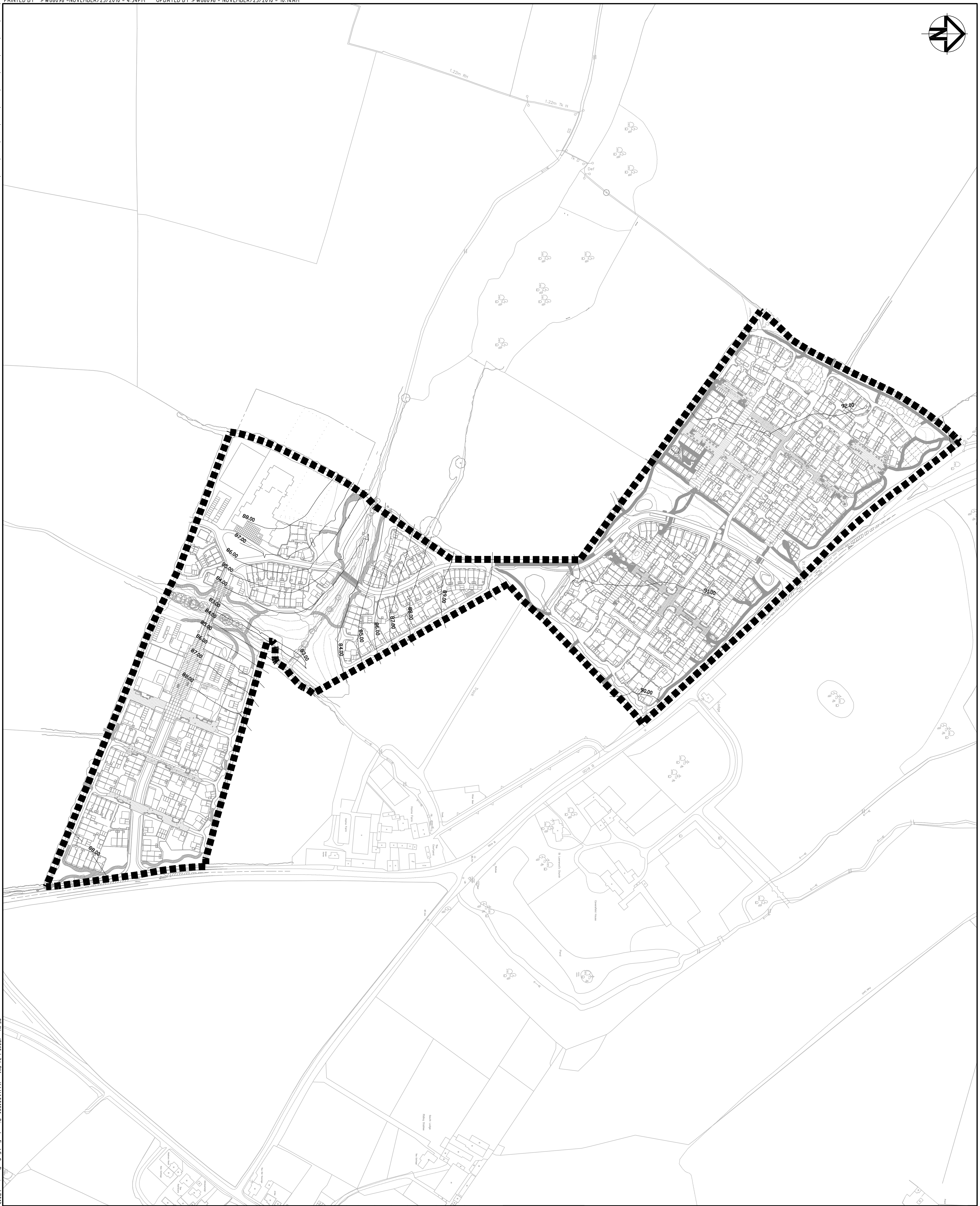

KEY

EXEMPLAR SITE BOUNDARY

NOTE:
HOUSING LAYOUT IS ILLUSTRATIVE ONLY

Issue	Description	Date
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Author: M.LLEWELLIN
Checker: M.PEARSON
Approver: S.A. DAVIES

Filename: 7013-UA001881-UP21D-06-EXEMPLAR PLAN AREA.DWG

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Project: BICESTER ECO DEVELOPMENT

Title: EXEMPLAR AREA

Drawing No: 7013 — Project No: UA001881 — Issue: 06

V1

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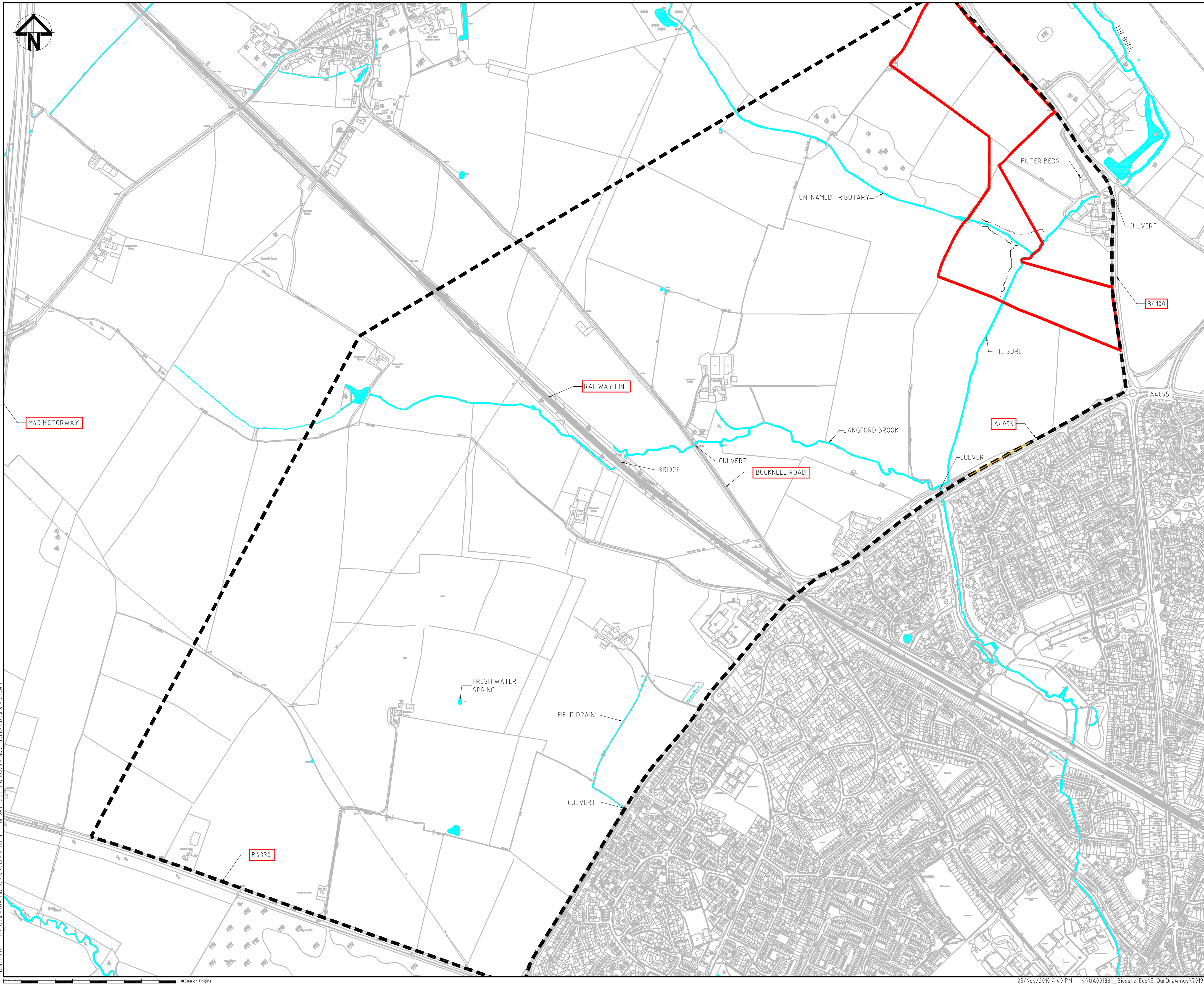

KEY

ECO DEVELOPMENT BOUNDARY

EXEMPLAR SITE BOUNDARY

Issue	Description	Date
02	MINOR REVISIONS	24/11/10

Status

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Title

EXISTING WATER FEATURES

Drawing No.	Project No.	Issue
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KEY

- SURFACE WATER PIPE RUN
- VILLAGE STREET SUDS FEATURE
- ROADSIDE SUDS FEATURE
- CATCHMENT BOUNDARIES
- PERMEABLE PAVING
- IMPERMEABLE PAVING
- PLOT SOAKAWAYS
- POND
- BASIN
- SWALE
- EXCEEDANCE FLOW PATHS
- MAINTENANCE ACCESS

Issue	Description	Date
02	LAYOUT REVISED	04/04/11
01	FIRST ISSUE	24/11/10

Status

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Original Size	A1	Checker M. PEARSON
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Title

EXEMPLAR SITE PROPOSED DEVELOPMENT SURFACE WATER DRAINAGE LAYOUT SHT 1 OF 2

Drawing No.		Project No.		Issue
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KEY

- SURFACE WATER PIPE RUN
- VILLAGE STREET SUDS FEATURE
- ROADSIDE SUDS FEATURE
- CATCHMENT BOUNDARIES
- PERMEABLE PAVING
- IMPERMEABLE PAVING
- PLOT SOAKAWAYS
- POND
- BASIN
- SWALE
- EXCEEDANCE FLOW PATHS
- MAINTENANCE ACCESS

Issue	Description	Date
02	LAYOUT REVISED	04/04/11
01	FIRST ISSUE	24/11/10

Status

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Title

EXEMPLAR SITE
PROPOSED DEVELOPMENT
SURFACE WATER
DRAINAGE LAYOUT SHT 2 OF 2

Drawing No.	Project No.	Issue
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KEY

- SITE BOUNDARY
- INDICATIVE ON-SITE FOUL WATER GRAVITY MAIN NETWORK
- INDICATIVE RISING MAIN TO CONNECT TO EXISTING FOUL SEWER NETWORK
- INDICATIVE LOCATION OF ON-SITE PUMPING STATION (LOCATION TO BE AGREED)

Issue	Description	Date
02	LAYOUT REVISED	04/04/11
01	FIRST ISSUE	25/11/10

Status

Scales	AS SHOWN	Author P. WILLIAMS
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Title

EXEMPLAR SITE
FOUL WATER
DRAINAGE

Drawing No.	Project No.	Issue
7162	UA001881	02

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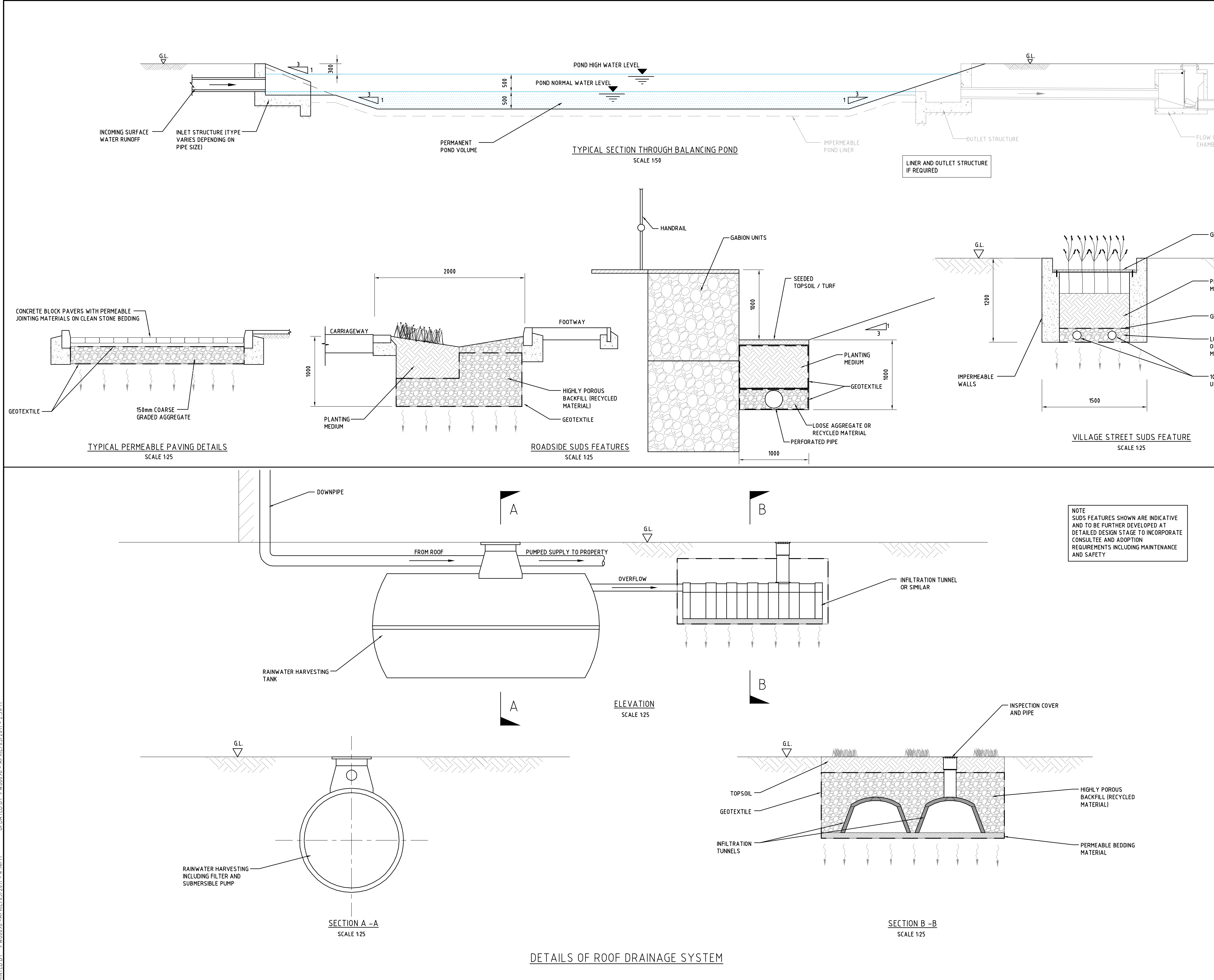

NOTE
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Issue	Description	Date
02	MINOR REVISIONS	04/04/11
01	FIRST ISSUE	25/11/10

Status

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Original Size	A1	Checker M. PEARSON
Height Datum	-	Approver S.A.DAVIES
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Title
EXEMPLAR SITE
TYPICAL DRAINAGE DETAILS

Drawing No.	Project No.	Issue
7163	UA001881	02

Appendix B

GROUND INFILTRATION RATES

2005-UA001881 – Soakaway Test Locations

Soil Infiltration Rate Test Data

KEY

(red line)	SITE BOUNDARY
SP1 / SA01	SOAKAWAY

Client: a2dominion — P3 Eco Ltd

Status	
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Height Datum	-
Grid	OS
Filename:	2005-UA001881-UP33D-01.DWG

Current Issue Signatures	
Author	P. WILLIAMS
Checker	M. PEARSON
Approver	S.A. DAVIES

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Project: BICESTER ECO DEVELOPMENT

Title: EXEMPLAR SITE SOAKAWAY TEST LOCATIONS

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Drawing No.	Project No.	Issue
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Issue	Description	Date
01	FIRST ISSUE	04/04/11

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V1

C.J. ASSOCIATES GEOTECHNICAL LTD.

SOIL INFILTRATION RATE TEST

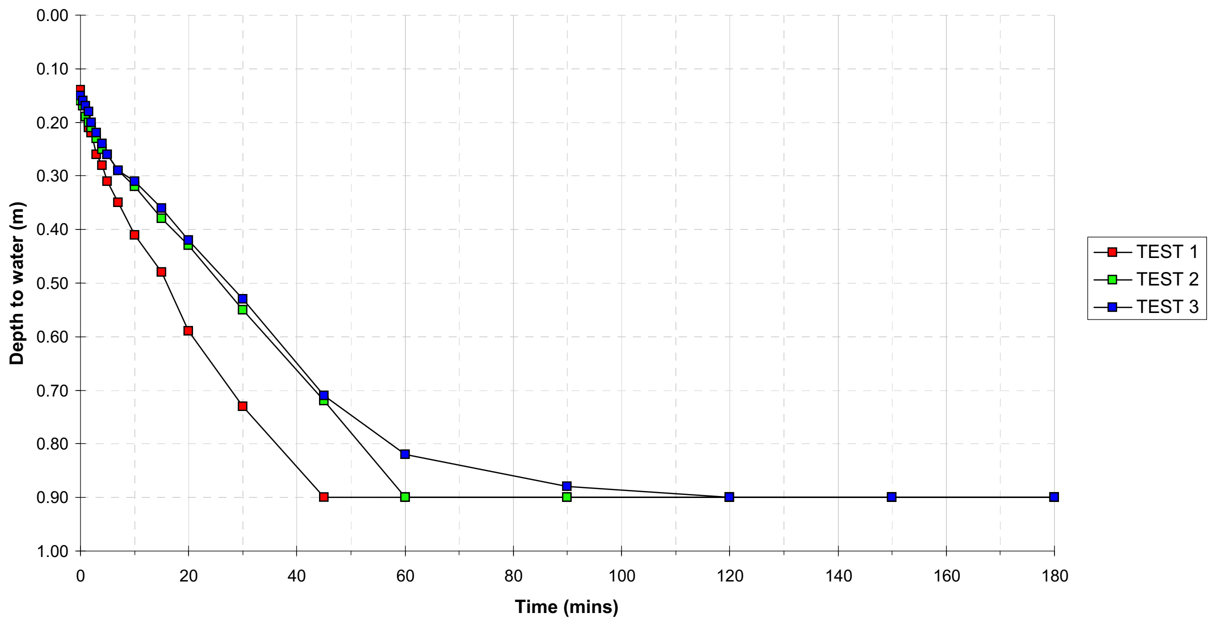
See B.R.E. Digest 365, 1991, Soakaway Design.

Site........ **Bicester**
Job Number........ **Y0964**
Date of Test........ 05.10.2010

Trial Pit Number........ **SP1**
Length........ 1.95 m
Width........ 0.30 m
Depth........ 0.90 m
Groundwater Level........ Dry

		TEST 1		TEST 2		TEST 3	
		Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
		0.0	0.14	0.0	0.16	0.0	0.15
		0.5	0.16	0.5	0.17	0.5	0.16
		1.0	0.19	1.0	0.19	1.0	0.17
		1.5	0.21	1.5	0.20	1.5	0.18
		2.0	0.22	2.0	0.21	2.0	0.20
		3.0	0.26	3.0	0.23	3.0	0.22
		4.0	0.28	4.0	0.25	4.0	0.24
		5.0	0.31	5.0	0.26	5.0	0.26
		7.0	0.35	7.0	0.29	7.0	0.29
		10	0.41	10	0.32	10	0.31
		15	0.48	15	0.38	15	0.36
		20	0.59	20	0.43	20	0.42
		30	0.73	30	0.55	30	0.53
		40	0.90	45	0.72	45	0.71
		60	0.90	58	0.90	60	0.82
		90	0.90	90	0.90	90	0.88
		120	0.90	110	0.90	95	0.90
		150	0.90	150	0.90	150	0.90
		180	0.90	180	0.90	165	0.90
Effective Storage Depth	m		0.76		0.74		0.75
75% Effective Storage Depth	m		0.57		0.56		0.56
(i.e. depth below GL)	m		0.33		0.35		0.34
25% Effective Storage Depth	m		0.19		0.19		0.19
(i.e. depth below GL)	m		0.71		0.72		0.71
Effective Storage Depth 75%-25%	m		0.38		0.37		0.38
Time to fall to 75% effective depth	mins		6.00		13.00		13.00
Time to fall to 25% effective depth	mins		28.00		45.00		45.00
V (75%-25%)	m3		0.22		0.22		0.22
a (50%)	m2		2.30		2.25		2.27
t (75%-25%)	mins		22.00		32.00		32.00
SOIL INFILTRATION RATE	m/s		**7.34E-05**		**5.01E-05**		**5.03E-05**

DESIGN SOIL INFILTRATION RATE, f **5.01E-05 m/s**



C.J. ASSOCIATES GEOTECHNICAL LTD.

SOIL INFILTRATION RATE TEST

See B.R.E. Digest 365, 1991, Soakaway Design.

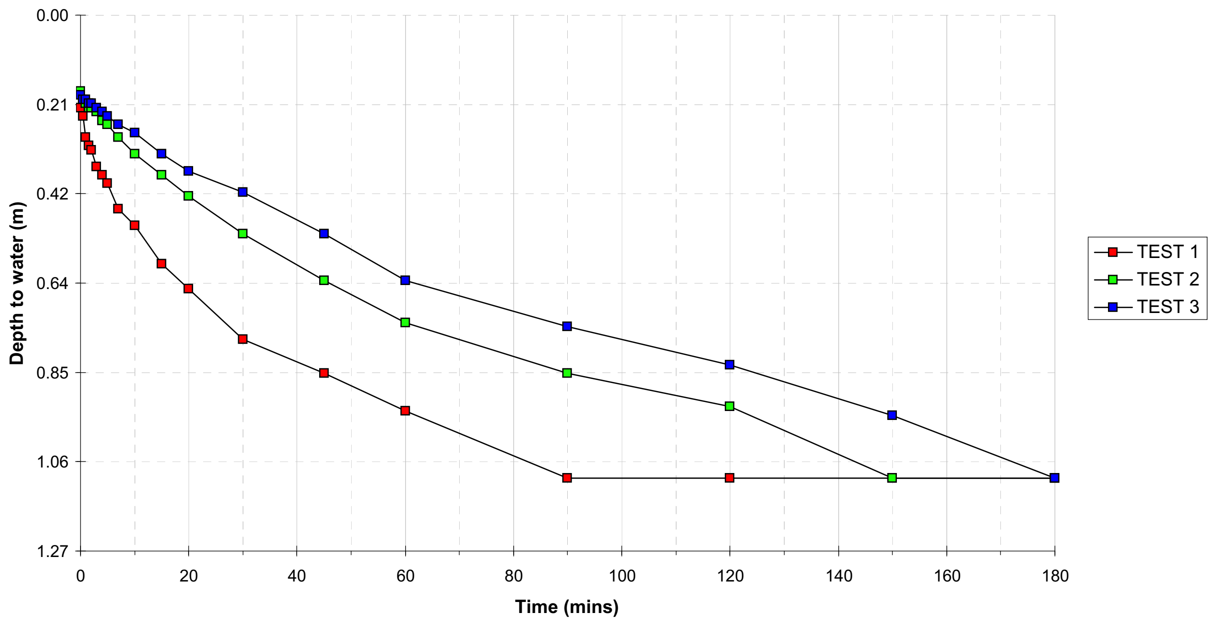
Site.................................... **Bicester**
Job Number........................ **Y0964**
Date of Test........................ 06.10.2010

Trial Pit Number............. **SP2**
Length............................. 1.50 m
Width............................... 0.30 m
Depth............................... 1.10 m
Groundwater Level......... Dry

	TEST 1		TEST 2		TEST 3	
	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
	0.0	0.22	0.0	0.18	0.0	0.19
	0.5	0.24	0.5	0.20	0.5	0.20
	1.0	0.29	1.0	0.21	1.0	0.20
	1.5	0.31	1.5	0.22	1.5	0.21
	2.0	0.32	2.0	0.22	2.0	0.21
	3.0	0.36	3.0	0.23	3.0	0.22
	4.0	0.38	4.0	0.25	4.0	0.23
	5.0	0.40	5.0	0.26	5.0	0.24
	7.0	0.46	7.0	0.29	7.0	0.26
	10	0.50	10	0.33	10	0.28
	15	0.59	15	0.38	15	0.33
	20	0.65	20	0.43	20	0.37
	30	0.77	30	0.52	30	0.42
	45	0.85	45	0.63	45	0.52
	60	0.94	58	0.73	60	0.63
	75	1.10	90	0.85	90	0.74
	120	1.10	120	0.93	120	0.83
	150	1.10	136	1.10	150	0.95
	180	1.10	180	1.10	178	1.10

		TEST 1	TEST 2	TEST 3
Effective Storage Depth	m	0.88	0.92	0.91
75% Effective Storage Depth	m	0.66	0.69	0.68
(i.e. depth below GL)	m	0.44	0.41	0.42
25% Effective Storage Depth	m	0.22	0.23	0.23
(i.e. depth below GL)	m	0.88	0.87	0.87
Effective Storage Depth 75%-25%	m	0.44	0.46	0.46
Time to fall to 75% effective depth	mins	6.50	18.00	30.00
Time to fall to 25% effective depth	mins	50.00	98.00	135.00
V (75%-25%)	m3	0.20	0.21	0.20
a (50%)	m2	2.03	2.11	2.09
t (75%-25%)	mins	43.50	80.00	105.00
SOIL INFILTRATION RATE	m/s	**3.73E-05**	**2.05E-05**	**1.56E-05**

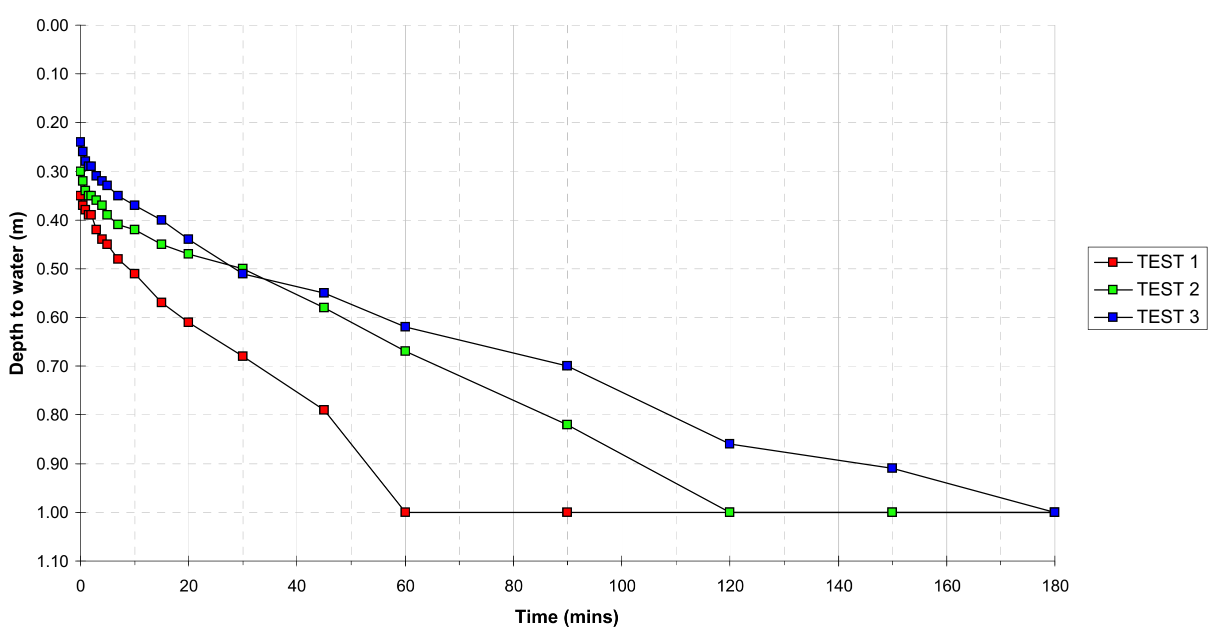
DESIGN SOIL INFILTRATION RATE, f **1.56E-05 m/s**



C.J. ASSOCIATES GEOTECHNICAL LTD. **SOIL INFILTRATION RATE TEST** See B.R.E. Digest 365, 1991, Soakaway Design.	Site.................................... **Bicester** Job Number........................ **Y0964** Date of Test........................ 05.10.2010	Trial Pit Number............. **SP3** Length............................ 2.10 m Width.............................. 0.30 m Depth.............................. 1.00 m Groundwater Level......... Dry

		TEST 1		TEST 2		TEST 3	
		Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
		0.0	0.35	0.0	0.30	0.0	0.24
		0.5	0.37	0.5	0.32	0.5	0.26
		1.0	0.38	1.0	0.34	1.0	0.28
		1.5	0.39	1.5	0.35	1.5	0.29
		2.0	0.39	2.0	0.35	2.0	0.29
		3.0	0.42	3.0	0.36	3.0	0.31
		4.0	0.44	4.0	0.37	4.0	0.32
		5.0	0.45	5.0	0.39	5.0	0.33
		7.0	0.48	7.0	0.41	7.0	0.35
		10	0.51	10	0.42	10	0.37
		15	0.57	15	0.45	15	0.40
		20	0.61	20	0.47	20	0.44
		30	0.68	30	0.50	30	0.51
		45	0.79	45	0.58	45	0.55
		55	1.00	60	0.67	60	0.62
		90	1.00	90	0.82	90	0.70
		120	1.00	110	1.00	120	0.86
		150	1.00	150	1.00	150	0.91
		180	1.00	180	1.00	165	1.00
Effective Storage Depth	m		0.65		0.70		0.76
75% Effective Storage Depth	m		0.49		0.53		0.57
(i.e. depth below GL)	m		0.51		0.48		0.43
25% Effective Storage Depth	m		0.16		0.18		0.19
(i.e. depth below GL)	m		0.84		0.83		0.81
Effective Storage Depth 75%-25%	m		0.33		0.35		0.38
Time to fall to 75% effective depth	mins		10.00		22.00		18.00
Time to fall to 25% effective depth	mins		50.00		92.00		110.00
V (75%-25%)	m3		0.20		0.22		0.24
a (50%)	m2		2.19		2.31		2.45
t (75%-25%)	mins		40.00		70.00		92.00
SOIL INFILTRATION RATE	m/s		**3.90E-05**		**2.27E-05**		**1.77E-05**

DESIGN SOIL INFILTRATION RATE, f **1.77E-05 m/s**



Appendix C

TREATMENT TRAIN ASSESSMENT

Water Source	Description	Train Description	SUDS Group	Technique	Treatment characteristics Total Suspended Solids	Heavy metals	Nutrients	Bacteria	Fines and disolved	Potential additional pretreatment
Building rooftops	Relatively clean, likely to contain some sediment, metals and organic matter	Roof to rainwater harvesting with overflow to soakaway discharging to ground	Source Control	Rainwater harvesting	M	L	L	L	-	
			Infiltration	Soakway	H	H	H	M	H	Leaf guards in guttering system
		Roof to rainwater harvesting with overflow to pipe network to swale discharging to ground	Source Control	Rainwater harvesting	M	L	L	L	-	
			Swale	Enhanced wet swale	H	H	M	H	H	Leaf guards in guttering system
Residential Roads and	Likely to contain grits,	Percolates surface, filters through substructure and infiltrates ground	Source Control	Permeable Pavement	H	H	H	H	H	
		Conveyed by channels to swale and discharging to ground	Swale	Enhanced wet swale	H	H	M	H	H	
Main Roads	Likely to contain grits, hydrocarbons and metals	Runs over edge of road and percolates through vegetated strip to ground below. In large rainfall events, runs through vegetation to infiltration trench beyond for storage and discharge to ground	Filtration	Bioretention/filter strips	H	H	H	M	H	

Appendix D

HYDRAULIC CALCULATIONS

7009-UA001881 – Domestic Soakaway

7010-UA001881 – Permeable Block Paving

7011-UA001881 – SuDS Storage Structures

7015-UA001881 – Surface Water Catchment Areas

7016-UA001881 – Greenfield Runoff Volumetric Calculation

Hyder Consulting	# CALCULATIONS	DOCUMENT No **7009-UA001881-UP21B-02**	
OFFICE **CARDIFF**		PROJECT TITLE **NW Bicester Eco Development**	
SUBJECT **Domestic Soakaway Sizing Calculation**			SHEET No 1 **OF 11**

ISSUE	TOTAL SHEETS	AUTHOR	DATE	CHECKED BY	DATE	APPROVED BY	DATE	COMMENTS
1	**4**	**MP**	**27/09/10**	**DCB**	**27/09/10**	**SAD**	**27/09/10**	
2	**11**	**DCB**	**25/11/10**	**MP**	**25/11/10**	**SAD**	**25/11/10**	
3								
4								
5								
SUPERSEDES DOC No								DATE

DESIGN BASIS STATEMENT (Inc. sources of info/data, assumptions made, standards, etc.)

Introduction

This calculation is intended to establish the size of a typical soakaway draining a residential property in order to establish the viability of providing domestic soakaways. Typical data for residential properties on the site has been used to establish indicative dimensions.
Design of the soakaway has been undertaken to suit Building Regulations Part H.
The soakaway has been assessed as a trench soakaway (2.4m x 2.4m in plan to a depth of 0.75m) using WinDES (an industry standard drainge design package produced by Microdrainage).

Assumptions
1) Contributing area from roof areas only (including garages)
2) Typical roof area = $90m^2$
3) Ground infitlration rates are assumed to be 180mm/hr for the north western area of the site and 64mm/hr for the south eastern area of the site
4) Design to accommodate 10 yr rainfall events with a variety of durations (required by Building Regs Part H)
5) Trench soakaway used, as defined by WinDES (void formed by a trench filled with gravel or similar porous material - for the purpose of this model porosity assumed as 60%)
6) Infiltration through all sides and base of trench
7) Factor of Safety of 2 applied to soakage rate
8) Inflow to soakaway is from rainwater harvesting tank overflow
9) Rainwater harvesting tank is full at start of rainfall event
10) Climate change factor of 30% applied to rainfall

Results
- North western area - 180 mm/hr infiltration
  - Maximum water depth - 493 mm (60 minute winter storm)
  - Half drain time - 66 minutes
- South eastern area - 64 mm/hr infiltration
  - Maximum water level - 682 mm (180 minute winter storm)
  - Half drain time - 212 minutes

Assessment of the domestic soakaway indicates that under both potential infiltration scenarios the maximum water level for the 1 in 10 year rainfall event would be contained within the soakaway.

The results also indicate that the half drain time of the system for both rates of infiltration is less than the maximum recommended 1440 minutes (24 hours).

Notes
A trench soakaway with 60% porosity is assumed to be representative of the soakaway proposals discussed within the drainage strategy report.
Approximate depth of impermeable stratum between 2.0 and 1.0m below ground level. Therefore soakaways should be kept less than 1m deep, and may not be suitable in areas where such stratum are shallowest.
The domestic trench soakaway has been initially sized such that a standard design may be used throughout the development, however soakaways could be designed to suit specific conditions for each location at detailed design stage.

Summary of Results for 10 year Return Period (+30%)

Half Drain Time : 66 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	9.584	0.334	0.2	1.2	O K
30 min Summer	9.650	0.400	0.2	1.4	O K
60 min Summer	9.679	0.429	0.2	1.5	O K
120 min Summer	9.674	0.424	0.2	1.5	O K
180 min Summer	9.654	0.404	0.2	1.4	O K
240 min Summer	9.630	0.380	0.2	1.3	O K
360 min Summer	9.584	0.334	0.2	1.2	O K
480 min Summer	9.542	0.292	0.2	1.0	O K
600 min Summer	9.505	0.255	0.2	0.9	O K
720 min Summer	9.472	0.222	0.2	0.8	O K
960 min Summer	9.418	0.168	0.2	0.6	O K
1440 min Summer	9.344	0.094	0.2	0.3	O K
2160 min Summer	9.298	0.048	0.2	0.2	O K
2880 min Summer	9.289	0.039	0.1	0.1	O K
4320 min Summer	9.279	0.029	0.1	0.1	O K
5760 min Summer	9.273	0.023	0.1	0.1	O K
7200 min Summer	9.270	0.020	0.1	0.1	O K
8640 min Summer	9.267	0.017	0.1	0.1	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	77.919	17
30 min Summer	50.334	31
60 min Summer	31.203	52
120 min Summer	18.861	86
180 min Summer	13.939	120
240 min Summer	11.215	154
360 min Summer	8.240	222
480 min Summer	6.617	288
600 min Summer	5.579	350
720 min Summer	4.852	412
960 min Summer	3.890	532
1440 min Summer	2.848	766
2160 min Summer	2.083	1100
2880 min Summer	1.668	1468
4320 min Summer	1.219	2164
5760 min Summer	0.976	2888
7200 min Summer	0.821	3664
8640 min Summer	0.712	4400

Summary of Results for 10 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Summer	9.265	0.015	0.0	0.1	O K
15 min Winter	9.628	0.378	0.2	1.3	O K
30 min Winter	9.706	0.456	0.3	1.6	O K
60 min Winter	9.743	0.493	0.3	1.7	O K
120 min Winter	9.734	0.484	0.3	1.7	O K
180 min Winter	9.702	0.452	0.3	1.6	O K
240 min Winter	9.666	0.416	0.2	1.4	O K
360 min Winter	9.596	0.346	0.2	1.2	O K
480 min Winter	9.535	0.285	0.2	1.0	O K
600 min Winter	9.483	0.233	0.2	0.8	O K
720 min Winter	9.438	0.188	0.2	0.6	O K
960 min Winter	9.367	0.117	0.2	0.4	O K
1440 min Winter	9.298	0.048	0.2	0.2	O K
2160 min Winter	9.285	0.035	0.1	0.1	O K
2880 min Winter	9.278	0.028	0.1	0.1	O K
4320 min Winter	9.271	0.021	0.1	0.1	O K
5760 min Winter	9.267	0.017	0.1	0.1	O K
7200 min Winter	9.264	0.014	0.0	0.0	O K
8640 min Winter	9.262	0.012	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
10080 min Summer	0.632	5120
15 min Winter	77.919	17
30 min Winter	50.334	31
60 min Winter	31.203	58
120 min Winter	18.861	92
180 min Winter	13.939	130
240 min Winter	11.215	166
360 min Winter	8.240	236
480 min Winter	6.617	304
600 min Winter	5.579	368
720 min Winter	4.852	432
960 min Winter	3.890	550
1440 min Winter	2.848	736
2160 min Winter	2.083	1104
2880 min Winter	1.668	1472
4320 min Winter	1.219	2200
5760 min Winter	0.976	2864
7200 min Winter	0.821	3592
8640 min Winter	0.712	4264

Summary of Results for 10 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Winter	9.261	0.011	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
10080 min Winter	0.632	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.009

Time (mins)	**Area (ha)**
0-4	0.009

Model Details

Storage is Online Cover Level (m) 10.000

Trench Soakaway Structure

Infiltration Coefficient Base (m/hr)	0.18000	Trench Width (m)	2.4
Infiltration Coefficient Side (m/hr)	0.18000	Trench Length (m)	2.4
Safety Factor	2.0	Slope (1:X)	10000.0
Porosity	0.60	Cap Volume Depth (m)	0.000
Invert Level (m)	9.250	Cap Infiltration Depth (m)	0.000

Summary of Results for 10 year Return Period (+30%)

Half Drain Time : 212 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	9.613	0.363	0.1	1.3	O K
30 min Summer	9.706	0.456	0.1	1.6	O K
60 min Summer	9.786	0.536	0.1	1.9	O K
120 min Summer	9.836	0.586	0.1	2.0	O K
180 min Summer	9.843	0.593	0.1	2.0	O K
240 min Summer	9.841	0.591	0.1	2.0	O K
360 min Summer	9.828	0.578	0.1	2.0	O K
480 min Summer	9.809	0.559	0.1	1.9	O K
600 min Summer	9.790	0.540	0.1	1.9	O K
720 min Summer	9.770	0.520	0.1	1.8	O K
960 min Summer	9.732	0.482	0.1	1.7	O K
1440 min Summer	9.664	0.414	0.1	1.4	O K
2160 min Summer	9.579	0.329	0.1	1.1	O K
2880 min Summer	9.510	0.260	0.1	0.9	O K
4320 min Summer	9.411	0.161	0.1	0.6	O K
5760 min Summer	9.347	0.097	0.1	0.3	O K
7200 min Summer	9.310	0.060	0.1	0.2	O K
8640 min Summer	9.297	0.047	0.1	0.2	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	77.919	18
30 min Summer	50.334	33
60 min Summer	31.203	62
120 min Summer	18.861	120
180 min Summer	13.939	158
240 min Summer	11.215	190
360 min Summer	8.240	254
480 min Summer	6.617	324
600 min Summer	5.579	394
720 min Summer	4.852	462
960 min Summer	3.890	598
1440 min Summer	2.848	866
2160 min Summer	2.083	1252
2880 min Summer	1.668	1616
4320 min Summer	1.219	2336
5760 min Summer	0.976	3048
7200 min Summer	0.821	3680
8640 min Summer	0.712	4400

Summary of Results for 10 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Summer	9.292	0.042	0.0	0.1	O K
15 min Winter	9.658	0.408	0.1	1.4	O K
30 min Winter	9.764	0.514	0.1	1.8	O K
60 min Winter	9.857	0.607	0.1	2.1	O K
120 min Winter	9.921	0.671	0.1	2.3	O K
180 min Winter	9.932	0.682	0.1	2.4	O K
240 min Winter	9.927	0.677	0.1	2.3	O K
360 min Winter	9.910	0.660	0.1	2.3	O K
480 min Winter	9.884	0.634	0.1	2.2	O K
600 min Winter	9.855	0.605	0.1	2.1	O K
720 min Winter	9.825	0.575	0.1	2.0	O K
960 min Winter	9.768	0.518	0.1	1.8	O K
1440 min Winter	9.668	0.418	0.1	1.4	O K
2160 min Winter	9.549	0.299	0.1	1.0	O K
2880 min Winter	9.458	0.208	0.1	0.7	O K
4320 min Winter	9.338	0.088	0.1	0.3	O K
5760 min Winter	9.297	0.047	0.1	0.2	O K
7200 min Winter	9.289	0.039	0.0	0.1	O K
8640 min Winter	9.284	0.034	0.0	0.1	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
10080 min Summer	0.632	5136
15 min Winter	77.919	18
30 min Winter	50.334	32
60 min Winter	31.203	60
120 min Winter	18.861	118
180 min Winter	13.939	172
240 min Winter	11.215	198
360 min Winter	8.240	272
480 min Winter	6.617	350
600 min Winter	5.579	426
720 min Winter	4.852	500
960 min Winter	3.890	644
1440 min Winter	2.848	922
2160 min Winter	2.083	1316
2880 min Winter	1.668	1696
4320 min Winter	1.219	2376
5760 min Winter	0.976	2904
7200 min Winter	0.821	3672
8640 min Winter	0.712	4408

Summary of Results for 10 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Winter	9.280	0.030	0.0	0.1	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
10080 min Winter	0.632	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.009

Time (mins)	**Area (ha)**
0-4	0.009

Model Details

Storage is Online Cover Level (m) 10.000

Trench Soakaway Structure

Infiltration Coefficient Base (m/hr)	0.06400	Trench Width (m)	2.4
Infiltration Coefficient Side (m/hr)	0.06400	Trench Length (m)	2.4
Safety Factor	2.0	Slope (1:X)	10000.0
Porosity	0.60	Cap Volume Depth (m)	0.000
Invert Level (m)	9.250	Cap Infiltration Depth (m)	0.000

Hyder Consulting	CALCULATIONS	DOCUMENT No **7010-UA001881-UP21B-02**

OFFICE	PROJECT TITLE
CARDIFF	**NW Bicester Eco Development**

SUBJECT	SHEET No
Permeable Block-Paving Design Calculation	1 **OF 11**

ISSUE	TOTAL SHEETS	AUTHOR	DATE	CHECKED BY	DATE	APPROVED BY	DATE	COMMENTS
1	**2**	**MP**	**27/09/10**	**DCB**	**27/09/10**	**SAD**	**27/09/10**	
2	**11**	**DCB**	**25/11/10**	**MP**	**25/11/10**	**SAD**	**25/11/10**	
3								
4								
5								

SUPERSEDES DOC No	DATE

DESIGN BASIS STATEMENT (Inc. sources of info/data, assumptions made, standards, etc.)

Introduction

This calculation is intended to establish the dimensions of a typical area of self-draining permeable pavement forming residential roads. The Interpave design guide (Guide to the Design, Construction and Maintenance of Concrete Block Permeable Pavements, Edition 6, Jan 2010, Interpave) has been used to define a suitable system which has then been tested, using WinDES (an industry standard drainge design package produced by Microdrainage) utilising the Modified Rational Method, to establish the system capacity during rainfall events.

Assumptions

1) Assessed for typical area of 6x20m paving (120m^2) with no additional runoff from surrounding areas
2) Base slope falling with approximate typical land profile of 1 in 200
3) Ground infitlration rates are assumed to be 180mm/hr for the north western area of the site and 64mm/hr for the south eastern area of the site
4) Tested to accommodate 100 year rainfall events with a range of durations
5) Tested as Permeable Paving as defined by WinDES (Layer of block paving above a gravel/sand layer of 30% porosity)
6) Infiltration through base of paving only
7) Factor of Safety of 2 applied to soakage rate
8) Climate change factor of 30% applied to rainfall
9) No evaporation or depression storage allowed for (conservative)

Design (using Interpave design guide)

Assuming discharge by infiltration only and usage Category 4 (ref Table 7, approx 10 large goods vehicles per week), Figure 23 indicates a suitable profile would be 80mm block paviors on a 50mm bedding layer, with 150mm of hydraulically bound coarse graded aggregate and a further 150mm of course graded aggregate beneath, giving a total system depth of 430mm.

Testing Results (using WinDES)

- North western area - 180mm/hr infiltration
  - Maximum water depth - 87mm
  - Half drain time - 4 minutes
  - Approximate surplus storage depth - 213mm (25m3)

- South eastern area - 64 mm/hr infiltration
  - Maximum water depth - 125mm
  - Half drain time - 23 minutes
  - Approximate surplus storage depth - 175mm (20m3)

Notes

Assessment of the permeable paving indicates that under both potential infiltration scenarios the maximum water level would not exceed 300mm, and would be contained within the aggregate under the paving.
The results also indicate that the half drain time of the system for both rates of infiltration is less than the maximum recommended 1440 minutes (24 hours).
Impermeable strata are anticipated at depths between 1 and 2m below ground level, therefore impermeable paving could be viable for use on site in all areas.

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 4 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.082	0.082	3.0	1.2	O K
30 min Summer	0.080	0.080	3.0	1.1	O K
60 min Summer	0.065	0.065	3.0	0.8	O K
120 min Summer	0.045	0.045	2.7	0.4	O K
180 min Summer	0.036	0.036	2.1	0.2	O K
240 min Summer	0.030	0.030	1.8	0.2	O K
360 min Summer	0.026	0.026	1.3	0.1	O K
480 min Summer	0.023	0.023	1.1	0.1	O K
600 min Summer	0.021	0.021	0.9	0.1	O K
720 min Summer	0.020	0.020	0.8	0.1	O K
960 min Summer	0.018	0.018	0.6	0.1	O K
1440 min Summer	0.015	0.015	0.5	0.0	O K
2160 min Summer	0.013	0.013	0.3	0.0	O K
2880 min Summer	0.012	0.012	0.3	0.0	O K
4320 min Summer	0.010	0.010	0.2	0.0	O K
5760 min Summer	0.009	0.009	0.2	0.0	O K
7200 min Summer	0.008	0.008	0.1	0.0	O K
8640 min Summer	0.008	0.008	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	12
30 min Summer	84.226	21
60 min Summer	52.662	36
120 min Summer	31.800	64
180 min Summer	23.353	94
240 min Summer	18.644	124
360 min Summer	13.543	184
480 min Summer	10.792	242
600 min Summer	9.043	302
720 min Summer	7.823	362
960 min Summer	6.219	480
1440 min Summer	4.493	734
2160 min Summer	3.241	1076
2880 min Summer	2.568	1468
4320 min Summer	1.847	2200
5760 min Summer	1.461	2904
7200 min Summer	1.217	3584
8640 min Summer	1.048	4376

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Summer	0.007	0.007	0.1	0.0	O K
15 min Winter	0.087	0.087	3.0	1.4	O K
30 min Winter	0.081	0.081	3.0	1.2	O K
60 min Winter	0.057	0.057	3.0	0.6	O K
120 min Winter	0.036	0.036	2.2	0.2	O K
180 min Winter	0.029	0.029	1.7	0.1	O K
240 min Winter	0.026	0.026	1.3	0.1	O K
360 min Winter	0.022	0.022	0.9	0.1	O K
480 min Winter	0.020	0.020	0.8	0.1	O K
600 min Winter	0.018	0.018	0.7	0.1	O K
720 min Winter	0.017	0.017	0.6	0.1	O K
960 min Winter	0.015	0.015	0.5	0.0	O K
1440 min Winter	0.013	0.013	0.3	0.0	O K
2160 min Winter	0.011	0.011	0.2	0.0	O K
2880 min Winter	0.010	0.010	0.2	0.0	O K
4320 min Winter	0.008	0.008	0.1	0.0	O K
5760 min Winter	0.008	0.008	0.1	0.0	O K
7200 min Winter	0.007	0.007	0.1	0.0	O K
8640 min Winter	0.006	0.006	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
10080 min Summer	0.923	4976
15 min Winter	128.285	13
30 min Winter	84.226	22
60 min Winter	52.662	36
120 min Winter	31.800	64
180 min Winter	23.353	92
240 min Winter	18.644	126
360 min Winter	13.543	188
480 min Winter	10.792	242
600 min Winter	9.043	302
720 min Winter	7.823	358
960 min Winter	6.219	484
1440 min Winter	4.493	728
2160 min Winter	3.241	1064
2880 min Winter	2.568	1360
4320 min Winter	1.847	2200
5760 min Winter	1.461	2776
7200 min Winter	1.217	3640
8640 min Winter	1.048	4336

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Winter	0.006	0.006	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
10080 min Winter	0.923	4880

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.012

Time (mins)	**Area (ha)**
0-4	0.012

Model Details

Storage is Online Cover Level (m) 0.430

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.18000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	20.0
Max Percolation (l/s)	33.3	Slope (1:X)	200.0
Safety Factor	2.0	Depression Storage (mm)	0
Porosity	0.30	Evaporation (mm/day)	0
Invert Level (m)	0.000	Cap Volume Depth (m)	0.000

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 23 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.108	0.108	1.1	2.1	O K
30 min Summer	0.114	0.114	1.1	2.3	O K
60 min Summer	0.113	0.113	1.1	2.3	O K
120 min Summer	0.101	0.101	1.1	1.8	O K
180 min Summer	0.089	0.089	1.1	1.4	O K
240 min Summer	0.076	0.076	1.1	1.0	O K
360 min Summer	0.055	0.055	1.1	0.5	O K
480 min Summer	0.045	0.045	1.0	0.4	O K
600 min Summer	0.039	0.039	0.8	0.3	O K
720 min Summer	0.035	0.035	0.7	0.2	O K
960 min Summer	0.029	0.029	0.6	0.2	O K
1440 min Summer	0.025	0.025	0.5	0.1	O K
2160 min Summer	0.021	0.021	0.3	0.1	O K
2880 min Summer	0.019	0.019	0.3	0.1	O K
4320 min Summer	0.016	0.016	0.2	0.0	O K
5760 min Summer	0.014	0.014	0.1	0.0	O K
7200 min Summer	0.013	0.013	0.1	0.0	O K
8640 min Summer	0.012	0.012	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	16
30 min Summer	84.226	25
60 min Summer	52.662	42
120 min Summer	31.800	76
180 min Summer	23.353	108
240 min Summer	18.644	138
360 min Summer	13.543	192
480 min Summer	10.792	250
600 min Summer	9.043	308
720 min Summer	7.823	368
960 min Summer	6.219	488
1440 min Summer	4.493	728
2160 min Summer	3.241	1080
2880 min Summer	2.568	1448
4320 min Summer	1.847	2192
5760 min Summer	1.461	2912
7200 min Summer	1.217	3560
8640 min Summer	1.048	4296

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Summer	0.012	0.012	0.1	0.0	O K
15 min Winter	0.117	0.117	1.1	2.4	O K
30 min Winter	0.125	0.125	1.1	2.7	O K
60 min Winter	0.121	0.121	1.1	2.6	O K
120 min Winter	0.103	0.103	1.1	1.9	O K
180 min Winter	0.083	0.083	1.1	1.2	O K
240 min Winter	0.063	0.063	1.1	0.7	O K
360 min Winter	0.043	0.043	0.9	0.3	O K
480 min Winter	0.035	0.035	0.8	0.2	O K
600 min Winter	0.030	0.030	0.6	0.2	O K
720 min Winter	0.028	0.028	0.6	0.1	O K
960 min Winter	0.025	0.025	0.5	0.1	O K
1440 min Winter	0.021	0.021	0.3	0.1	O K
2160 min Winter	0.018	0.018	0.2	0.1	O K
2880 min Winter	0.016	0.016	0.2	0.0	O K
4320 min Winter	0.014	0.014	0.1	0.0	O K
5760 min Winter	0.012	0.012	0.1	0.0	O K
7200 min Winter	0.011	0.011	0.1	0.0	O K
8640 min Winter	0.010	0.010	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
10080 min Summer	0.923	4992
15 min Winter	128.285	16
30 min Winter	84.226	28
60 min Winter	52.662	46
120 min Winter	31.800	82
180 min Winter	23.353	114
240 min Winter	18.644	140
360 min Winter	13.543	192
480 min Winter	10.792	250
600 min Winter	9.043	308
720 min Winter	7.823	368
960 min Winter	6.219	488
1440 min Winter	4.493	734
2160 min Winter	3.241	1116
2880 min Winter	2.568	1476
4320 min Winter	1.847	2152
5760 min Winter	1.461	2904
7200 min Winter	1.217	3808
8640 min Winter	1.048	4392

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
10080 min Winter	0.010	0.010	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
10080 min Winter	0.923	4992

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.012

Time (mins)	**Area (ha)**
0-4	0.012

Model Details

Storage is Online Cover Level (m) 0.430

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.06400	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	20.0
Max Percolation (l/s)	33.3	Slope (1:X)	200.0
Safety Factor	2.0	Depression Storage (mm)	0
Porosity	0.30	Evaporation (mm/day)	0
Invert Level (m)	0.000	Cap Volume Depth (m)	0.000

Hyder Consulting	CALCULATIONS	DOCUMENT No **7011-UA001881-UP21B-02**

OFFICE	PROJECT TITLE
CARDIFF	**NW Bicester Eco Development**

SUBJECT	SHEET No
Exemplar Site - SUDS Storage Structure Design Calculation	1 **OF 37**

ISSUE	TOTAL SHEETS	AUTHOR	DATE	CHECKED BY	DATE	APPROVED BY	DATE	COMMENTS
1	**25**	**DCB**	**25/11/10**	**MP**	**25/11/10**	**SAD**	**25/11/10**	
2	**25**	**MP**	**05/04/11**	**DCB**	**05/04/11**	**SAD**	**05/04/11**	
3								
4								
5								

SUPERSEDES DOC No	DATE

DESIGN BASIS STATEMENT (Inc. sources of info/data, assumptions made, standards, etc.)

Introduction

This calculation has been prepared to assess the sizes of SUDS infiltration features throughout the site. Features have also been assessed with a restricted discharge to simulate worst case scenarion of discharge to watercourse at existing greenfield rates.

Each basin has been assessed using WinDES (an industry standard drainge design package produced by Microdrainage).

Assumptions

1) Contributing area as per calculation 7015
2) Design to accommodate 100 year rainfall events with a variety of durations in accordance with EA requirements
3) Climate change factor of 30% applied to rainfall
4) Existing greenfield runoff rate calculated as 40 l/s (Ref. Report 3501-UA001881 Flood Risk Assessment - Exemplar Site)
5) In 'no infiltration' worst case scenario SuDS catchments 1,2,3,4 and 5 discharge to catchment 6.
6) In 'no infiltration' worst case scenario SuDS catchment 6 discharges to catchment 7.
7) In 'no infiltration' worst case scenario SuDS catchments 7, 8 and 9 discharge to the watercourse.

Results

A caclulation titled 'infiltration' is for a SuDS feature tested for discharge by infitlration alone.
A caclulation titled 'no infiltration' is for a SuDS feature tested for discharge to watercourse.

Catchment	Storage volume (m^3)	Discharge rate in 'no infiltration' scenario
1	250	5
2	245	5
3	120	5
4	190	5
5	165	5
6	55	15
7	135	20
8	175	10
9	405	10

Combined discharge to watercourse = 20 + 10 + 10 = 40 l/s

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 458 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	91.238	0.438	0.0	4.9	4.9	114.5	O K
30 min Summer	91.305	0.505	0.0	4.9	4.9	148.7	O K
60 min Summer	91.362	0.562	0.0	4.9	4.9	180.8	O K
120 min Summer	91.404	0.604	0.0	4.9	4.9	206.4	O K
180 min Summer	91.418	0.618	0.0	4.9	4.9	215.1	O K
240 min Summer	91.421	0.621	0.0	4.9	4.9	216.7	O K
360 min Summer	91.413	0.613	0.0	4.9	4.9	212.0	O K
480 min Summer	91.402	0.602	0.0	4.9	4.9	205.1	O K
600 min Summer	91.392	0.592	0.0	4.9	4.9	198.4	O K
720 min Summer	91.381	0.581	0.0	4.9	4.9	192.1	O K
960 min Summer	91.362	0.562	0.0	4.9	4.9	180.4	O K
1440 min Summer	91.323	0.523	0.0	4.9	4.9	158.6	O K
2160 min Summer	91.265	0.465	0.0	4.9	4.9	128.0	O K
2880 min Summer	91.206	0.406	0.0	4.9	4.9	99.8	O K
4320 min Summer	91.089	0.289	0.0	4.9	4.9	53.6	O K
5760 min Summer	91.004	0.204	0.0	4.9	4.9	27.7	O K
7200 min Summer	90.958	0.158	0.0	4.6	4.6	16.4	O K
8640 min Summer	90.935	0.135	0.0	4.2	4.2	11.6	O K
10080 min Summer	90.919	0.119	0.0	3.7	3.7	8.8	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	25
30 min Summer	84.226	40
60 min Summer	52.662	68
120 min Summer	31.800	126
180 min Summer	23.353	186
240 min Summer	18.644	244
360 min Summer	13.543	354
480 min Summer	10.792	408
600 min Summer	9.043	468
720 min Summer	7.823	530
960 min Summer	6.219	666
1440 min Summer	4.493	940
2160 min Summer	3.241	1344
2880 min Summer	2.568	1728
4320 min Summer	1.847	2420
5760 min Summer	1.461	3056
7200 min Summer	1.217	3680
8640 min Summer	1.048	4408
10080 min Summer	0.923	5136

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	91.267	0.467	0.0	4.9	4.9	128.9	O K
30 min Winter	91.340	0.540	0.0	4.9	4.9	167.7	O K
60 min Winter	91.402	0.602	0.0	4.9	4.9	204.6	O K
120 min Winter	91.449	0.649	0.0	4.9	4.9	235.4	O K
180 min Winter	91.467	0.667	0.0	4.9	4.9	247.2	O K
240 min Winter	91.472	0.672	0.0	4.9	4.9	250.9	O K
360 min Winter	91.470	0.670	0.0	4.9	4.9	249.1	O K
480 min Winter	91.459	0.659	0.0	4.9	4.9	241.9	O K
600 min Winter	91.445	0.645	0.0	4.9	4.9	232.6	O K
720 min Winter	91.433	0.633	0.0	4.9	4.9	224.7	O K
960 min Winter	91.408	0.608	0.0	4.9	4.9	208.6	O K
1440 min Winter	91.355	0.555	0.0	4.9	4.9	176.5	O K
2160 min Winter	91.269	0.469	0.0	4.9	4.9	129.9	O K
2880 min Winter	91.175	0.375	0.0	4.9	4.9	86.2	O K
4320 min Winter	91.001	0.201	0.0	4.9	4.9	27.0	O K
5760 min Winter	90.938	0.138	0.0	4.2	4.2	12.2	O K
7200 min Winter	90.914	0.114	0.0	3.6	3.6	8.1	O K
8640 min Winter	90.900	0.100	0.0	3.1	3.1	6.0	O K
10080 min Winter	90.890	0.090	0.0	2.7	2.7	4.8	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	25
30 min Winter	84.226	39
60 min Winter	52.662	68
120 min Winter	31.800	124
180 min Winter	23.353	182
240 min Winter	18.644	238
360 min Winter	13.543	350
480 min Winter	10.792	456
600 min Winter	9.043	498
720 min Winter	7.823	568
960 min Winter	6.219	720
1440 min Winter	4.493	1022
2160 min Winter	3.241	1448
2880 min Winter	2.568	1820
4320 min Winter	1.847	2384
5760 min Winter	1.461	2992
7200 min Winter	1.217	3680
8640 min Winter	1.048	4400
10080 min Winter	0.923	5120

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.500

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.125	4-8	0.250	8-12	0.125

Model Details

Storage is Online Cover Level (m) 91.800

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	150.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	90.800	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Hydro-Brake® Outflow Control

Design Head (m)	0.700	Diameter (mm)	101
Design Flow (l/s)	5.0	Invert Level (m)	90.800
Hydro-Brake® Type	Md6 SW Only		

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	1.200	6.4	3.000	10.1	7.000	15.4
0.200	4.9	1.400	6.9	3.500	10.9	7.500	15.9
0.300	4.7	1.600	7.4	4.000	11.6	8.000	16.5
0.400	4.5	1.800	7.8	4.500	12.3	8.500	17.0
0.500	4.5	2.000	8.2	5.000	13.0	9.000	17.5
0.600	4.7	2.200	8.6	5.500	13.6	9.500	17.9
0.800	5.2	2.400	9.0	6.000	14.3		
1.000	5.8	2.600	9.4	6.500	14.8		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 448 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	91.242	0.442	3.9	116.5	O K
30 min Summer	91.310	0.510	4.4	151.3	O K
60 min Summer	91.369	0.569	4.8	184.8	O K
120 min Summer	91.415	0.615	5.2	213.0	O K
180 min Summer	91.432	0.632	5.3	224.1	O K
240 min Summer	91.438	0.638	5.3	227.9	O K
360 min Summer	91.438	0.638	5.3	227.8	O K
480 min Summer	91.435	0.635	5.3	226.1	O K
600 min Summer	91.431	0.631	5.3	223.5	O K
720 min Summer	91.426	0.626	5.3	220.3	O K
960 min Summer	91.415	0.615	5.2	212.8	O K
1440 min Summer	91.389	0.589	5.0	196.6	O K
2160 min Summer	91.351	0.551	4.7	174.0	O K
2880 min Summer	91.317	0.517	4.4	154.9	O K
4320 min Summer	91.259	0.459	4.0	124.6	O K
5760 min Summer	91.211	0.411	3.7	102.1	O K
7200 min Summer	91.171	0.371	3.4	84.8	O K
8640 min Summer	91.138	0.338	3.1	71.3	O K
10080 min Summer	91.108	0.308	2.9	60.3	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	26
30 min Summer	84.226	40
60 min Summer	52.662	68
120 min Summer	31.800	126
180 min Summer	23.353	184
240 min Summer	18.644	242
360 min Summer	13.543	324
480 min Summer	10.792	384
600 min Summer	9.043	446
720 min Summer	7.823	512
960 min Summer	6.219	650
1440 min Summer	4.493	926
2160 min Summer	3.241	1328
2880 min Summer	2.568	1732
4320 min Summer	1.847	2476
5760 min Summer	1.461	3232
7200 min Summer	1.217	3960
8640 min Summer	1.048	4672
10080 min Summer	0.923	5360

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	91.271	0.471	4.1	130.7	O K
30 min Winter	91.344	0.544	4.6	170.0	O K
60 min Winter	91.407	0.607	5.1	208.0	O K
120 min Winter	91.457	0.657	5.5	240.8	O K
180 min Winter	91.477	0.677	5.6	254.4	O K
240 min Winter	91.485	0.685	5.7	259.9	O K
360 min Winter	91.487	0.687	5.7	261.5	O K
480 min Winter	91.482	0.682	5.7	257.8	O K
600 min Winter	91.477	0.677	5.6	254.5	O K
720 min Winter	91.471	0.671	5.6	250.2	O K
960 min Winter	91.456	0.656	5.5	239.6	O K
1440 min Winter	91.420	0.620	5.2	216.4	O K
2160 min Winter	91.368	0.568	4.8	184.0	O K
2880 min Winter	91.321	0.521	4.5	157.1	O K
4320 min Winter	91.242	0.442	3.9	116.7	O K
5760 min Winter	91.180	0.380	3.4	88.5	O K
7200 min Winter	91.130	0.330	3.1	68.2	O K
8640 min Winter	91.089	0.289	2.7	53.4	O K
10080 min Winter	91.055	0.255	2.5	42.3	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	26
30 min Winter	84.226	39
60 min Winter	52.662	68
120 min Winter	31.800	124
180 min Winter	23.353	182
240 min Winter	18.644	238
360 min Winter	13.543	346
480 min Winter	10.792	404
600 min Winter	9.043	472
720 min Winter	7.823	548
960 min Winter	6.219	702
1440 min Winter	4.493	1000
2160 min Winter	3.241	1428
2880 min Winter	2.568	1824
4320 min Winter	1.847	2600
5760 min Winter	1.461	3352
7200 min Winter	1.217	4104
8640 min Winter	1.048	4768
10080 min Winter	0.923	5544

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.500

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.125	4-8	0.250	8-12	0.125

Model Details

Storage is Online Cover Level (m) 91.800

Swale Structure

Infiltration Coefficient Base (m/hr)	0.05600	Length (m)	150.0
Infiltration Coefficient Side (m/hr)	0.05600	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	90.800	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

<u>Summary of Results for 100 year Return Period (+30%)</u>

Half Drain Time : 468 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	91.043	0.443	0.0	4.9	4.9	116.9	O K
30 min Summer	91.111	0.511	0.0	4.9	4.9	151.8	O K
60 min Summer	91.169	0.569	0.0	4.9	4.9	184.7	O K
120 min Summer	91.212	0.612	0.0	4.9	4.9	211.0	O K
180 min Summer	91.226	0.626	0.0	4.9	4.9	220.2	O K
240 min Summer	91.229	0.629	0.0	4.9	4.9	222.1	O K
360 min Summer	91.222	0.622	0.0	4.9	4.9	217.6	O K
480 min Summer	91.211	0.611	0.0	4.9	4.9	210.6	O K
600 min Summer	91.200	0.600	0.0	4.9	4.9	203.9	O K
720 min Summer	91.190	0.590	0.0	4.9	4.9	197.6	O K
960 min Summer	91.171	0.571	0.0	4.9	4.9	185.8	O K
1440 min Summer	91.133	0.533	0.0	4.9	4.9	163.9	O K
2160 min Summer	91.076	0.476	0.0	4.9	4.9	133.2	O K
2880 min Summer	91.017	0.417	0.0	4.9	4.9	104.9	O K
4320 min Summer	90.900	0.300	0.0	4.9	4.9	57.5	O K
5760 min Summer	90.812	0.212	0.0	4.9	4.9	29.8	O K
7200 min Summer	90.762	0.162	0.0	4.6	4.6	17.3	O K
8640 min Summer	90.738	0.138	0.0	4.2	4.2	12.1	O K
10080 min Summer	90.722	0.122	0.0	3.8	3.8	9.2	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	25
30 min Summer	84.226	40
60 min Summer	52.662	68
120 min Summer	31.800	126
180 min Summer	23.353	186
240 min Summer	18.644	244
360 min Summer	13.543	358
480 min Summer	10.792	410
600 min Summer	9.043	472
720 min Summer	7.823	534
960 min Summer	6.219	668
1440 min Summer	4.493	942
2160 min Summer	3.241	1344
2880 min Summer	2.568	1732
4320 min Summer	1.847	2424
5760 min Summer	1.461	3056
7200 min Summer	1.217	3688
8640 min Summer	1.048	4408
10080 min Summer	0.923	5136

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	91.073	0.473	0.0	4.9	4.9	131.6	O K
30 min Winter	91.146	0.546	0.0	4.9	4.9	171.2	O K
60 min Winter	91.209	0.609	0.0	4.9	4.9	209.0	O K
120 min Winter	91.257	0.657	0.0	4.9	4.9	240.6	O K
180 min Winter	91.275	0.675	0.0	4.9	4.9	252.9	O K
240 min Winter	91.281	0.681	0.0	4.9	4.9	256.9	O K
360 min Winter	91.279	0.679	0.0	4.9	4.9	255.6	O K
480 min Winter	91.269	0.669	0.0	4.9	4.9	248.5	O K
600 min Winter	91.255	0.655	0.0	4.9	4.9	239.1	O K
720 min Winter	91.243	0.643	0.0	4.9	4.9	231.2	O K
960 min Winter	91.218	0.618	0.0	4.9	4.9	215.1	O K
1440 min Winter	91.166	0.566	0.0	4.9	4.9	183.0	O K
2160 min Winter	91.082	0.482	0.0	4.9	4.9	136.4	O K
2880 min Winter	90.989	0.389	0.0	4.9	4.9	92.4	O K
4320 min Winter	90.811	0.211	0.0	4.9	4.9	29.7	O K
5760 min Winter	90.742	0.142	0.0	4.3	4.3	12.9	O K
7200 min Winter	90.717	0.117	0.0	3.6	3.6	8.4	O K
8640 min Winter	90.702	0.102	0.0	3.1	3.1	6.3	O K
10080 min Winter	90.692	0.092	0.0	2.8	2.8	5.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	25
30 min Winter	84.226	39
60 min Winter	52.662	68
120 min Winter	31.800	124
180 min Winter	23.353	182
240 min Winter	18.644	240
360 min Winter	13.543	350
480 min Winter	10.792	456
600 min Winter	9.043	504
720 min Winter	7.823	570
960 min Winter	6.219	722
1440 min Winter	4.493	1026
2160 min Winter	3.241	1452
2880 min Winter	2.568	1840
4320 min Winter	1.847	2424
5760 min Winter	1.461	3000
7200 min Winter	1.217	3672
8640 min Winter	1.048	4408
10080 min Winter	0.923	5072

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.510

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.128	4-8	0.255	8-12	0.127

Model Details

Storage is Online Cover Level (m) 91.600

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	150.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	90.600	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Hydro-Brake® Outflow Control

Design Head (m)	0.700	Diameter (mm)	101
Design Flow (l/s)	5.0	Invert Level (m)	90.600
Hydro-Brake® Type	Md6 SW Only		

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	1.200	6.4	3.000	10.1	7.000	15.4
0.200	4.9	1.400	6.9	3.500	10.9	7.500	15.9
0.300	4.7	1.600	7.4	4.000	11.6	8.000	16.5
0.400	4.5	1.800	7.8	4.500	12.3	8.500	17.0
0.500	4.5	2.000	8.2	5.000	13.0	9.000	17.5
0.600	4.7	2.200	8.6	5.500	13.6	9.500	17.9
0.800	5.2	2.400	9.0	6.000	14.3		
1.000	5.8	2.600	9.4	6.500	14.8		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 453 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	91.047	0.447	3.9	118.8	O K
30 min Summer	91.116	0.516	4.4	154.4	O K
60 min Summer	91.175	0.575	4.9	188.6	O K
120 min Summer	91.222	0.622	5.2	217.5	O K
180 min Summer	91.240	0.640	5.4	229.0	O K
240 min Summer	91.246	0.646	5.4	233.0	O K
360 min Summer	91.246	0.646	5.4	233.0	O K
480 min Summer	91.243	0.643	5.4	231.3	O K
600 min Summer	91.239	0.639	5.4	228.7	O K
720 min Summer	91.234	0.634	5.3	225.5	O K
960 min Summer	91.223	0.623	5.2	218.0	O K
1440 min Summer	91.197	0.597	5.0	201.6	O K
2160 min Summer	91.159	0.559	4.8	178.7	O K
2880 min Summer	91.125	0.525	4.5	159.2	O K
4320 min Summer	91.066	0.466	4.1	128.4	O K
5760 min Summer	91.018	0.418	3.7	105.4	O K
7200 min Summer	90.978	0.378	3.4	87.7	O K
8640 min Summer	90.944	0.344	3.2	73.8	O K
10080 min Summer	90.914	0.314	2.9	62.5	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	26
30 min Summer	84.226	40
60 min Summer	52.662	68
120 min Summer	31.800	126
180 min Summer	23.353	184
240 min Summer	18.644	242
360 min Summer	13.543	326
480 min Summer	10.792	386
600 min Summer	9.043	448
720 min Summer	7.823	514
960 min Summer	6.219	652
1440 min Summer	4.493	926
2160 min Summer	3.241	1328
2880 min Summer	2.568	1732
4320 min Summer	1.847	2504
5760 min Summer	1.461	3232
7200 min Summer	1.217	3968
8640 min Summer	1.048	4672
10080 min Summer	0.923	5440

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	91.076	0.476	4.1	133.4	O K
30 min Winter	91.150	0.550	4.7	173.5	O K
60 min Winter	91.214	0.614	5.2	212.3	O K
120 min Winter	91.265	0.665	5.5	245.9	O K
180 min Winter	91.285	0.685	5.7	259.9	O K
240 min Winter	91.293	0.693	5.8	265.7	O K
360 min Winter	91.296	0.696	5.8	267.5	O K
480 min Winter	91.291	0.691	5.7	263.8	O K
600 min Winter	91.286	0.686	5.7	260.5	O K
720 min Winter	91.280	0.680	5.7	256.2	O K
960 min Winter	91.264	0.664	5.5	245.6	O K
1440 min Winter	91.229	0.629	5.3	222.1	O K
2160 min Winter	91.176	0.576	4.9	189.2	O K
2880 min Winter	91.129	0.529	4.5	161.8	O K
4320 min Winter	91.050	0.450	3.9	120.5	O K
5760 min Winter	90.987	0.387	3.5	91.6	O K
7200 min Winter	90.937	0.337	3.1	70.9	O K
8640 min Winter	90.895	0.295	2.8	55.6	O K
10080 min Winter	90.861	0.261	2.5	44.2	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	26
30 min Winter	84.226	39
60 min Winter	52.662	68
120 min Winter	31.800	124
180 min Winter	23.353	182
240 min Winter	18.644	238
360 min Winter	13.543	346
480 min Winter	10.792	408
600 min Winter	9.043	472
720 min Winter	7.823	550
960 min Winter	6.219	702
1440 min Winter	4.493	1000
2160 min Winter	3.241	1428
2880 min Winter	2.568	1828
4320 min Winter	1.847	2600
5760 min Winter	1.461	3352
7200 min Winter	1.217	4104
8640 min Winter	1.048	4832
10080 min Winter	0.923	5544

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.510

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.128	4-8	0.255	8-12	0.127

Model Details

Storage is Online Cover Level (m) 91.600

Swale Structure

Infiltration Coefficient Base (m/hr)	0.05600	Length (m)	150.0
Infiltration Coefficient Side (m/hr)	0.05600	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	90.600	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 225 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	90.576	0.576	0.0	4.1	4.1	62.4	O K
30 min Summer	90.703	0.703	0.0	4.3	4.3	79.7	Flood Risk
60 min Summer	90.809	0.809	0.0	4.6	4.6	94.3	Flood Risk
120 min Summer	90.868	0.868	0.0	4.7	4.7	102.3	Flood Risk
180 min Summer	90.863	0.863	0.0	4.7	4.7	101.7	Flood Risk
240 min Summer	90.845	0.845	0.0	4.6	4.6	99.1	Flood Risk
360 min Summer	90.807	0.807	0.0	4.5	4.5	94.0	Flood Risk
480 min Summer	90.773	0.773	0.0	4.5	4.5	89.3	Flood Risk
600 min Summer	90.741	0.741	0.0	4.4	4.4	84.9	Flood Risk
720 min Summer	90.709	0.709	0.0	4.3	4.3	80.6	Flood Risk
960 min Summer	90.650	0.650	0.0	4.1	4.1	72.4	O K
1440 min Summer	90.538	0.538	0.0	4.1	4.1	57.2	O K
2160 min Summer	90.388	0.388	0.0	4.1	4.1	36.6	O K
2880 min Summer	90.266	0.266	0.0	4.1	4.1	20.0	O K
4320 min Summer	90.153	0.153	0.0	3.9	3.9	6.7	O K
5760 min Summer	90.117	0.117	0.0	3.3	3.3	3.9	O K
7200 min Summer	90.098	0.098	0.0	2.7	2.7	2.7	O K
8640 min Summer	90.086	0.086	0.0	2.4	2.4	2.1	O K
10080 min Summer	90.078	0.078	0.0	2.1	2.1	1.7	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	18
30 min Summer	84.226	33
60 min Summer	52.662	62
120 min Summer	31.800	120
180 min Summer	23.353	170
240 min Summer	18.644	198
360 min Summer	13.543	262
480 min Summer	10.792	330
600 min Summer	9.043	400
720 min Summer	7.823	470
960 min Summer	6.219	606
1440 min Summer	4.493	878
2160 min Summer	3.241	1252
2880 min Summer	2.568	1584
4320 min Summer	1.847	2208
5760 min Summer	1.461	2936
7200 min Summer	1.217	3672
8640 min Summer	1.048	4400
10080 min Summer	0.923	5088

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	90.634	0.634	0.0	4.1	4.1	70.4	O K
30 min Winter	90.779	0.779	0.0	4.5	4.5	90.1	Flood Risk
60 min Winter	90.904	0.904	0.0	4.8	4.8	107.2	Flood Risk
120 min Winter	90.983	0.983	0.0	5.0	5.0	118.0	Flood Risk
180 min Winter	90.989	0.989	0.0	5.0	5.0	118.8	Flood Risk
240 min Winter	90.967	0.967	0.0	5.0	5.0	115.9	Flood Risk
360 min Winter	90.920	0.920	0.0	4.8	4.8	109.4	Flood Risk
480 min Winter	90.873	0.873	0.0	4.7	4.7	103.0	Flood Risk
600 min Winter	90.826	0.826	0.0	4.6	4.6	96.6	Flood Risk
720 min Winter	90.780	0.780	0.0	4.5	4.5	90.3	Flood Risk
960 min Winter	90.692	0.692	0.0	4.2	4.2	78.2	O K
1440 min Winter	90.526	0.526	0.0	4.1	4.1	55.5	O K
2160 min Winter	90.290	0.290	0.0	4.1	4.1	23.2	O K
2880 min Winter	90.163	0.163	0.0	4.0	4.0	7.6	O K
4320 min Winter	90.107	0.107	0.0	3.0	3.0	3.2	O K
5760 min Winter	90.087	0.087	0.0	2.4	2.4	2.1	O K
7200 min Winter	90.075	0.075	0.0	2.0	2.0	1.6	O K
8640 min Winter	90.067	0.067	0.0	1.7	1.7	1.3	O K
10080 min Winter	90.062	0.062	0.0	1.5	1.5	1.1	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	18
30 min Winter	84.226	32
60 min Winter	52.662	62
120 min Winter	31.800	118
180 min Winter	23.353	174
240 min Winter	18.644	224
360 min Winter	13.543	278
480 min Winter	10.792	356
600 min Winter	9.043	434
720 min Winter	7.823	508
960 min Winter	6.219	656
1440 min Winter	4.493	938
2160 min Winter	3.241	1280
2880 min Winter	2.568	1528
4320 min Winter	1.847	2204
5760 min Winter	1.461	2936
7200 min Winter	1.217	3584
8640 min Winter	1.048	4400
10080 min Winter	0.923	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.275

Time (mins)	**Area (ha)**
0-4	0.275

Model Details

Storage is Online Cover Level (m) 91.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.9
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	240.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	90.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Outflow Control

Design Head (m)	1.000	Diameter (mm)	94
Design Flow (l/s)	5.0	Invert Level (m)	90.000
Hydro-Brake® Type	Md6 SW Only		

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.8	1.200	5.5	3.000	8.7	7.000	13.3
0.200	4.1	1.400	6.0	3.500	9.4	7.500	13.8
0.300	3.9	1.600	6.4	4.000	10.1	8.000	14.3
0.400	3.8	1.800	6.8	4.500	10.7	8.500	14.7
0.500	3.8	2.000	7.1	5.000	11.3	9.000	15.1
0.600	4.0	2.200	7.5	5.500	11.8	9.500	15.5
0.800	4.5	2.400	7.8	6.000	12.3		
1.000	5.0	2.600	8.1	6.500	12.9		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 161 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	90.575	0.575	5.3	62.2	O K
30 min Summer	90.697	0.697	5.7	79.0	O K
60 min Summer	90.797	0.797	6.1	92.6	Flood Risk
120 min Summer	90.842	0.842	6.3	98.7	Flood Risk
180 min Summer	90.839	0.839	6.3	98.3	Flood Risk
240 min Summer	90.825	0.825	6.2	96.4	Flood Risk
360 min Summer	90.790	0.790	6.1	91.6	Flood Risk
480 min Summer	90.753	0.753	5.9	86.5	Flood Risk
600 min Summer	90.716	0.716	5.8	81.6	Flood Risk
720 min Summer	90.682	0.682	5.7	76.8	O K
960 min Summer	90.618	0.618	5.4	68.2	O K
1440 min Summer	90.512	0.512	5.0	53.7	O K
2160 min Summer	90.394	0.394	4.6	37.4	O K
2880 min Summer	90.311	0.311	4.3	26.1	O K
4320 min Summer	90.227	0.227	3.8	14.7	O K
5760 min Summer	90.191	0.191	3.1	10.4	O K
7200 min Summer	90.165	0.165	2.7	7.8	O K
8640 min Summer	90.146	0.146	2.3	6.0	O K
10080 min Summer	90.130	0.130	2.1	4.8	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	18
30 min Summer	84.226	33
60 min Summer	52.662	62
120 min Summer	31.800	116
180 min Summer	23.353	144
240 min Summer	18.644	176
360 min Summer	13.543	244
480 min Summer	10.792	314
600 min Summer	9.043	382
720 min Summer	7.823	450
960 min Summer	6.219	580
1440 min Summer	4.493	838
2160 min Summer	3.241	1208
2880 min Summer	2.568	1556
4320 min Summer	1.847	2244
5760 min Summer	1.461	2944
7200 min Summer	1.217	3672
8640 min Summer	1.048	4408
10080 min Summer	0.923	5136

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	90.632	0.632	5.5	70.0	O K
30 min Winter	90.772	0.772	6.0	89.3	Flood Risk
60 min Winter	90.889	0.889	6.4	105.2	Flood Risk
120 min Winter	90.951	0.951	6.7	113.7	Flood Risk
180 min Winter	90.944	0.944	6.6	112.7	Flood Risk
240 min Winter	90.927	0.927	6.6	110.4	Flood Risk
360 min Winter	90.879	0.879	6.4	103.8	Flood Risk
480 min Winter	90.825	0.825	6.2	96.5	Flood Risk
600 min Winter	90.772	0.772	6.0	89.2	Flood Risk
720 min Winter	90.722	0.722	5.8	82.3	Flood Risk
960 min Winter	90.630	0.630	5.5	69.8	O K
1440 min Winter	90.482	0.482	4.9	49.5	O K
2160 min Winter	90.325	0.325	4.3	28.1	O K
2880 min Winter	90.238	0.238	4.0	16.2	O K
4320 min Winter	90.181	0.181	2.9	9.4	O K
5760 min Winter	90.147	0.147	2.3	6.2	O K
7200 min Winter	90.125	0.125	2.0	4.4	O K
8640 min Winter	90.109	0.109	1.7	3.4	O K
10080 min Winter	90.096	0.096	1.5	2.6	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	18
30 min Winter	84.226	32
60 min Winter	52.662	60
120 min Winter	31.800	116
180 min Winter	23.353	162
240 min Winter	18.644	186
360 min Winter	13.543	264
480 min Winter	10.792	340
600 min Winter	9.043	412
720 min Winter	7.823	484
960 min Winter	6.219	624
1440 min Winter	4.493	882
2160 min Winter	3.241	1236
2880 min Winter	2.568	1528
4320 min Winter	1.847	2248
5760 min Winter	1.461	2944
7200 min Winter	1.217	3672
8640 min Winter	1.048	4368
10080 min Winter	0.923	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.275

Time (mins)	**Area (ha)**
0-4	0.275

Model Details

Storage is Online Cover Level (m) 91.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.05600	Trench Width (m)	1.9
Infiltration Coefficient Side (m/hr)	0.05600	Trench Length (m)	240.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	90.000	Cap Infiltration Depth (m)	0.000

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 328 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	89.943	0.443	0.0	4.9	4.9	85.9	O K
30 min Summer	90.014	0.514	0.0	4.9	4.9	111.1	O K
60 min Summer	90.071	0.571	0.0	4.9	4.9	133.9	O K
120 min Summer	90.109	0.609	0.0	4.9	4.9	150.1	O K
180 min Summer	90.117	0.617	0.0	4.9	4.9	153.6	O K
240 min Summer	90.114	0.614	0.0	4.9	4.9	151.9	O K
360 min Summer	90.099	0.599	0.0	4.9	4.9	145.5	O K
480 min Summer	90.085	0.585	0.0	4.9	4.9	139.5	O K
600 min Summer	90.071	0.571	0.0	4.9	4.9	133.7	O K
720 min Summer	90.057	0.557	0.0	4.9	4.9	128.1	O K
960 min Summer	90.030	0.530	0.0	4.9	4.9	117.3	O K
1440 min Summer	89.975	0.475	0.0	4.9	4.9	97.0	O K
2160 min Summer	89.891	0.391	0.0	4.9	4.9	69.3	O K
2880 min Summer	89.808	0.308	0.0	4.9	4.9	46.0	O K
4320 min Summer	89.690	0.190	0.0	4.8	4.8	20.1	O K
5760 min Summer	89.642	0.142	0.0	4.3	4.3	11.9	O K
7200 min Summer	89.619	0.119	0.0	3.7	3.7	8.5	O K
8640 min Summer	89.604	0.104	0.0	3.2	3.2	6.5	O K
10080 min Summer	89.594	0.094	0.0	2.9	2.9	5.2	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	25
30 min Summer	84.226	39
60 min Summer	52.662	68
120 min Summer	31.800	126
180 min Summer	23.353	184
240 min Summer	18.644	240
360 min Summer	13.543	300
480 min Summer	10.792	362
600 min Summer	9.043	428
720 min Summer	7.823	496
960 min Summer	6.219	632
1440 min Summer	4.493	900
2160 min Summer	3.241	1280
2880 min Summer	2.568	1624
4320 min Summer	1.847	2256
5760 min Summer	1.461	2944
7200 min Summer	1.217	3672
8640 min Summer	1.048	4400
10080 min Summer	0.923	5136

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	89.975	0.475	0.0	4.9	4.9	96.8	O K
30 min Winter	90.051	0.551	0.0	4.9	4.9	125.5	O K
60 min Winter	90.114	0.614	0.0	4.9	4.9	152.0	O K
120 min Winter	90.158	0.658	0.0	4.9	4.9	172.0	O K
180 min Winter	90.170	0.670	0.0	4.9	4.9	177.8	O K
240 min Winter	90.170	0.670	0.0	4.9	4.9	177.6	O K
360 min Winter	90.156	0.656	0.0	4.9	4.9	170.9	O K
480 min Winter	90.138	0.638	0.0	4.9	4.9	162.8	O K
600 min Winter	90.121	0.621	0.0	4.9	4.9	155.2	O K
720 min Winter	90.103	0.603	0.0	4.9	4.9	147.3	O K
960 min Winter	90.065	0.565	0.0	4.9	4.9	131.5	O K
1440 min Winter	89.985	0.485	0.0	4.9	4.9	100.7	O K
2160 min Winter	89.851	0.351	0.0	4.9	4.9	57.6	O K
2880 min Winter	89.725	0.225	0.0	4.9	4.9	26.9	O K
4320 min Winter	89.632	0.132	0.0	4.1	4.1	10.4	O K
5760 min Winter	89.605	0.105	0.0	3.3	3.3	6.7	O K
7200 min Winter	89.590	0.090	0.0	2.7	2.7	4.8	O K
8640 min Winter	89.580	0.080	0.0	2.3	2.3	3.8	O K
10080 min Winter	89.573	0.073	0.0	2.1	2.1	3.1	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	25
30 min Winter	84.226	39
60 min Winter	52.662	66
120 min Winter	31.800	124
180 min Winter	23.353	180
240 min Winter	18.644	236
360 min Winter	13.543	340
480 min Winter	10.792	384
600 min Winter	9.043	462
720 min Winter	7.823	538
960 min Winter	6.219	688
1440 min Winter	4.493	974
2160 min Winter	3.241	1348
2880 min Winter	2.568	1644
4320 min Winter	1.847	2248
5760 min Winter	1.461	2936
7200 min Winter	1.217	3672
8640 min Winter	1.048	4408
10080 min Winter	0.923	5048

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.380

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.095	4-8	0.190	8-12	0.095

Model Details

Storage is Online Cover Level (m) 90.500

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	100.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	89.500	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Hydro-Brake® Outflow Control

Design Head (m)	0.700	Diameter (mm)	101
Design Flow (l/s)	5.0	Invert Level (m)	89.500
Hydro-Brake® Type	Md6 SW Only		

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	1.200	6.4	3.000	10.1	7.000	15.4
0.200	4.9	1.400	6.9	3.500	10.9	7.500	15.9
0.300	4.7	1.600	7.4	4.000	11.6	8.000	16.5
0.400	4.5	1.800	7.8	4.500	12.3	8.500	17.0
0.500	4.5	2.000	8.2	5.000	13.0	9.000	17.5
0.600	4.7	2.200	8.6	5.500	13.6	9.500	17.9
0.800	5.2	2.400	9.0	6.000	14.3		
1.000	5.8	2.600	9.4	6.500	14.8		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 486 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	89.951	0.451	2.8	88.7	O K
30 min Summer	90.024	0.524	3.1	115.2	O K
60 min Summer	90.088	0.588	3.4	141.0	O K
120 min Summer	90.138	0.638	3.7	162.9	O K
180 min Summer	90.158	0.658	3.8	171.9	O K
240 min Summer	90.165	0.665	3.8	175.4	O K
360 min Summer	90.166	0.666	3.8	175.9	O K
480 min Summer	90.164	0.664	3.8	174.8	O K
600 min Summer	90.160	0.660	3.8	173.0	O K
720 min Summer	90.156	0.656	3.8	170.8	O K
960 min Summer	90.144	0.644	3.7	165.6	O K
1440 min Summer	90.118	0.618	3.6	153.9	O K
2160 min Summer	90.079	0.579	3.4	137.2	O K
2880 min Summer	90.044	0.544	3.2	122.9	O K
4320 min Summer	89.984	0.484	2.9	100.2	O K
5760 min Summer	89.934	0.434	2.7	82.9	O K
7200 min Summer	89.892	0.392	2.5	69.7	O K
8640 min Summer	89.856	0.356	2.3	59.0	O K
10080 min Summer	89.825	0.325	2.1	50.6	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	26
30 min Summer	84.226	40
60 min Summer	52.662	68
120 min Summer	31.800	126
180 min Summer	23.353	184
240 min Summer	18.644	244
360 min Summer	13.543	338
480 min Summer	10.792	394
600 min Summer	9.043	456
720 min Summer	7.823	520
960 min Summer	6.219	658
1440 min Summer	4.493	930
2160 min Summer	3.241	1344
2880 min Summer	2.568	1736
4320 min Summer	1.847	2512
5760 min Summer	1.461	3240
7200 min Summer	1.217	3968
8640 min Summer	1.048	4680
10080 min Summer	0.923	5448

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	89.982	0.482	2.9	99.5	O K
30 min Winter	90.060	0.560	3.3	129.5	O K
60 min Winter	90.129	0.629	3.6	158.7	O K
120 min Winter	90.184	0.684	3.9	184.2	O K
180 min Winter	90.206	0.706	4.0	195.1	Flood Risk
240 min Winter	90.216	0.716	4.1	199.8	Flood Risk
360 min Winter	90.220	0.720	4.1	201.9	Flood Risk
480 min Winter	90.216	0.716	4.1	199.8	Flood Risk
600 min Winter	90.211	0.711	4.1	197.2	Flood Risk
720 min Winter	90.205	0.705	4.0	194.4	Flood Risk
960 min Winter	90.190	0.690	4.0	187.1	O K
1440 min Winter	90.155	0.655	3.8	170.4	O K
2160 min Winter	90.101	0.601	3.5	146.6	O K
2880 min Winter	90.053	0.553	3.3	126.3	O K
4320 min Winter	89.971	0.471	2.9	95.5	O K
5760 min Winter	89.905	0.405	2.5	73.7	O K
7200 min Winter	89.852	0.352	2.3	57.8	O K
8640 min Winter	89.808	0.308	2.1	45.9	O K
10080 min Winter	89.771	0.271	1.9	36.9	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	26
30 min Winter	84.226	39
60 min Winter	52.662	68
120 min Winter	31.800	124
180 min Winter	23.353	182
240 min Winter	18.644	238
360 min Winter	13.543	348
480 min Winter	10.792	446
600 min Winter	9.043	478
720 min Winter	7.823	554
960 min Winter	6.219	708
1440 min Winter	4.493	1010
2160 min Winter	3.241	1436
2880 min Winter	2.568	1848
4320 min Winter	1.847	2640
5760 min Winter	1.461	3400
7200 min Winter	1.217	4112
8640 min Winter	1.048	4840
10080 min Winter	0.923	5552

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.380

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.095	4-8	0.190	8-12	0.095

Model Details

Storage is Online Cover Level (m) 90.500

Swale Structure

Infiltration Coefficient Base (m/hr)	0.05600	Length (m)	100.0
Infiltration Coefficient Side (m/hr)	0.05600	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	89.500	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 293 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	89.955	0.455	0.0	4.9	4.9	78.6	O K
30 min Summer	90.030	0.530	0.0	4.9	4.9	101.5	O K
60 min Summer	90.090	0.590	0.0	4.9	4.9	121.8	O K
120 min Summer	90.127	0.627	0.0	4.9	4.9	135.3	O K
180 min Summer	90.133	0.633	0.0	4.9	4.9	137.3	O K
240 min Summer	90.125	0.625	0.0	4.9	4.9	134.7	O K
360 min Summer	90.108	0.608	0.0	4.9	4.9	128.2	O K
480 min Summer	90.091	0.591	0.0	4.9	4.9	122.3	O K
600 min Summer	90.075	0.575	0.0	4.9	4.9	116.7	O K
720 min Summer	90.059	0.559	0.0	4.9	4.9	111.2	O K
960 min Summer	90.027	0.527	0.0	4.9	4.9	100.7	O K
1440 min Summer	89.963	0.463	0.0	4.9	4.9	80.9	O K
2160 min Summer	89.865	0.365	0.0	4.9	4.9	54.2	O K
2880 min Summer	89.774	0.274	0.0	4.9	4.9	33.2	O K
4320 min Summer	89.668	0.168	0.0	4.7	4.7	13.6	O K
5760 min Summer	89.631	0.131	0.0	4.1	4.1	8.0	O K
7200 min Summer	89.611	0.111	0.0	3.5	3.5	5.6	O K
8640 min Summer	89.597	0.097	0.0	3.0	3.0	4.3	O K
10080 min Summer	89.588	0.088	0.0	2.6	2.6	3.4	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	25
30 min Summer	84.226	39
60 min Summer	52.662	68
120 min Summer	31.800	126
180 min Summer	23.353	182
240 min Summer	18.644	232
360 min Summer	13.543	288
480 min Summer	10.792	352
600 min Summer	9.043	420
720 min Summer	7.823	488
960 min Summer	6.219	624
1440 min Summer	4.493	890
2160 min Summer	3.241	1260
2880 min Summer	2.568	1592
4320 min Summer	1.847	2252
5760 min Summer	1.461	2944
7200 min Summer	1.217	3672
8640 min Summer	1.048	4400
10080 min Summer	0.923	5120

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	89.989	0.489	0.0	4.9	4.9	88.7	O K
30 min Winter	90.070	0.570	0.0	4.9	4.9	114.8	O K
60 min Winter	90.136	0.636	0.0	4.9	4.9	138.5	O K
120 min Winter	90.181	0.681	0.0	4.9	4.9	155.6	O K
180 min Winter	90.191	0.691	0.0	4.9	4.9	159.6	O K
240 min Winter	90.187	0.687	0.0	4.9	4.9	158.2	O K
360 min Winter	90.167	0.667	0.0	4.9	4.9	150.2	O K
480 min Winter	90.147	0.647	0.0	4.9	4.9	142.6	O K
600 min Winter	90.126	0.626	0.0	4.9	4.9	134.9	O K
720 min Winter	90.104	0.604	0.0	4.9	4.9	127.0	O K
960 min Winter	90.060	0.560	0.0	4.9	4.9	111.4	O K
1440 min Winter	89.964	0.464	0.0	4.9	4.9	81.1	O K
2160 min Winter	89.805	0.305	0.0	4.9	4.9	39.9	O K
2880 min Winter	89.688	0.188	0.0	4.8	4.8	16.8	O K
4320 min Winter	89.621	0.121	0.0	3.8	3.8	6.8	O K
5760 min Winter	89.598	0.098	0.0	3.0	3.0	4.3	O K
7200 min Winter	89.585	0.085	0.0	2.5	2.5	3.2	O K
8640 min Winter	89.576	0.076	0.0	2.2	2.2	2.5	O K
10080 min Winter	89.569	0.069	0.0	1.9	1.9	2.1	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	25
30 min Winter	84.226	39
60 min Winter	52.662	66
120 min Winter	31.800	124
180 min Winter	23.353	180
240 min Winter	18.644	234
360 min Winter	13.543	330
480 min Winter	10.792	376
600 min Winter	9.043	454
720 min Winter	7.823	530
960 min Winter	6.219	678
1440 min Winter	4.493	958
2160 min Winter	3.241	1308
2880 min Winter	2.568	1588
4320 min Winter	1.847	2212
5760 min Winter	1.461	2920
7200 min Winter	1.217	3632
8640 min Winter	1.048	4352
10080 min Winter	0.923	5112

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.350

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.088	4-8	0.175	8-12	0.087

Model Details

Storage is Online Cover Level (m) 90.500

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	150.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	1.5
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	89.500	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.8		

Hydro-Brake® Outflow Control

Design Head (m)	0.700	Diameter (mm)	101
Design Flow (l/s)	5.0	Invert Level (m)	89.500
Hydro-Brake® Type	Md6 SW Only		

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	1.200	6.4	3.000	10.1	7.000	15.4
0.200	4.9	1.400	6.9	3.500	10.9	7.500	15.9
0.300	4.7	1.600	7.4	4.000	11.6	8.000	16.5
0.400	4.5	1.800	7.8	4.500	12.3	8.500	17.0
0.500	4.5	2.000	8.2	5.000	13.0	9.000	17.5
0.600	4.7	2.200	8.6	5.500	13.6	9.500	17.9
0.800	5.2	2.400	9.0	6.000	14.3		
1.000	5.8	2.600	9.4	6.500	14.8		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 480 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	89.966	0.466	2.6	81.6	O K
30 min Summer	90.044	0.544	2.9	106.1	O K
60 min Summer	90.112	0.612	3.2	129.7	O K
120 min Summer	90.166	0.666	3.4	149.8	O K
180 min Summer	90.187	0.687	3.5	158.0	O K
240 min Summer	90.194	0.694	3.6	161.0	O K
360 min Summer	90.195	0.695	3.6	161.3	O K
480 min Summer	90.192	0.692	3.5	160.1	O K
600 min Summer	90.188	0.688	3.5	158.4	O K
720 min Summer	90.182	0.682	3.5	156.2	O K
960 min Summer	90.169	0.669	3.4	151.2	O K
1440 min Summer	90.140	0.640	3.3	140.2	O K
2160 min Summer	90.098	0.598	3.1	124.7	O K
2880 min Summer	90.060	0.560	3.0	111.5	O K
4320 min Summer	89.994	0.494	2.7	90.3	O K
5760 min Summer	89.940	0.440	2.5	74.3	O K
7200 min Summer	89.895	0.395	2.3	61.8	O K
8640 min Summer	89.856	0.356	2.1	51.9	O K
10080 min Summer	89.822	0.322	2.0	43.9	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	26
30 min Summer	84.226	40
60 min Summer	52.662	68
120 min Summer	31.800	126
180 min Summer	23.353	184
240 min Summer	18.644	244
360 min Summer	13.543	338
480 min Summer	10.792	392
600 min Summer	9.043	454
720 min Summer	7.823	520
960 min Summer	6.219	658
1440 min Summer	4.493	930
2160 min Summer	3.241	1344
2880 min Summer	2.568	1736
4320 min Summer	1.847	2512
5760 min Summer	1.461	3240
7200 min Summer	1.217	3968
8640 min Summer	1.048	4680
10080 min Summer	0.923	5448

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	89.999	0.499	2.7	91.6	O K
30 min Winter	90.082	0.582	3.1	119.2	O K
60 min Winter	90.156	0.656	3.4	146.0	O K
120 min Winter	90.215	0.715	3.6	169.4	Flood Risk
180 min Winter	90.239	0.739	3.7	179.3	Flood Risk
240 min Winter	90.249	0.749	3.8	183.5	Flood Risk
360 min Winter	90.253	0.753	3.8	185.3	Flood Risk
480 min Winter	90.248	0.748	3.8	183.1	Flood Risk
600 min Winter	90.242	0.742	3.8	180.7	Flood Risk
720 min Winter	90.236	0.736	3.7	177.9	Flood Risk
960 min Winter	90.219	0.719	3.7	170.9	Flood Risk
1440 min Winter	90.180	0.680	3.5	155.2	O K
2160 min Winter	90.121	0.621	3.2	133.1	O K
2880 min Winter	90.068	0.568	3.0	114.4	O K
4320 min Winter	89.979	0.479	2.6	85.7	O K
5760 min Winter	89.908	0.408	2.3	65.3	O K
7200 min Winter	89.850	0.350	2.1	50.4	O K
8640 min Winter	89.802	0.302	1.9	39.3	O K
10080 min Winter	89.762	0.262	1.7	30.8	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	26
30 min Winter	84.226	39
60 min Winter	52.662	68
120 min Winter	31.800	124
180 min Winter	23.353	182
240 min Winter	18.644	238
360 min Winter	13.543	348
480 min Winter	10.792	444
600 min Winter	9.043	478
720 min Winter	7.823	554
960 min Winter	6.219	708
1440 min Winter	4.493	1008
2160 min Winter	3.241	1432
2880 min Winter	2.568	1848
4320 min Winter	1.847	2640
5760 min Winter	1.461	3400
7200 min Winter	1.217	4112
8640 min Winter	1.048	4840
10080 min Winter	0.923	5552

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.350

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.088	4-8	0.175	8-12	0.087

Model Details

Storage is Online Cover Level (m) 90.500

Swale Structure

Infiltration Coefficient Base (m/hr)	0.05600	Length (m)	150.0
Infiltration Coefficient Side (m/hr)	0.05600	Side Slope (1:X)	1.5
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	89.500	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.8		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 72 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	89.325	0.025	3.5	22.1	O K
30 min Summer	89.330	0.030	4.3	27.3	O K
60 min Summer	89.334	0.034	4.8	30.4	O K
120 min Summer	89.335	0.035	5.0	31.8	O K
180 min Summer	89.335	0.035	4.9	31.5	O K
240 min Summer	89.334	0.034	4.8	30.5	O K
360 min Summer	89.332	0.032	4.5	28.4	O K
480 min Summer	89.329	0.029	4.1	26.4	O K
600 min Summer	89.327	0.027	3.8	24.7	O K
720 min Summer	89.326	0.026	3.6	23.1	O K
960 min Summer	89.323	0.023	3.2	20.6	O K
1440 min Summer	89.319	0.019	2.6	17.0	O K
2160 min Summer	89.315	0.015	2.1	13.6	O K
2880 min Summer	89.313	0.013	1.8	11.4	O K
4320 min Summer	89.310	0.010	1.4	8.7	O K
5760 min Summer	89.308	0.008	1.1	7.2	O K
7200 min Summer	89.307	0.007	1.0	6.0	O K
8640 min Summer	89.306	0.006	0.8	5.3	O K
10080 min Summer	89.305	0.005	0.7	4.6	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	17
30 min Summer	84.226	31
60 min Summer	52.662	52
120 min Summer	31.800	84
180 min Summer	23.353	118
240 min Summer	18.644	152
360 min Summer	13.543	218
480 min Summer	10.792	284
600 min Summer	9.043	348
720 min Summer	7.823	412
960 min Summer	6.219	538
1440 min Summer	4.493	780
2160 min Summer	3.241	1144
2880 min Summer	2.568	1500
4320 min Summer	1.847	2244
5760 min Summer	1.461	2952
7200 min Summer	1.217	3680
8640 min Summer	1.048	4416
10080 min Summer	0.923	5144

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	89.328	0.028	3.9	24.9	O K
30 min Winter	89.334	0.034	4.8	30.7	O K
60 min Winter	89.338	0.038	5.3	34.2	O K
120 min Winter	89.339	0.039	5.5	35.2	O K
180 min Winter	89.338	0.038	5.3	34.1	O K
240 min Winter	89.336	0.036	5.1	32.5	O K
360 min Winter	89.333	0.033	4.6	29.3	O K
480 min Winter	89.329	0.029	4.1	26.5	O K
600 min Winter	89.327	0.027	3.8	24.1	O K
720 min Winter	89.325	0.025	3.5	22.1	O K
960 min Winter	89.321	0.021	3.0	19.1	O K
1440 min Winter	89.317	0.017	2.4	14.9	O K
2160 min Winter	89.313	0.013	1.8	11.3	O K
2880 min Winter	89.310	0.010	1.4	9.2	O K
4320 min Winter	89.308	0.008	1.1	6.8	O K
5760 min Winter	89.306	0.006	0.9	5.4	O K
7200 min Winter	89.305	0.005	0.7	4.5	O K
8640 min Winter	89.304	0.004	0.6	3.9	O K
10080 min Winter	89.304	0.004	0.5	3.5	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	17
30 min Winter	84.226	31
60 min Winter	52.662	56
120 min Winter	31.800	90
180 min Winter	23.353	126
240 min Winter	18.644	162
360 min Winter	13.543	232
480 min Winter	10.792	300
600 min Winter	9.043	364
720 min Winter	7.823	428
960 min Winter	6.219	556
1440 min Winter	4.493	796
2160 min Winter	3.241	1164
2880 min Winter	2.568	1528
4320 min Winter	1.847	2216
5760 min Winter	1.461	2912
7200 min Winter	1.217	3616
8640 min Winter	1.048	4504
10080 min Winter	0.923	5256

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.100

Time (mins)	Area (ha)
0-4	0.100

Model Details

Storage is Online Cover Level (m) 90.300

Infiltration Basin Structure

Invert Level (m) 89.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.05600 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.05600

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	900.0	1.000	900.0

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	89.327	0.027	0.4	23.9	O K
30 min Summer	89.334	0.034	0.6	31.0	O K
60 min Summer	89.342	0.042	1.0	38.0	O K
120 min Summer	89.349	0.049	1.3	43.7	O K
180 min Summer	89.351	0.051	1.4	45.8	O K
240 min Summer	89.352	0.052	1.4	46.4	O K
360 min Summer	89.353	0.053	1.5	47.3	O K
480 min Summer	89.353	0.053	1.5	47.8	O K
600 min Summer	89.353	0.053	1.5	48.1	O K
720 min Summer	89.353	0.053	1.5	48.1	O K
960 min Summer	89.353	0.053	1.5	47.8	O K
1440 min Summer	89.352	0.052	1.4	46.4	O K
2160 min Summer	89.349	0.049	1.3	44.1	O K
2880 min Summer	89.347	0.047	1.2	41.9	O K
4320 min Summer	89.343	0.043	1.0	38.4	O K
5760 min Summer	89.340	0.040	0.9	35.6	O K
7200 min Summer	89.337	0.037	0.8	33.4	O K
8640 min Summer	89.335	0.035	0.7	31.7	O K
10080 min Summer	89.334	0.034	0.6	30.2	O K
15 min Winter	89.330	0.030	0.5	26.7	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	19
30 min Summer	84.226	34
60 min Summer	52.662	62
120 min Summer	31.800	122
180 min Summer	23.353	180
240 min Summer	18.644	218
360 min Summer	13.543	272
480 min Summer	10.792	336
600 min Summer	9.043	404
720 min Summer	7.823	470
960 min Summer	6.219	606
1440 min Summer	4.493	868
2160 min Summer	3.241	1256
2880 min Summer	2.568	1644
4320 min Summer	1.847	2380
5760 min Summer	1.461	3120
7200 min Summer	1.217	3888
8640 min Summer	1.048	4584
10080 min Summer	0.923	5344
15 min Winter	128.285	19

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
30 min Winter	89.339	0.039	0.8	34.7	O K
60 min Winter	89.347	0.047	1.2	42.4	O K
120 min Winter	89.354	0.054	1.6	48.7	O K
180 min Winter	89.357	0.057	1.7	51.0	O K
240 min Winter	89.357	0.057	1.7	51.7	O K
360 min Winter	89.358	0.058	1.8	52.3	O K
480 min Winter	89.358	0.058	1.8	52.5	O K
600 min Winter	89.358	0.058	1.8	52.3	O K
720 min Winter	89.358	0.058	1.8	51.8	O K
960 min Winter	89.356	0.056	1.7	50.6	O K
1440 min Winter	89.353	0.053	1.5	47.9	O K
2160 min Winter	89.349	0.049	1.3	44.2	O K
2880 min Winter	89.346	0.046	1.1	41.3	O K
4320 min Winter	89.341	0.041	0.9	36.7	O K
5760 min Winter	89.337	0.037	0.8	33.5	O K
7200 min Winter	89.335	0.035	0.7	31.1	O K
8640 min Winter	89.332	0.032	0.6	29.2	O K
10080 min Winter	89.331	0.031	0.5	27.6	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
30 min Winter	84.226	33
60 min Winter	52.662	62
120 min Winter	31.800	118
180 min Winter	23.353	174
240 min Winter	18.644	226
360 min Winter	13.543	278
480 min Winter	10.792	354
600 min Winter	9.043	428
720 min Winter	7.823	500
960 min Winter	6.219	644
1440 min Winter	4.493	922
2160 min Winter	3.241	1320
2880 min Winter	2.568	1704
4320 min Winter	1.847	2468
5760 min Winter	1.461	3224
7200 min Winter	1.217	3960
8640 min Winter	1.048	4752
10080 min Winter	0.923	5448

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.100

Time (mins)	**Area (ha)**
0-4	0.100

Model Details

Storage is Online Cover Level (m) 90.300

Tank or Pond Structure

Invert Level (m) 89.300

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	900.0	1.000	900.0

Hydro-Brake® Outflow Control

Design Head (m) 0.500 Hydro-Brake® Type Md2 Invert Level (m) 89.300
Design Flow (l/s) 10.0 Diameter (mm) 117

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.6	1.200	15.7	3.000	24.7	7.000	37.8
0.200	8.8	1.400	16.9	3.500	26.7	7.500	39.1
0.300	8.4	1.600	18.1	4.000	28.6	8.000	40.4
0.400	9.1	1.800	19.2	4.500	30.3	8.500	41.7
0.500	10.1	2.000	20.2	5.000	31.9	9.000	42.9
0.600	11.1	2.200	21.2	5.500	33.5	9.500	44.0
0.800	12.8	2.400	22.1	6.000	35.0		
1.000	14.3	2.600	23.0	6.500	36.4		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 715 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	84.326	0.526	2.1	94.1	O K
30 min Summer	84.430	0.630	2.4	122.6	O K
60 min Summer	84.523	0.723	2.6	150.8	Flood Risk
120 min Summer	84.602	0.802	2.8	176.5	Flood Risk
180 min Summer	84.636	0.836	2.9	188.6	Flood Risk
240 min Summer	84.654	0.854	2.9	194.7	Flood Risk
360 min Summer	84.668	0.868	3.0	199.8	Flood Risk
480 min Summer	84.669	0.869	3.0	200.2	Flood Risk
600 min Summer	84.666	0.866	3.0	199.1	Flood Risk
720 min Summer	84.662	0.862	3.0	197.7	Flood Risk
960 min Summer	84.652	0.852	2.9	194.0	Flood Risk
1440 min Summer	84.626	0.826	2.9	185.1	Flood Risk
2160 min Summer	84.583	0.783	2.8	170.4	Flood Risk
2880 min Summer	84.542	0.742	2.7	156.7	Flood Risk
4320 min Summer	84.469	0.669	2.5	134.1	O K
5760 min Summer	84.406	0.606	2.3	115.7	O K
7200 min Summer	84.351	0.551	2.2	100.6	O K
8640 min Summer	84.302	0.502	2.0	88.0	O K
10080 min Summer	84.258	0.458	1.9	77.3	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	26
30 min Summer	84.226	40
60 min Summer	52.662	70
120 min Summer	31.800	128
180 min Summer	23.353	186
240 min Summer	18.644	246
360 min Summer	13.543	364
480 min Summer	10.792	476
600 min Summer	9.043	522
720 min Summer	7.823	582
960 min Summer	6.219	708
1440 min Summer	4.493	982
2160 min Summer	3.241	1392
2880 min Summer	2.568	1796
4320 min Summer	1.847	2600
5760 min Summer	1.461	3360
7200 min Summer	1.217	4112
8640 min Summer	1.048	4848
10080 min Summer	0.923	5560

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	84.369	0.569	2.2	105.5	O K
30 min Winter	84.481	0.681	2.5	137.7	O K
60 min Winter	84.581	0.781	2.8	169.6	Flood Risk
120 min Winter	84.666	0.866	3.0	199.1	Flood Risk
180 min Winter	84.705	0.905	3.1	213.2	Flood Risk
240 min Winter	84.725	0.925	3.1	220.8	Flood Risk
360 min Winter	84.744	0.944	3.2	227.9	Flood Risk
480 min Winter	84.749	0.949	3.2	229.8	Flood Risk
600 min Winter	84.746	0.946	3.2	228.8	Flood Risk
720 min Winter	84.739	0.939	3.2	226.2	Flood Risk
960 min Winter	84.727	0.927	3.1	221.6	Flood Risk
1440 min Winter	84.695	0.895	3.0	209.7	Flood Risk
2160 min Winter	84.638	0.838	2.9	189.3	Flood Risk
2880 min Winter	84.582	0.782	2.8	169.8	Flood Risk
4320 min Winter	84.480	0.680	2.5	137.4	O K
5760 min Winter	84.394	0.594	2.3	112.5	O K
7200 min Winter	84.321	0.521	2.1	92.8	O K
8640 min Winter	84.257	0.457	1.9	76.9	O K
10080 min Winter	84.201	0.401	1.8	64.2	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	26
30 min Winter	84.226	40
60 min Winter	52.662	68
120 min Winter	31.800	126
180 min Winter	23.353	184
240 min Winter	18.644	240
360 min Winter	13.543	354
480 min Winter	10.792	464
600 min Winter	9.043	570
720 min Winter	7.823	662
960 min Winter	6.219	750
1440 min Winter	4.493	1058
2160 min Winter	3.241	1504
2880 min Winter	2.568	1936
4320 min Winter	1.847	2768
5760 min Winter	1.461	3568
7200 min Winter	1.217	4328
8640 min Winter	1.048	5096
10080 min Winter	0.923	5768

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.400

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.100	4-8	0.200	8-12	0.100

Model Details

Storage is Online Cover Level (m) 84.800

Swale Structure

Infiltration Coefficient Base (m/hr)	0.05600	Length (m)	50.0
Infiltration Coefficient Side (m/hr)	0.05600	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	83.800	Cap Infiltration Depth (m)	0.000
Base Width (m)	2.0		

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	84.216	0.416	16.9	83.2	O K
30 min Summer	84.322	0.522	17.2	104.4	O K
60 min Summer	84.384	0.584	18.2	116.7	O K
120 min Summer	84.394	0.594	18.4	118.9	O K
180 min Summer	84.371	0.571	18.0	114.2	O K
240 min Summer	84.338	0.538	17.5	107.6	O K
360 min Summer	84.270	0.470	16.9	94.0	O K
480 min Summer	84.205	0.405	16.9	81.0	O K
600 min Summer	84.142	0.342	16.9	68.4	O K
720 min Summer	84.092	0.292	16.9	58.3	O K
960 min Summer	84.035	0.235	15.9	47.0	O K
1440 min Summer	83.979	0.179	13.1	35.9	O K
2160 min Summer	83.944	0.144	10.1	28.7	O K
2880 min Summer	83.924	0.124	8.1	24.9	O K
4320 min Summer	83.903	0.103	6.0	20.5	O K
5760 min Summer	83.890	0.090	4.8	18.0	O K
7200 min Summer	83.882	0.082	4.0	16.3	O K
8640 min Summer	83.875	0.075	3.4	15.0	O K
10080 min Summer	83.870	0.070	3.0	14.1	O K
15 min Winter	84.270	0.470	16.9	94.0	O K
30 min Winter	84.391	0.591	18.3	118.1	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	22
30 min Summer	84.226	35
60 min Summer	52.662	56
120 min Summer	31.800	90
180 min Summer	23.353	124
240 min Summer	18.644	158
360 min Summer	13.543	226
480 min Summer	10.792	290
600 min Summer	9.043	348
720 min Summer	7.823	402
960 min Summer	6.219	516
1440 min Summer	4.493	752
2160 min Summer	3.241	1108
2880 min Summer	2.568	1472
4320 min Summer	1.847	2204
5760 min Summer	1.461	2936
7200 min Summer	1.217	3664
8640 min Summer	1.048	4400
10080 min Summer	0.923	5136
15 min Winter	128.285	23
30 min Winter	84.226	35

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	84.463	0.663	19.4	132.5	O K
120 min Winter	84.465	0.665	19.4	132.9	O K
180 min Winter	84.426	0.626	18.8	125.2	O K
240 min Winter	84.376	0.576	18.1	115.1	O K
360 min Winter	84.274	0.474	16.9	94.8	O K
480 min Winter	84.173	0.373	16.9	74.6	O K
600 min Winter	84.085	0.285	16.9	57.0	O K
720 min Winter	84.039	0.239	16.1	47.9	O K
960 min Winter	83.989	0.189	13.8	37.8	O K
1440 min Winter	83.947	0.147	10.4	29.4	O K
2160 min Winter	83.919	0.119	7.6	23.7	O K
2880 min Winter	83.903	0.103	6.0	20.7	O K
4320 min Winter	83.886	0.086	4.3	17.1	O K
5760 min Winter	83.876	0.076	3.5	15.1	O K
7200 min Winter	83.869	0.069	2.9	13.7	O K
8640 min Winter	83.864	0.064	2.5	12.7	O K
10080 min Winter	83.860	0.060	2.2	11.9	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
60 min Winter	52.662	60
120 min Winter	31.800	96
180 min Winter	23.353	134
240 min Winter	18.644	170
360 min Winter	13.543	242
480 min Winter	10.792	306
600 min Winter	9.043	354
720 min Winter	7.823	408
960 min Winter	6.219	520
1440 min Winter	4.493	756
2160 min Winter	3.241	1108
2880 min Winter	2.568	1476
4320 min Winter	1.847	2204
5760 min Winter	1.461	2936
7200 min Winter	1.217	3656
8640 min Winter	1.048	4376
10080 min Winter	0.923	5048

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.400

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.100	4-8	0.200	8-12	0.100

Model Details

Storage is Online Cover Level (m) 84.800

Tank or Pond Structure

Invert Level (m) 83.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	1.000	200.0

Hydro-Brake® Outflow Control

Design Head (m) 0.700 Hydro-Brake® Type Md2 Invert Level (m) 83.800
Design Flow (l/s) 20.0 Diameter (mm) 151

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.7	1.200	26.1	3.000	41.2	7.000	63.0
0.200	14.5	1.400	28.2	3.500	44.5	7.500	65.2
0.300	16.8	1.600	30.1	4.000	47.6	8.000	67.3
0.400	15.8	1.800	31.9	4.500	50.5	8.500	69.4
0.500	16.9	2.000	33.7	5.000	53.2	9.000	71.4
0.600	18.4	2.200	35.3	5.500	55.8	9.500	73.3
0.800	21.3	2.400	36.9	6.000	58.3		
1.000	23.8	2.600	38.4	6.500	60.7		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 733 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	99.492	0.492	2.2	99.0	O K
30 min Summer	99.598	0.598	2.4	129.0	O K
60 min Summer	99.694	0.694	2.6	158.6	O K
120 min Summer	99.775	0.775	2.8	185.6	Flood Risk
180 min Summer	99.811	0.811	2.9	198.3	Flood Risk
240 min Summer	99.829	0.829	3.0	204.8	Flood Risk
360 min Summer	99.845	0.845	3.0	210.4	Flood Risk
480 min Summer	99.846	0.846	3.0	211.0	Flood Risk
600 min Summer	99.842	0.842	3.0	209.5	Flood Risk
720 min Summer	99.838	0.838	3.0	207.8	Flood Risk
960 min Summer	99.826	0.826	2.9	203.6	Flood Risk
1440 min Summer	99.798	0.798	2.9	193.6	Flood Risk
2160 min Summer	99.752	0.752	2.8	177.7	Flood Risk
2880 min Summer	99.709	0.709	2.7	163.6	Flood Risk
4320 min Summer	99.634	0.634	2.5	139.7	O K
5760 min Summer	99.567	0.567	2.3	120.1	O K
7200 min Summer	99.509	0.509	2.2	103.6	O K
8640 min Summer	99.456	0.456	2.1	89.7	O K
10080 min Summer	99.410	0.410	2.0	78.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	23
30 min Summer	84.226	37
60 min Summer	52.662	66
120 min Summer	31.800	126
180 min Summer	23.353	184
240 min Summer	18.644	244
360 min Summer	13.543	362
480 min Summer	10.792	480
600 min Summer	9.043	536
720 min Summer	7.823	594
960 min Summer	6.219	718
1440 min Summer	4.493	986
2160 min Summer	3.241	1404
2880 min Summer	2.568	1816
4320 min Summer	1.847	2600
5760 min Summer	1.461	3400
7200 min Summer	1.217	4176
8640 min Summer	1.048	4848
10080 min Summer	0.923	5640

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	99.536	0.536	2.3	111.1	O K
30 min Winter	99.650	0.650	2.5	144.8	O K
60 min Winter	99.754	0.754	2.8	178.4	Flood Risk
120 min Winter	99.842	0.842	3.0	209.3	Flood Risk
180 min Winter	99.883	0.883	3.1	224.3	Flood Risk
240 min Winter	99.904	0.904	3.1	232.3	Flood Risk
360 min Winter	99.924	0.924	3.2	240.1	Flood Risk
480 min Winter	99.930	0.930	3.2	242.4	Flood Risk
600 min Winter	99.928	0.928	3.2	241.5	Flood Risk
720 min Winter	99.921	0.921	3.2	238.9	Flood Risk
960 min Winter	99.907	0.907	3.1	233.5	Flood Risk
1440 min Winter	99.873	0.873	3.1	220.7	Flood Risk
2160 min Winter	99.813	0.813	2.9	198.8	Flood Risk
2880 min Winter	99.753	0.753	2.8	178.2	Flood Risk
4320 min Winter	99.648	0.648	2.5	144.2	O K
5760 min Winter	99.557	0.557	2.3	117.2	O K
7200 min Winter	99.478	0.478	2.1	95.4	O K
8640 min Winter	99.409	0.409	2.0	77.9	O K
10080 min Winter	99.349	0.349	1.8	63.5	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	22
30 min Winter	84.226	37
60 min Winter	52.662	66
120 min Winter	31.800	124
180 min Winter	23.353	182
240 min Winter	18.644	238
360 min Winter	13.543	354
480 min Winter	10.792	464
600 min Winter	9.043	572
720 min Winter	7.823	670
960 min Winter	6.219	756
1440 min Winter	4.493	1066
2160 min Winter	3.241	1516
2880 min Winter	2.568	1960
4320 min Winter	1.847	2772
5760 min Winter	1.461	3576
7200 min Winter	1.217	4328
8640 min Winter	1.048	5104
10080 min Winter	0.923	5848

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.420

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.210	4-8	0.210

Model Details

Storage is Online Cover Level (m) 100.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.05600	Length (m)	45.0
Infiltration Coefficient Side (m/hr)	0.05600	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	99.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	3.0		

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	99.534	0.534	9.5	93.4	O K
30 min Summer	99.683	0.683	9.5	119.6	O K
60 min Summer	99.804	0.804	9.5	140.8	Flood Risk
120 min Summer	99.859	0.859	9.5	150.4	Flood Risk
180 min Summer	99.852	0.852	9.5	149.1	Flood Risk
240 min Summer	99.832	0.832	9.5	145.5	Flood Risk
360 min Summer	99.782	0.782	9.5	136.8	Flood Risk
480 min Summer	99.729	0.729	9.5	127.5	Flood Risk
600 min Summer	99.676	0.676	9.5	118.2	O K
720 min Summer	99.623	0.623	9.5	109.0	O K
960 min Summer	99.522	0.522	9.5	91.4	O K
1440 min Summer	99.353	0.353	9.5	61.7	O K
2160 min Summer	99.224	0.224	9.2	39.2	O K
2880 min Summer	99.175	0.175	8.1	30.6	O K
4320 min Summer	99.133	0.133	6.1	23.3	O K
5760 min Summer	99.111	0.111	4.9	19.5	O K
7200 min Summer	99.097	0.097	4.1	17.0	O K
8640 min Summer	99.088	0.088	3.6	15.3	O K
10080 min Summer	99.080	0.080	3.2	14.0	O K
15 min Winter	99.602	0.602	9.5	105.4	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	21
30 min Summer	84.226	35
60 min Summer	52.662	64
120 min Summer	31.800	120
180 min Summer	23.353	148
240 min Summer	18.644	180
360 min Summer	13.543	248
480 min Summer	10.792	316
600 min Summer	9.043	384
720 min Summer	7.823	452
960 min Summer	6.219	580
1440 min Summer	4.493	810
2160 min Summer	3.241	1144
2880 min Summer	2.568	1480
4320 min Summer	1.847	2208
5760 min Summer	1.461	2936
7200 min Summer	1.217	3672
8640 min Summer	1.048	4400
10080 min Summer	0.923	5136
15 min Winter	128.285	21

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
30 min Winter	99.772	0.772	9.5	135.1	Flood Risk
60 min Winter	99.913	0.913	9.7	159.7	Flood Risk
120 min Winter	99.986	0.986	10.0	172.6	Flood Risk
180 min Winter	99.974	0.974	9.9	170.5	Flood Risk
240 min Winter	99.948	0.948	9.8	165.8	Flood Risk
360 min Winter	99.878	0.878	9.5	153.7	Flood Risk
480 min Winter	99.801	0.801	9.5	140.2	Flood Risk
600 min Winter	99.722	0.722	9.5	126.4	Flood Risk
720 min Winter	99.642	0.642	9.5	112.4	O K
960 min Winter	99.485	0.485	9.5	84.8	O K
1440 min Winter	99.261	0.261	9.5	45.7	O K
2160 min Winter	99.167	0.167	7.8	29.3	O K
2880 min Winter	99.135	0.135	6.3	23.7	O K
4320 min Winter	99.104	0.104	4.5	18.3	O K
5760 min Winter	99.088	0.088	3.6	15.4	O K
7200 min Winter	99.078	0.078	3.0	13.6	O K
8640 min Winter	99.070	0.070	2.6	12.3	O K
10080 min Winter	99.065	0.065	2.3	11.3	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
30 min Winter	84.226	35
60 min Winter	52.662	62
120 min Winter	31.800	118
180 min Winter	23.353	166
240 min Winter	18.644	190
360 min Winter	13.543	268
480 min Winter	10.792	342
600 min Winter	9.043	416
720 min Winter	7.823	488
960 min Winter	6.219	616
1440 min Winter	4.493	820
2160 min Winter	3.241	1144
2880 min Winter	2.568	1496
4320 min Winter	1.847	2208
5760 min Winter	1.461	2936
7200 min Winter	1.217	3672
8640 min Winter	1.048	4400
10080 min Winter	0.923	5120

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.420

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.210	4-8	0.210

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 99.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	175.0	1.000	175.0

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Diameter (mm) 132
Design Flow (l/s) 10.0 Invert Level (m) 99.000
Hydro-Brake® Type Md6 SW Only

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.3	1.200	10.9	3.000	17.2	7.000	26.3
0.200	8.8	1.400	11.8	3.500	18.6	7.500	27.2
0.300	9.5	1.600	12.6	4.000	19.9	8.000	28.1
0.400	9.2	1.800	13.3	4.500	21.1	8.500	29.0
0.500	8.9	2.000	14.1	5.000	22.2	9.000	29.8
0.600	8.8	2.200	14.7	5.500	23.3	9.500	30.6
0.800	9.2	2.400	15.4	6.000	24.4		
1.000	10.0	2.600	16.0	6.500	25.3		

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 316 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	86.557	0.557	9.6	192.2	O K
30 min Summer	86.673	0.673	10.2	248.9	O K
60 min Summer	86.780	0.780	10.7	301.2	Flood Risk
120 min Summer	86.861	0.861	11.1	340.7	Flood Risk
180 min Summer	86.884	0.884	11.3	351.7	Flood Risk
240 min Summer	86.883	0.883	11.3	351.1	Flood Risk
360 min Summer	86.869	0.869	11.2	344.3	Flood Risk
480 min Summer	86.852	0.852	11.1	335.9	Flood Risk
600 min Summer	86.832	0.832	11.0	326.5	Flood Risk
720 min Summer	86.812	0.812	10.9	316.4	Flood Risk
960 min Summer	86.770	0.770	10.7	296.1	Flood Risk
1440 min Summer	86.692	0.692	10.3	258.1	O K
2160 min Summer	86.592	0.592	9.8	209.6	O K
2880 min Summer	86.511	0.511	9.4	169.8	O K
4320 min Summer	86.392	0.392	8.8	112.1	O K
5760 min Summer	86.323	0.323	8.3	78.1	O K
7200 min Summer	86.287	0.287	7.3	61.6	O K
8640 min Summer	86.257	0.257	6.5	49.7	O K
10080 min Summer	86.234	0.234	5.9	41.2	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	25
30 min Summer	84.226	39
60 min Summer	52.662	68
120 min Summer	31.800	126
180 min Summer	23.353	182
240 min Summer	18.644	234
360 min Summer	13.543	290
480 min Summer	10.792	352
600 min Summer	9.043	420
720 min Summer	7.823	490
960 min Summer	6.219	626
1440 min Summer	4.493	898
2160 min Summer	3.241	1284
2880 min Summer	2.568	1656
4320 min Summer	1.847	2380
5760 min Summer	1.461	3048
7200 min Summer	1.217	3752
8640 min Summer	1.048	4488
10080 min Summer	0.923	5152

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	86.606	0.606	9.8	216.1	O K
30 min Winter	86.737	0.737	10.5	280.3	Flood Risk
60 min Winter	86.861	0.861	11.1	340.4	Flood Risk
120 min Winter	86.958	0.958	11.6	387.6	Flood Risk
180 min Winter	86.989	0.989	11.8	402.9	Flood Risk
240 min Winter	86.993	0.993	11.8	405.0	Flood Risk
360 min Winter	86.973	0.973	11.7	395.2	Flood Risk
480 min Winter	86.952	0.952	11.6	384.8	Flood Risk
600 min Winter	86.926	0.926	11.5	372.2	Flood Risk
720 min Winter	86.897	0.897	11.3	358.2	Flood Risk
960 min Winter	86.837	0.837	11.0	329.0	Flood Risk
1440 min Winter	86.723	0.723	10.4	273.5	Flood Risk
2160 min Winter	86.579	0.579	9.7	203.2	O K
2880 min Winter	86.466	0.466	9.1	147.9	O K
4320 min Winter	86.324	0.324	8.4	78.7	O K
5760 min Winter	86.271	0.271	6.9	54.9	O K
7200 min Winter	86.233	0.233	5.9	40.6	O K
8640 min Winter	86.204	0.204	5.1	31.3	O K
10080 min Winter	86.182	0.182	4.5	24.9	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	25
30 min Winter	84.226	39
60 min Winter	52.662	66
120 min Winter	31.800	124
180 min Winter	23.353	180
240 min Winter	18.644	234
360 min Winter	13.543	328
480 min Winter	10.792	376
600 min Winter	9.043	454
720 min Winter	7.823	530
960 min Winter	6.219	680
1440 min Winter	4.493	968
2160 min Winter	3.241	1368
2880 min Winter	2.568	1736
4320 min Winter	1.847	2376
5760 min Winter	1.461	3064
7200 min Winter	1.217	3752
8640 min Winter	1.048	4496
10080 min Winter	0.923	5160

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.840

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.210	4-8	0.420	8-12	0.210

Model Details

Storage is Online Cover Level (m) 87.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.05600	Trench Width (m)	3.0
Infiltration Coefficient Side (m/hr)	0.05600	Trench Length (m)	325.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	0.50	Cap Volume Depth (m)	0.000
Invert Level (m)	86.000	Cap Infiltration Depth (m)	0.000

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 365 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	86.555	0.555	0.0	9.5	9.5	191.1	O K
30 min Summer	86.671	0.671	0.0	9.5	9.5	247.8	O K
60 min Summer	86.778	0.778	0.0	9.5	9.5	299.9	Flood Risk
120 min Summer	86.857	0.857	0.0	9.5	9.5	338.8	Flood Risk
180 min Summer	86.879	0.879	0.0	9.5	9.5	349.5	Flood Risk
240 min Summer	86.878	0.878	0.0	9.5	9.5	348.6	Flood Risk
360 min Summer	86.853	0.853	0.0	9.5	9.5	336.6	Flood Risk
480 min Summer	86.828	0.828	0.0	9.5	9.5	324.5	Flood Risk
600 min Summer	86.804	0.804	0.0	9.5	9.5	312.8	Flood Risk
720 min Summer	86.781	0.781	0.0	9.5	9.5	301.6	Flood Risk
960 min Summer	86.737	0.737	0.0	9.5	9.5	280.0	Flood Risk
1440 min Summer	86.653	0.653	0.0	9.5	9.5	239.2	O K
2160 min Summer	86.535	0.535	0.0	9.5	9.5	181.8	O K
2880 min Summer	86.430	0.430	0.0	9.5	9.5	130.5	O K
4320 min Summer	86.288	0.288	0.0	9.5	9.5	62.4	O K
5760 min Summer	86.212	0.212	0.0	9.1	9.1	33.6	O K
7200 min Summer	86.175	0.175	0.0	8.1	8.1	22.9	O K
8640 min Summer	86.152	0.152	0.0	7.1	7.1	17.3	O K
10080 min Summer	86.136	0.136	0.0	6.3	6.3	13.9	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	128.285	25
30 min Summer	84.226	39
60 min Summer	52.662	68
120 min Summer	31.800	126
180 min Summer	23.353	184
240 min Summer	18.644	242
360 min Summer	13.543	314
480 min Summer	10.792	378
600 min Summer	9.043	440
720 min Summer	7.823	508
960 min Summer	6.219	646
1440 min Summer	4.493	916
2160 min Summer	3.241	1304
2880 min Summer	2.568	1676
4320 min Summer	1.847	2336
5760 min Summer	1.461	2992
7200 min Summer	1.217	3680
8640 min Summer	1.048	4408
10080 min Summer	0.923	5136

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	86.604	0.604	0.0	9.5	9.5	215.3	O K
30 min Winter	86.736	0.736	0.0	9.5	9.5	279.6	Flood Risk
60 min Winter	86.859	0.859	0.0	9.5	9.5	339.6	Flood Risk
120 min Winter	86.956	0.956	0.0	9.9	9.9	387.0	Flood Risk
180 min Winter	86.988	0.988	0.0	10.0	10.0	402.5	Flood Risk
240 min Winter	86.993	0.993	0.0	10.0	10.0	404.7	Flood Risk
360 min Winter	86.972	0.972	0.0	9.9	9.9	394.7	Flood Risk
480 min Winter	86.939	0.939	0.0	9.8	9.8	378.5	Flood Risk
600 min Winter	86.909	0.909	0.0	9.7	9.7	364.0	Flood Risk
720 min Winter	86.878	0.878	0.0	9.5	9.5	348.9	Flood Risk
960 min Winter	86.815	0.815	0.0	9.5	9.5	318.2	Flood Risk
1440 min Winter	86.690	0.690	0.0	9.5	9.5	257.4	O K
2160 min Winter	86.508	0.508	0.0	9.5	9.5	168.6	O K
2880 min Winter	86.353	0.353	0.0	9.5	9.5	92.9	O K
4320 min Winter	86.200	0.200	0.0	8.8	8.8	29.9	O K
5760 min Winter	86.154	0.154	0.0	7.2	7.2	17.8	O K
7200 min Winter	86.131	0.131	0.0	6.0	6.0	12.8	O K
8640 min Winter	86.116	0.116	0.0	5.2	5.2	10.0	O K
10080 min Winter	86.105	0.105	0.0	4.6	4.6	8.3	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	128.285	25
30 min Winter	84.226	39
60 min Winter	52.662	68
120 min Winter	31.800	124
180 min Winter	23.353	180
240 min Winter	18.644	236
360 min Winter	13.543	344
480 min Winter	10.792	396
600 min Winter	9.043	470
720 min Winter	7.823	546
960 min Winter	6.219	700
1440 min Winter	4.493	998
2160 min Winter	3.241	1396
2880 min Winter	2.568	1728
4320 min Winter	1.847	2292
5760 min Winter	1.461	2944
7200 min Winter	1.217	3672
8640 min Winter	1.048	4400
10080 min Winter	0.923	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.840

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.210	4-8	0.420	8-12	0.210

Model Details

Storage is Online Cover Level (m) 87.000

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	3.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	325.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	0.50	Cap Volume Depth (m)	0.000
Invert Level (m)	86.000	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Outflow Control

Design Head (m)	1.000	Diameter (mm)	132
Design Flow (l/s)	10.0	Invert Level (m)	86.000
Hydro-Brake® Type	Md6 SW Only		

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	4.3	1.200	10.9	3.000	17.2	7.000	26.2
0.200	8.8	1.400	11.7	3.500	18.6	7.500	27.2
0.300	9.5	1.600	12.6	4.000	19.8	8.000	28.1
0.400	9.2	1.800	13.3	4.500	21.0	8.500	28.9
0.500	8.8	2.000	14.0	5.000	22.2	9.000	29.8
0.600	8.8	2.200	14.7	5.500	23.3	9.500	30.6
0.800	9.2	2.400	15.4	6.000	24.3		
1.000	10.0	2.600	16.0	6.500	25.3		

Hyder Consulting	CALCULATIONS	DOCUMENT No **7015-UA001881-UP21B-01**

OFFICE	PROJECT TITLE
CARDIFF	**NW Bicester Eco Development**

SUBJECT	SHEET No
Surface Water Catchment Areas	1 OF 1

ISSUE	TOTAL SHEETS	AUTHOR	DATE	CHECKED BY	DATE	APPROVED BY	DATE	COMMENTS
1	**1**	**MP**	**25/03/11**	**DCB**	**25/03/11**	**SAD**	**25/03/11**	
2								
3								
4								
5								

SUPERSEDES DOC No | DATE

DESIGN BASIS STATEMENT (Inc. sources of info/data, assumptions made, standards, etc.)

Introduction

This calculation has been prepared to establish the contributing impermeable area for each group of SuDS features based on topographically derived catchment areas.

Assumptions

1) Catchment areas are as shown on drawings 7160 & 7161 UA001881-UP21D-02, and have been measured for this calculation using AutoCAD.

1) Contributing areas are derived from the area of impermeable paving adjacent to the SuDS features within the catchment, plus 20% of the remaining impermeable area for the catchment.

3) Main commercial areas are assumed to provide surface water storage within the plot boundary, and have been omitted from these calculations.

Calculation

Catchment	Total Catchment Area (ha)	Impermeable Paving (ha)	20% of Remaining Catchment (ha)	Contributing Area (ha)
1	2.00	0.13	0.38	0.50
2	2.15	0.10	0.41	0.51
3		0.28		0.28
4	1.55	0.09	0.29	0.38
5	1.45	0.08	0.28	0.35
6		0.10		0.10
7	1.45	0.15	0.26	0.41
8	1.20	0.22	0.20	0.42
9	2.85	0.34	0.50	0.84

Hyder	CALCULATIONS			DOCUMENT No 7016-UA001881-UP21B-01				
OFFICE Cardiff				PROJECT TITLE NW Bicester Eco-Town				
SUBJECT Greenfield Runoff - Volumetric Calculation								SHEET No 1 OF 1
ISSUE	TOTAL SHEETS	AUTHOR	DATE	CHECKED BY	DATE	APPROVED BY	DATE	COMMENTS
1	**1**	**DCB**	**25/03/11**	**MP**	**25/03/11**	**SAD**	**25/03/11**	
2								
3								
4								
5								
SUPERSEDES DOC No								DATE

DESIGN BASIS STATEMENT (Inc. sources of info/data, assumptions made, standards, etc.)

Introduction

This calculation has been prepared to assess the greenfield runoff volume in accordance with The SUDS Manual (CIRIA) - Section 4.2.2: Estimating greenfield runoff volumes.

For the purpose of this calculation we have used the FSSR 16 runoff model - fixed percentage runoff, assuming larger rainfall depths.

Assumptions

1) Catchment Area = 17.5 Ha
2) SPR = 13.1 (obtained from FEH descriptors)
3) CWI = 103 (obtained from The SUDS Manual - Fig 4.4 for an annual average rainfall of 647mm)
4) Rainfall Depth (P) = 62.5mm (obtained through Windes modelling for the 100 year 360 minute storm)

Results

The SUDS Manual - Box 4.3:

Percentage Runoff (PR_{RURAL}) $= SPR + DPR_{CWI} + DPR_{RAIN}$

Where:

- $DPR_{CWI} = 0.25 \times (CWI - 125) = -5.5$
- $DPR_{RAIN} = 0.45\ (P - 40)^{0.7} = 4.0$

Therefore:

$PR_{RURAL} = 13.1 + (-5.5) + 4.0 = 11.6\ \%$

The SUDS Manual - Section 4.2.2:

Runoff Volume = Percentage Runoff (PR) x Catchment Area x Rainfall Depth
= 0.116 x 175,000 x 0.0625
= $\underline{1{,}270\ m^3}$

The above runoff volume represents the approximate existing greenfield runoff for the undeveloped Exemplar Site.

Assuming the proposed development is to be limited to the same runoff volume of $1{,}270 m^3$, this would equate to the discharge volume from a developed area of approximately $25{,}400 m^2$ (2.5 Ha), assuming a PR of 80%.

Appendix E

FOUL WATER LOADINGS

7006-UA001881- Site Sewage Generation

Hyder Consulting	CALCULATIONS	DOCUMENT No **7006-UA001881-UP21B-03**

OFFICE	PROJECT TITLE
CARDIFF	**NW Bicester Eco Development**

SUBJECT	SHEET No
Exemplar Site Sewage Generation Calculation	1 **OF 2**

ISSUE	TOTAL SHEETS	AUTHOR	DATE	CHECKED BY	DATE	APPROVED BY	DATE	COMMENTS
1	**2**	**DB**	**02/09/10**	**SD**	**02/09/10**	**SD**	**02/09/10**	
2	**2**	**DB**	**12/11/10**	**MP**	**12/11/10**	**SD**	**12/11/10**	
3	**2**	**DB**	**25/11/10**	**MP**	**25/11/10**	**SD**	**25/11/10**	
4								
5								
SUPERSEDES DOC No								DATE

DESIGN BASIS STATEMENT (Inc. sources of info/data, assumptions made, standards, etc.)

Property information (use, size, etc.):

Plot areas and land use split in accordance with data provided within the Exemplar Site masterplan non-residential buildings brief (4/11/2010) and Accommodation Schedule (29/10/1010).

Water Demand:

Conventional Development Rates:
Thames Water Guidelines for Undertaking Sewerage Modelling (November 2005)

Sustainable Development Rates:
Code For Sustainable Homes Technical Guide (May 2009 - Version 2)
BREEAM Offices - Assessment Prediction Checklist

NW Bicester Eco Development
7006-UA001881-UP21B-03
Exemplar Site Sewage Generation Calculation

Land Use	Area (m2)	Number of Properties	Total Population	Water Consumption (l/person[m2]/day)	Rainwater Harvesting Contribution (l/person[m2]/day)	Average Discharge (l/day)	Average Discharge (l/s)	Peak Discharge (l/s)
Residential		400	1151	80	12.00	105,928.80	3.68	22.07
Social / Community	540	N/A	123	6.5	0.98	920.45	0.03	0.19
Commercial	3,610	N/A	820	6.5	0.98	6,153.41	0.21	1.28
Restaurant	300	N/A	68	162	24.30	12,702.27	0.44	2.65
Retail / Leisure	660	N/A	N/A	2.4	0.36	1,821.60	0.06	0.38
Education	1,110	N/A	139	48	7.20	7,659.00	0.27	1.60
						135,185.54	4.69	28.16
Development Total						**135,186**	**5**	**28**

Assumptions:

Factors

Peaking Factor 6 [Conversion from average discharge rate to peak discharge rate]

Infiltration 0%

Rainwater Harvesting 15% [Additional contribution to foul discharge rates]

Residential:

Baseline for Conventional Development 150 l/person/day [Thames Water Guidelines for Undertaking Sewerage Modelling (November 2005): General Housing = 600 l/property/day]

Sustainable Development 80 l/person/day [Code for Sustainable Homes (Level 6)]

Residential split
- Affordable 123
- Private 270

Residents per property
- Affordable 4.40
- Private 2.26

Water consumption assumed to be over an 8 hour day

Commercial (Offices / Hairdressers) and Social / Community:

Baseline for Conventional Development 33 l/person/day [Thames Water Guidelines for Undertaking Sewerage Modelling (November 2005): Offices = 750 l/100m2/day (population density as below)]

Sustainable Development 6.5 l/person/day [BREEAM Offices 2005 (16-24 points): 1.5m3 per person per year (assume 230 working days per year)]

Staff density 4.4 m2/person [The Workplace (Health, Safety & Welfare) Regulations 1992: Minimum working space = 11m3 (assume 2.5m high)]

Water consumption assumed to be over an 8 hour day

Restaurant (Take-away / Pub):

Baseline for Conventional Development 270 l/person/day [Thames Water Guidelines for Undertaking Sewerage Modelling (November 2005): Restaurant = 270 l/seat/day (population density as below)]

Sustainable Development 162 l/person/day [Assume 40% reduction from baseline]

Staff / customer density 4.4 m2/person [Assumption - The Workplace (Health, Safety & Welfare) Regulations 1992: Minimum working space = 11m3 (assume 2.5m high)]

Water consumption assumed to be over an 8 hour day

Retail / Leisure:

Baseline for Conventional Development 4 l/m2/day [Thames Water Guidelines for Undertaking Sewerage Modelling (November 2005): Shopping Centre = 400 l/100m2/day]

Sustainable Development 2.4 l/m2/day [Assume 40% reduction from baseline]

Water consumption assumed to be over an 8 hour day

Education:

Baseline for Conventional Development 80 l/person/day [Thames Water Guidelines for Undertaking Sewerage Modelling (November 2005): School]

Sustainable Development 48 l/person/day [Assume 40% reduction from baseline]

Pupil density 8 m2/pupil [Assumption]

Water consumption assumed to be over an 8 hour day

Appendix F

CORRESPONDENCE

TW email 23 Nov 2010

Subject: FW: NW Bicester eco-town - Kick-off meeting with Thames Water

-----Original Message-----
From: Andrew.Forestiero@thameswater.co.uk
[mailto:Andrew.Forestiero@thameswater.co.uk]
Sent: 22 November 2010 23:13
To: Michael Pearson
Cc: Angela.Barugh@thameswater.co.uk; Geoff.Nokes@thameswater.co.uk; Karl.Tuchscherer@thameswater.co.uk; Nick.Ayling@thameswater.co.uk; Pete.Pearce@thameswater.co.uk
Subject: RE: NW Bicester eco-town - Kick-off meeting with Thames Water

Dear Mike,

Apologies for the delay in responding. Geoff Nokes made the following point in relation to the Exemplar site:

A Grampian condition will be imposed on this planned development to ensure that any identified reinforcement works will be carried out prior to occupation and thus avoid detrimental impact on our wastewater network. It should be possible to accommodate much of the Exemplar site without reinforcement but the trigger point will need to be identified prior to occupation and this will be the condition, especially as the Mid Level Sustainability Peak Discharge may have not yet been agreed on this first phase.

I understand that you are progressing matters with Karl regarding water network reinforcement.

Hope this helps.

Kind regards,

Andy

Andy Forestiero
Customer Led Manager
Developer Services
07747 642805
Int. 42805