

Hyde Park Hayes Development

HPH4 and HPH5

Report on Flood Risk Assessment and Surface
Water Drainage Strategy

July 2012

Halcrow Group Limited

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Hyde Park Hayes Development HPH4 and HPH5

Report on Flood Risk Assessment and Surface Water Drainage Strategy

Contents Amendment Record

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1 Introduction and Scope

Halcrow has been commissioned to undertake a Flood Risk Assessment (FRA) for the development of a site adjacent to Millington Road, Hyde Park Hayes HPH4 and HPH5. The site falls within London Borough of Hillingdon. The primary objective of this assessment is to obtain a Building Research Establishment Environmental Assessment Method (BREEAM) accreditation for the proposed development. Although HPH4 and HPH5 will be covered under separate planning applications, they are being considered under a single site for flood risk assessment and subsequent surface water drainage strategy due to their proximity and connectivity

The FRA has followed the BREEAM Policy 5 (Flood Risk, Education, 2008) guidance and reviewed flood risks from all sources of flooding applicable to the site: groundwater, surface water, fluvial and sewers. The BREEAM policy document refers to Planning Policy Statement 25: Development and Flood risk (PPS25) set out by Communities and Local Government. This document has been superseded by National Planning Policy Framework (NPPF) published in March 2012. However it is apparent that the guidance for the flood risk assessment is similar to that provided in PPS25. NPPF states that even if a development is outside of the flood plain (Flood Zone 1), it can generate significant volume of surface water that needs to be managed so that there is no impact upon others and the surrounding area.

This report presents the surface water drainage design strategy in relation to the development proposal and provides details of the methodology followed to assess the flood risk. It also discusses how the risk has been mitigated and controlled by integrating necessary storage/attenuation facilities into the drainage design.

The approach set out in Department for Environment, Food and Rural Affairs (DEFRA) /Environment Agency (EA) Flood Risk User Guide has been used to estimate the design parameters to calculate the discharge rate and storage facilities. The criteria state that the discharge flow rate from the redevelopment site should be less than or equivalent to the runoff generated from the existing site in its current state for storm events of up to and including those with 1 in 100 year return period, plus an allowance for climate change.

The proposed surface water drainage network design is provided in this report to support FRA and to acquire planning approval from Thames Water as the site drainage discharges to Thames Water's sewers.

The capacity of existing sewers receiving the site runoff is taken into account for an assessment of the permissible discharge rate for the proposed development and for the subsequent attenuation requirements.

The FRA and the drainage strategy have mainly drawn upon the sources of information as provided below:

- Hyde Park Hayes Stage D Report – May 2012, prepared by 3D Reid
- Topographical Survey Drawing No 10004-115_3DT showing the existing site drainage details
- Landscape Master Plan – HED.983.102 Rev C prepared by Hyland Edgar Driver
- National Planning Policy Framework (NPPF) and Technical Guidance on NPPF published in March 2012 by Communities and Local Government
- DEFRA/EA Flood Risk user guide for the calculation of discharge rates and attenuation requirements
- Consultation with Environment Agency, London Borough of Hillingdon and Thames Water

2

Site Description

2.1

Location

The development site is located within existing Business Park known as Hyde Park Hayes, Greater London. The site is bounded by Millington Road to the north and east, and by Dawley Road to the west. The location of the site is detailed in the figure below and selected physical data is provided in Table 1.

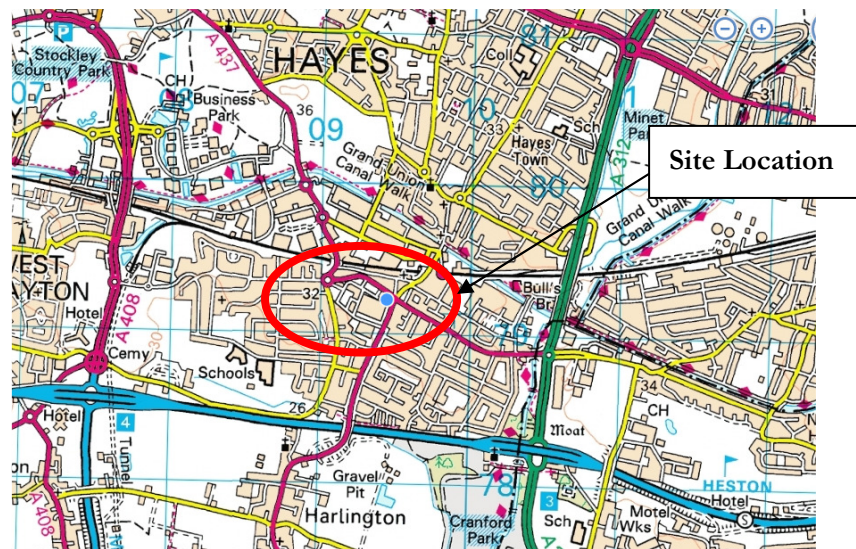


Figure showing site location

Based upon the Ordnance Survey Map with the Permission of the Controller of Her Majesty's Stationery Office Crown copyright. All rights reserved. Environment Agency, 100026380, 2006

Table 1: Selected physical data for the development

Approximate Elevation	31 to 32 mAOD
Grid Ref	509210, 179260
Post Code	UB3 4AZ

Both sites are brownfield, with the former buildings having been demolished. The topographical surveys indicate that the site lies on relatively level ground, with a slight fall towards the south east.

2.2

The Drainage Catchment

Review of the drainage surveys for the site indicates that there are surface water sewers across the development site. The drainage network that runs through the site also serves the existing development at north of development. The collective drainage for the development sites, including the associated catchment to the north, currently discharge into manhole MH216 located at the southern edge of HPH4 site boundary. See Figure 1 for the extent of existing site drainage and associated catchment.

The drainage information also indicates that the private road east to HPH5 is served by soakaways and the connectivity to the existing site drainage at this location is unclear. It is noted that the existing site for development of HPH4 and HPH5 are brownfield and hence the pre-development runoff rates are to be calculated for the catchment as fully impermeable areas.

2.3

Development Proposal

The HPH4 site was formerly occupied by a mixed use building which contained office facilities, storage space, and a canteen serving several buildings on the site. This building has been demolished in preparation for the new development. The proposed development covers an area of 0.36 hectares and will consist of a four storey office building with basement parking.

The HPH5 site was a warehouse containing spare parts for the automotive industry, which has also been demolished. The proposed development at HPH5 site covers an area of 0.63 hectares and will consist of a five storey office building with basement parking. The HPH5 development also includes a section of Millington Road, approximately 0.21 hectares which serves both HPH4 and HPH5 and will be upgraded as part of the development. Arrangements of the proposed developments can be seen in Figure 2.

The contributing catchment areas for the proposed surface water drainage strategy are provided in Table 2 below.

Table 2: Site drainage catchment

Drainage Catchment	Contributing Area (ha)
HPH4	0.3634
HPH 5	0.8457
Development north of HPH4	0.7062
Development north of HPH5	0.200
Total	2.1153

Note – HPH5 site catchment includes 0.21 ha of public and private roads. The proposed surface water sewers will continue to provide drainage for development north of HPH4 and HPH5 sites and thus considered as a part of total catchment for development.

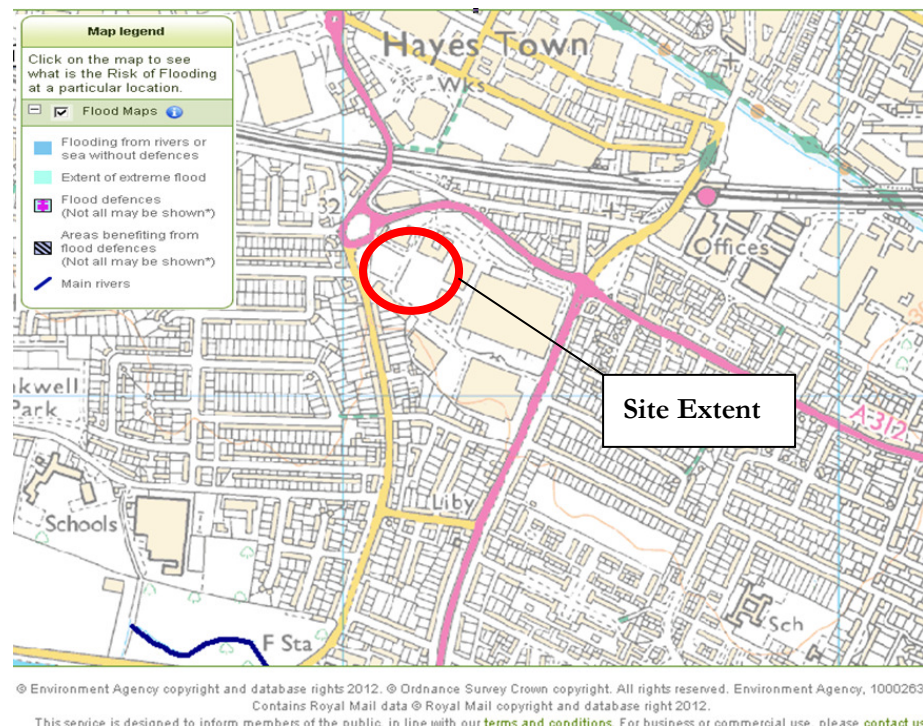
Table 2 shows the contributing areas used to calculate runoff from the site. It should be noted that in both its pre-development and post-development state, the site is considered to be fully impermeable and as such volumes and peak flow rates will remain broadly the same. However, an allowance of 30% for climate change will result in higher flows to be accommodated in the system. Although the landscape master plan for the development site includes some soft landscaping, grass verges and permeable paving, the development has been considered as fully impermeable to determine the runoff rates for design storms and for the drainage proposals provided in this report. The unaccounted green/porous pavement areas within the development proposal are considered as providing wider benefits not considered here.

The drainage proposal for the development site will continue to discharge into the existing sewers (MH216) off the site prior to connecting to Thames Water's network. As the connectivity of the road drainage and soakaways east of HPH5 is unclear, the drainage strategy shall demonstrate that the discharge from the proposed development has been limited to existing sewer capacity for the design storm events and that there is no impact on the Thames Water's sewers.

2.4

Flood Risk

The flood envelope published on the Environment Agency's website as shown below indicates that the site is in fluvial flood zone 1 (low annual probability of flooding). However the Environment Agency's flood map does not include flooding from groundwater, surface waters or sewers. A flood risk assessment is required nevertheless as the site is greater than 1 ha in area, and for the BREEAM assessment.



Environment Agency Indicate Flood Plain (Zone 1)

Whilst there is a little risk of fluvial flooding, the flood risk assessment needs to consider the adequacy of the drainage system cope with the surface water runoff and to ensure that the runoff from the proposed development site will be limited to the pre-development conditions. There is no anecdotal evidence of the site being flooded in the past.

3

Methodology

3.1

National Planning Policy Framework

National Planning Policy Framework (NPPF) supersedes Planning Policy Statement 25: Development and Flood Risk (PPS25). NPPF sets out the Government Policy on development and flood risk, and requires local planning authorities to apply a risk-based approach in the preparation of development plans and the decisions on development control through a sequential test. NPPF uses “Flood Zones” to assist in applying sequential tests in flood sensitivity locations. Flood zones provide an indication of the likelihood of flooding and the predicted extent of the natural flood plain and extreme flood events.

Table 1 of Technical guidance to NPPF defines Flood Zone 1 as a little or no risk zone. The “Consultation Matrix” provided on EA’s website states that there is no requirement for an Exception Test to be carried out on any development in a Zone 1 flood area.

The technical guidance to the NPPF states that for development proposals on sites greater than 1 hectare in Flood Zone 1, the vulnerability to flooding from other sources as well as from river and sea flooding and the potential to increase the flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff, should be incorporated in a FRA. It also states that the FRA should seek opportunities to reduce overall level of flood risk in the area and beyond through the layout and form of development, and the appropriate application of sustainable drainage systems.

3.2

Effects of Climate Change

In general climate change is expected to result in an increase in rainfall intensity, higher peak river flows and a rise in net sea levels. Current technical guidance to NPPF Table 5 states that for peak rainfall intensity an additional 30% should be added for climate change assuming the design life of the development is 100 years.

3.3

DEFRA-EA Flood Risk User Guide

This guide stipulates that the discharge rate from the proposed development should be less than or equivalent to the runoff generated from the existing site in its current state, for storm events up to and including those with 1 in 100 year storm return period plus climate change. To achieve this requirement,

attenuation/storage will need to be provided within the site boundary. The pre-development and post-development runoff has been determined using Wallingford Procedure Volume 4 – Modified Rational Method.

3.4

London Borough of Hillingdon (LBH) - SFRA and PFRA

London Borough of Hillingdon commissioned Scott Wilson Group to develop a Strategic Flood Risk Assessment (SFRA). The assessment was issued in November 2008 and is available on the council's website. In 2011, Scott Wilson Group and Capita Symonds completed a Preliminary Flood Risk Assessment (PFRA) for the London Borough of Hillingdon. This document built upon the findings of the SFRA to produce a high level overview of the flood risk from all sources within the borough. The SFRA and PFRA have been used as the principal sources of data for an assessment of flood risk in this report.

3.5

Development Control Thames region, SUDS – A practical guide

In the Environment Agency publication, *Development Control Thames Region, SUDS – A practical guide (2006)*, the underlying principles to surface water management are that surface water runoff should be controlled as close as possible to its source before it is discharged to a watercourse or sewer. This involves moving away from traditional piped drainage systems towards softer engineering solutions which seek to mimic natural drainage regimes. The guide also identifies a list of criteria by which drainage system design should be governed, as detailed below:

- Seek greenfield discharge rates on greenfield sites, and on brownfield sites where possible
- Demonstrate that opportunities to implement sustainable drainage techniques at the site have been maximised.
- Demonstrate that the surface water drainage system can accommodate any storm event for the site with the flow balancing system being bypassed.

3.6

London Plan and Supplementary Planning Guidance

The Greater London Assembly published the London Plan, Spatial development Strategy for Greater London in July 2011. The published London Plan is a statutory planning document, and covers period of up to 2031. The London Plan also sets out policies pertaining to flood risk that should be considered as a part of the development process. The relevant policies include Flood Risk Management, Sustainable Drainage, Water Quality, and Wastewater Infrastructure. The Mayor of London has also published Supplementary Planning Guidance (SPG) to provide

additional information and support the implementation of the London Plan. Under various sustainable design and construction categories, the SPG sets out “Essential Standards”, that must be met by new developments and “Preferred Standards” which are desirable. In particular these include:

- Use of Sustainable Drainage Systems, wherever practical.
- Achieve 50% attenuation of the undeveloped site’s surface water run-off at peak times.

3.7

Existing Sewers Capacity and Permissible Discharge Rate

As noted in Section 2.3 it is intended to discharge runoff generated at the development to Thames Water’s surface water drainage network. Runoff from adjacent areas that currently discharges to the development (piped flows and overland flows) will also be discharged to Thames Water’s network. The runoff will be conveyed to the Thames Water network by an existing surface water sewer.

The capacity of the existing sewer is not sufficient to convey the runoff from the development site in its current (brown field) state; refer to Section 5.3 for details. For design strategy purposes, the full bore capacity of the existing sewer has therefore been used as a baseline to demonstrate that the rate of discharge from the new development to the Thames Water network does not exceed the current rate of discharge.

For severe storms, the existing sewer is probably operates under surcharged conditions. Under surcharged conditions the existing sewer will generate flows in excess of the full bore capacity. Restricting flows to the full bore capacity is therefore likely to provide betterment in terms of the rate of discharge the Thames Water network during severe storms.

4 Flood Risk Assessment

4.1 *Introduction*

Flood risk assessments should be carried out to the appropriate degree at all levels of the planning process, to assess the risks of all forms of flooding to and from the development taking climate change into account and to substantiate the application of the NPPF sequential test approach.

4.2 *Assessment of flood risk*

4.2.1 *Flooding sources*

In accordance with the NPPF definition, the main flooding sources associated with the proposed development could be from:

- Rivers
- The sea
- Land
- Groundwater
- Sewers

These forms of flooding and their applicability to the development site in terms of flood risk are detailed below.

4.2.2 *Flooding from rivers (fluvial)*

Rivers flood when the amount of water in them exceeds the flow capacity of the river channel. Review of the Environment Agency Flood Map indicates that the site lies wholly within Flood Zone 1. As a result, risk of flooding at the development site due to fluvial flooding is not considered to be an issue.

4.2.3 *Flooding from the sea (tidal)*

Flooding from the sea is caused by storm surges and high tides. Where tidal defences exist, they can be overtopped or breached during a severe storm, which may become more likely with climate change. Sea flooding alone is not considered to be an issue as the Thames Tidal Defence system provides defence against tidal flood for a 1 in 1000 year return period.

The Thames Barrier is the main structure of the Thames Tidal Defence system. It has been used to control risk of fluvial flooding to the upper stretches of the

Thames by closing during low tides, thereby increasing the storage capacity of the river for fluvial waters during extreme events.

The London Borough of Hillingdon is a land-locked borough and none of its rivers are subject to tides. Tidal flooding is not an issue at the site, as the site lies in Flood Zone 1.

4.2.4

Flooding from land (pluvial)

Intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems can quickly run off land and result in local flooding.

The PFRA investigated historic flooding within the borough from a number of sources to identify areas of past and future risk. The PFRA has not identified any historic pluvial flooding incidents at or near the site. The PRFA also summarised future flood risk from surface water flooding that is being undertaken as part of the Storm Water Management Plan for London Borough of Hillingdon, which has not been published at the time of writing. The PFRA includes preliminary Flood Hazard Ratings and flow directions based on the 1 in 200 year rainfall event. The majority of the site is identified as lying within the Caution Zone (very low hazard), with a very small corner of the site lying within the Moderate Zone (danger for some). It is likely that these zones are the result of local topography and as such is not significant for the whole development site.

Due to the above, pluvial flooding is not considered an issue for the site.

4.2.5

Flooding from groundwater

Groundwater flooding occurs when water levels in the ground rise above surface elevations. The SFRA notes that an assessment of risk from groundwater flooding is difficult to undertake due to a lack of groundwater record data, the variability in geological conditions and a lack of predictive groundwater modelling tools. Neither the SFRA nor the PFRA identified any historical groundwater flooding events at or near the site.

The PRFA identifies areas of 'increased Potential for Elevated Groundwater' based on available groundwater flood maps and general underlying ground conditions across the borough. These are high level assessments and do not consider any areas that may be vulnerable due to localised conditions. The map shows areas where there is an increased potential for the groundwater to rise sufficiently to interact with the ground surface or be within 2m of the ground surface. The

majority of the site is identified as being within the low risk zone, with a small portion of the site to the west falling within an area of permeable superficial deposits, giving rise to a higher likelihood of elevated groundwater.

The geotechnical assessment included as part of the Hyde Park Hayes Stage D Report indicates that groundwater levels were in the region of 3.5m below ground, which indicates that flooding is unlikely to be an issue.

Notwithstanding the above, there is no known history of groundwater flooding in this area and thus has not been considered further.

4.2.6

Flooding from sewers

In urban areas, rainwater is frequently drained to surface water or combined sewers. Flooding can occur when the sewer is overwhelmed, becomes blocked, or is of insufficient capacity. Topographic survey of the site indicates that there are private foul and surface water sewers along Millington Road, most of which are connected to Thames Water networks in the main roads around the site.

The SFRA acknowledges that there is a lack of appropriate record data for sewer flooding. Based on what data is available, the SFRA indicates areas that are at risk from groundwater, pluvial or sewer flooding. The development sites outside of the areas identified.

The PFRA uses sewer flood data obtained from Thames Water to map the historical sewer flooding events based on the 4-digit post code. The development site has no historical sewer flooding events. As a result, sewer flooding at the site is not considered to be an issue.

4.3

Flood Risk Assessment Summary

The review of the flooding risk from all sources as discussed in section 4.2 suggests that the proposed development site has a low flood risk in its current conditions. However, the guidance provided in NPPF states that although the development is outside the flood plain with minimum flood risk, it can generate significant volumes of surface water that need to be managed so that there is no impact upon others and the surrounding area. The surface water drainage strategy for the development site is outlined in Section 5.

5

Surface Water Drainage Strategy

5.1

Introduction

This section covers the surface water drainage strategy in relation to the proposed development sites HPH4 and HPH5. The drainage proposals for the site are in accordance with the guidance set out in the NPPF and DEFRA/EA flood risk user guide. The proposal has also taken into account the various guidance on flood risk as discussed in Section 3 of this report. The EA will be consulted to obtain an approval on the drainage proposal provided in this report.

The surface water drainage strategy detailed in this report considers the rerouting of sewers across the development and indicates suitable connection points to existing sewers. Thames Water will be consulted to confirm the feasibility of the drainage strategy provided in this report.

5.2

Approach

The discharge flow rate from the pre-development site is calculated for the storm events up to and including those with 1 in 100 year return period to assess the current discharges into existing sewers. Similarly the post-development runoff is determined considering the effect of climate change as an additional 30% of peak runoff for the 1 in 100 year return period storm event. The attenuation requirements for the relevant design storms are determined to balance the increase in runoff from the post-development site with climate change.

The drainage proposal has identified common a discharge point on a line of existing sewers. These sewers are connected to Thames Water's sewers further downstream and hence an assessment is required on the permissible discharge rate to existing sewers. The existing sewers capacity check has been made and compared against the pre-development discharge rates for relevant design storms. The attenuation and storage requirements are further reviewed in line with the restricted capacity of existing sewers.

The surface water drainage design has followed sustainable drainage design (SUDS) principles and maximised the use of SUDS features to the extent possible for the site conditions. WinDES software package 12.6.1 is used for the determination of storage volumes and for the proposed surface water network design to support the FRA and drainage strategy.

5.3

Pre-development site runoff

As discussed in sections 2.2 and 2.3 of this report, the drainage for the existing site condition serves the former buildings at the HPH4 and HPH5 sites and developments to the north of HPH4 and HPH5. It is assumed that the drainage network also collects the runoff from Millington Road and private roads within the whole development. The existing site is brownfield and thus the contributing areas are considered to be fully impermeable for the calculation of pre-development site runoff.

The impermeable runoff is calculated from “Modified Rational Method – Wallingford Procedure Volume 4” using the following equation:

$$Q = 2.78 CIA \dots\dots\dots \text{Eq 1}$$

Where,

- Q – is peak discharge in l/s
- C – is the discharge co-efficient (proportion of rainfall contributing to runoff)
- I – is the average intensity of the design storm of duration T_c in mm/hr
- A – is the contributing area in hectares

Rainfall intensities were calculated for a range of storm durations (15 minutes to 120 minutes) using FEH (Flood Estimation Handbook), excluding any allowance for climate change. It should be noted that the Institute of Hydrology highlighted that the FEH data is unreliable for storm durations less than 30 minutes.

The time of concentration (T_c) has been calculated by determining the time taken for rainfall falling at the most remote part of the site to flow across the site and hence discharge, using the following equation (Wallingford procedure – Volume 1- page 58):

$$T_c = T_e + T_f \dots\dots\dots \text{Eq 2}$$

Where,

$$T_e = 7.44 L^{0.133} S^{-0.274}$$

- Where, L – is the longest drainage path
- S – is the average slope of the catchment in %

T_f = time of flow through the pipe system to the point of discharge

The critical storm duration for the site catchment has been calculated as 16 minutes (see Appendix A for calculations). Given the FEH data is unreliable for storm durations of less than 30 min it has been determined, taking a slightly conservative approach that the critical storm duration of 30 minutes is appropriate for the design of the drainage system.

The pre-development runoff is calculated using Eq 1 for a critical storm duration of 30 minutes and for a storm return period of 1, 30 and 100 years in line with the requirements of NPPF and DEFRA/EA. The pre-development runoff rates calculations are shown in Appendix A and summarised in Table 3 below:

Table 3: Pre-development site runoff

Catchment	Area (ha)	Pre-development Runoff (l/s) for storm return periods		
		1 year	30 year	100 year
HPH4 site	0.3634	20	62	93
HPH5 site	0.8457	46	144	217
Existing development north to HPH4	0.7062	38	38	38
Existing development north to HPH5	0.2000	11	11	11
Total	2.1153	115	255	359

Note: - The catchments for the existing development north of HPH4 and HPH5 are indicative and assumed from the current site drainage surveys. The runoff from these catchments for 30 year and 100 year return period is considered to be an equivalent to pipe full capacity or existing site runoff whichever is higher.

It is noted the development north of HPH4 and HPH5 is connected to existing site drainage and will need to be served by the proposed drainage network for HPH4 and HPH5 sites.

5.4

Post-development site runoff

As discussed in section 2.3 in this report, the proposed development site is considered to be fully impermeable although the development plan includes soft landscaping, grass verges, tree planting and permeable surfaces, which are not accounted for here. Therefore, it is believed that the runoff volumes and peak flow rates will remain broadly the same as pre-development flows. However, an allowance of 30% for climate change has also been considered in determining the post-development site runoff.

The runoff for the development site is calculated following the similar approach as discussed in section 5.3 above. See Appendix A for the post-development site runoff calculations which are summarised in Table 4 below:

Table 4: Estimation of Post-development site runoff

Catchment	Area (ha)	Post-development Runoff (l/s) for storm return periods		
		1 year	30 year	100 year
HPH4	0.3634	25	80	121
HPH5	0.8457	59	187	282
Existing development north to HPH4	0.7062	38	38	38
Existing development north to HPH5	0.2000	11	11	11
Total	2.1153	133	316	452

Note: - The drainage associated with the existing development north of HPH4 and HPH5 needs to be served by the proposed system. The runoff from these catchments is based on the assumptions provided in section 5.3 and considered to be the same for the post-development site runoff as they fall outside the development boundary.

5.5

Attenuation requirements

To ensure compliance of NPPF and The London Plan it is necessary to provide attenuation storage to reduce the runoff associated with the developed site to an acceptable level. These criteria state that the discharge flow rate should be less than or equivalent to the runoff generated from an existing site in its current state measured at 1 in 1 year, 1 in 30 year and 1 in 100 year return period storm events, plus a 30% allowance for climate change.

The Micro Drainage WinDES W 12.6 package is used to calculate the volume of the storage required to limit the rate of runoff to the pre-development site conditions shown in Table 3. The source control module of WinDES is utilised together with an automatic insertion of rainfall data and flow control devices to determine the attenuation volume. See Appendix B for the results of the storage requirement calculations. These are summarised in Table 5 below:

Table 5: Storage requirements for pre-development site runoff

Storm return period	Pre-development site runoff (l/s)	Required Storage Volume (m3)
1 year storm	115	60
30 year storm	255	150
100 year storm	359	195

Note: - Refer Table 3 for pre-development site runoff and Appendix B for the WinDES results

5.6

Existing Sewers Capacity and Permissible Discharge Rate

As discussed in section 2.3 and 5.2 of this report, the drainage proposal for the development plans to continue discharging into existing Thames Water sewers and hence it is necessary to assess the capacity of sewer against the pre-development site flows and to establish the permissible discharge rate for the proposed development sites.

Based on the drainage survey records, the existing sewers capacity has been determined for the 525mm diameter sewer runs along the southern edge of HPH4 site from existing MH219 prior to connecting to Thames Water's sewers. See Appendix C for the existing sewers capacity check which is summarised in Table 6 below:

Table 6: Existing sewers capacity check

U/s Ref	D/s Ref	Dia (mm)	Full bore capacity (l/s)
MH219	MH216	525	540.21
MH216	MH218	525	89.56
MH218	TW0207	525	828.78

Note: - Refer Appendix C for existing sewers capacity check and permissible discharge rate

It can be seen from Table 6 that the section of pipe between MH216 and MH218 is limiting the site runoff to a full bore capacity of 90 l/s. The pre-development runoff rates provided in Table 3 are found to be higher than the existing sewers capacity. Therefore, it is necessary to restrict the site runoff to 90 l/s for the proposed development for all of the design storm events so that there will not be any impact on existing sewers and ultimately to Thames Water's network.

The storage requirements are revised in line with the restricted outflows of 90 l/s for the design storm return periods and using Source Control module of WinDES as discussed in section 5.5 of this report. These are summarised in Table 7 as below:

Table 7: Attenuation for permissible site runoff

Storm return period	Permissible discharge rate (l/s)	Storage Volume (m3)	% increase against pre-development discharge rates
1 year storm	90	90	50 %
30 year storm	90	330	120 %
100 year storm	90	465	140 %

Note: - Refer Table 6 for permissible discharge rate and Appendix D for the WinDES results

It can be seen that the attenuation have increased by about double the requirements for the 100year design storm event when compared to the storage for the pre-development runoff. Thus this is considered to be a conservative estimate to comply with NPPF requirements and other guidance listed in section 3 of this report.

The proposed surface water drainage design has been developed using WinDES to demonstrate how the attenuation within the development boundary has been achieved for the restricted outflows of 90 l/s. This is discussed in further detail in section 5.7 and 5.8.

5.7

Drainage Design Principles (Sustainable Urban Drainage Systems)

The guidance provided in section 3 of this report indicates that a sustainable drainage approach should be followed to achieve storage of the surface water volumes generated by the development site. The proposed landscape plan shown in Figure 2 has been reviewed to assess suitability of SUDS features for the site conditions. They are discussed in detail below.

5.7.1

Green roofs

Green roofs or living roofs are effective in various ways to meet the SUDS requirements. They are multi-layered systems comprising of vegetation or landscaping over a drainage layer covering the roof of a building structure. They

are useful to slow the rate at which runoff enters any drainage system as well as reducing pollution and providing wildlife habitat within urban areas.

Although, Green roofs are considered to be effective they are not taken into account for the proposed drainage strategy due to the fact that the system becomes non-functioning during extreme rainfall events, require significant maintenance and the possibility of damage to the roof structure if not properly drained. However, the opportunity to review and utilise this system during the detailed design is recommended with a view to convert sections of the proposed building roofs to green roofs.

5.7.2

Ponds and Wetlands

These techniques are widely used as cost-effective methods of reducing storm water generated from developments. Ponds are created using an existing natural depression, by excavating new depressions, or by constructing embankments. Wetlands are constructed as shallow marsh water areas. Ponds and wetlands are normally fed by swales, filter drains or piped systems.

These are normally provided at the lowest point to receive the runoff from the entire site and remain either generally permanently wet (ponds and wetlands) or dry (basins). They can be designed to accommodate considerable variations in water level during storms, and hence increase the storage capacity. Runoff entering ponds is detained and treated for a long time to allow solids to settle and treat pollutants through the planting. The soil below ponds and wetlands should be sufficiently impermeable to maintain water levels at the required level.

Due to the limited availability of space on site the use of ponds or wetlands on the development site is not feasible.

5.7.3

Soakaways/Infiltration Devices

Soakaways are widely used and are suitable for any kind of development as they provide limited storm water attenuation and ground water recharge. They are generally square or circular excavations, and are either brickwork lined, pre-cast concrete or polyethylene rings/perforated storage structures, which are surrounded by granular backfill. They can be grouped and linked together to drain a large area. Soakaways minimise land take, are relatively easy to construct and operate and can be retrofitted into existing sites.

The suitability for the performance of soakaways will mainly depend on the soil characteristics and its ability to absorb the rainwater that soaks into the ground. The existing site utilises soakaways for the drainage discharge for the private road east of HPH5. There is no information available about the functionality of these soakaways at this stage; however the topographic survey states that many of these are blocked or flooded. It is assumed that the site conditions are limited with regards to infiltration and thus soakaways will not be effective. However, existing soakaways could be considered wherever possible to provide additional storage along the drainage network.

Infiltration trenches comprising of trenches filled with stone which acts as a filter media could be used on the site, depending on the ground conditions. Wherever possible narrow infiltration trenches within the sites could be provided to allow water to percolate through the surface and reduce the surface water runoff in addition to providing extra storage within the media. It is recommended to review the suitability of using this system during detailed design.

5.7.4

Permeable surfaces and filter drains

Permeable pavements are used to allow rainwater to drain through the sub-base where the water is temporarily stored before infiltrating into the ground or draining to a discharge point. Permeable pavements are typically built as an alternative to impermeable surfaces and therefore require no additional space for construction.

They can be designed within the sub-base facility depending upon the soil infiltration characteristics, i.e. with infiltration or without infiltration from sub-base. It may be possible to provide this system with an overflow connected to a positive drainage system so that the non-infiltrated water can drain back into the system.

The site development proposal shows areas of permeable paving for the walkways and car parks. These areas can be converted to the porous pavements which will reduce the amount of the surface water runoff from the existing site and will allow storage within the sub-surface media. The areas identified with the permeable paving with sub-surface storage are shown on Figure 3. The design has taken a conservative approach and has not considered any infiltration through the base and that the system discharges into the drainage network.

5.7.5

Geocellular/modular systems

Modular plastic geocellular systems have a high void ratio that can be used to create an infiltration or storage structure below paved or landscaped areas. The high void ratio provides a high storage capacity and hence these systems are capable of managing high flow events. They can be placed underneath traffic/non traffic areas.

The site currently has some green areas and permeable walkways around the development and these could be converted to this system to reduce the runoff rate and provide storage against extreme storms events. The outlet at the bottom of the structure will allow the drainage through the structure in case infiltration is not achievable. This system is included in the proposed drainage design for the areas identified on Figure 3.

5.7.6

Tanked Systems

Tanked systems are used to store surface water in tanks before discharging to a sewer or watercourse. Rainwater harvesting is a method of reducing runoff by storing rainwater for use in flushing toilets and other systems. Rainwater harvesting could be used for the development site to collect and store roof runoff for use in the building. This option is not considered due to limited space available at site which could limit the rainwater storage and thus effectiveness of the system.

5.8

Proposed Drainage Network Modelling

The existing surface water drainage system across the sites HPH4 and HPH5 will be subject to changes to suit the development. The main surface water sewer will be relocated along Millington Road and a new connection provided at existing MH216 south-west of HPH4 site. Provisions have been made to allow the continuity of existing drainage north of the catchment. The new surface water sewers will collect and convey the runoff generated through the buildings as well as the roads. See Figure 3 – Surface Water Drainage Strategy.

The drainage network for the proposed development sites has been designed using WinDES software. The package allows automatic insertion of rainfall data for the site. The design was checked for 1 in 1, 1 in 30 and 1 in 100 year storm plus 30 % climate change, limiting the discharge rate to maximum 90 l/s to meet the receiving sewers capacity as discussed in section 5.6 of this report. The restricted flows were achieved by provision of a flow control device (hydro brake) at the proposed discharge point (MH216) to the existing network.

The “Source Control” module was used to represent the storage achieved through recommended SUDS features as discussed in section 5.7 and was incorporated into drainage design. Additional storage has been achieved within the pipe networks. See Appendix E for the proposed drainage network design.

It is noted that the development areas identified for the grass verge, soft landscaping and permeable paving are considered as impermeable for the proposed drainage design undertaken using WinDES. The SUDS features included in the design do not take into account any infiltration through the base. Therefore the results are conservative and there is an extra benefit in terms of reduced flood risk as the runoff rate will be lower than allowed for in the design.

6

Summary and Conclusions

6.1

Introduction

The rationale behind the calculations and the proposals made by Halcrow Group Ltd are to obtain BREEAM accreditation for the proposed development. The EA will be consulted for their agreement and approval on the drainage proposal provided in this report.

The surface water drainage discharge is proposed to existing sewers outside the development boundary which are further connected to Thames Water's sewers. Although the connections to Thames Water's sewers are unchanged from the pre-developed to the post-developed site, final agreement and approval of the proposed drainage discharge will be required prior to the commencement of the development. .

6.2

Development Proposals

The proposed development will comprise of a new 4 storey office building at HPH4 site and a new 5 storey office building at HPH5 site. Both the sites are to have basement parking. The sites are a re-development of existing brownfield sites and thus there will be no net increase in impermeable area. However, an allowance for climate change and considerations of green areas as impermeable for the developments are taken into account to deliver wider benefits for the flood risk management.

The drainage proposal will maintain the existing connection to MH216 located on the sewer running south of HPH4, which discharges further downstream to Thames Water's sewer in Dawley Road. Therefore, it is required to demonstrate that the runoff generated through the development sites is limited to existing sewers capacity at MH216 and thus the performance of Thames Water's sewer downstream is not affected.

6.3

Flood risk

A flood risk assessment has been undertaken in accordance with the guidelines set out in the NPPF. The Strategic Flood Risk Assessment (SFRA) for Hillingdon and the Preliminary Flood Risk Assessment (PRFA) for Hillingdon were used to facilitate preparation of the flood risk assessment.

An assessment of flood risk to the development from five main sources of flooding has been undertaken. The site lies within EA Flood Zone 1 for fluvial and tidal flooding. Although limited data was available for the preparation of the SFRA and PFRA, there are no recorded instances of flooding from groundwater, sewers or overland flow at the site and thus the site is considered to be at a low risk of flooding.

6.4

Surface water drainage strategy

The drainage proposals provided in this report have followed the guidance provided by NPPF and other legislation applicable to flood risk management for new development sites as discussed in Section 3. The flows from the development sites are required to be restricted to pre-development site conditions where possible. The surface water drainage design for the development has been adequately sized for contributing runoff for storms up to a 1 in 100 year storm event including an allowance of 30% for climate change.

The pre-development runoff rate for 1 in 1, 1 in 30 and 1 in 100 year storm events is estimated as 115 l/s, 255 l/s and 359 l/s respectively. The increased runoff through the developments is required to be attenuated within the site boundary to restrict the discharge at pre-development site conditions. The “Source Control” module of WinDES package has been used to determine the storage volume for all design storms and relevant restricted flows rates. The amount of storage required for a 1 in 1, 1 in 30 and 1 in 100 year storm event is estimated as 55 m³, 150m³ and 195m³ respectively.

The existing sewer capacity was checked at the proposed connection point (MH216) and was reviewed against the pre-development runoff for design storm events in order to establish the permissible discharge rate and to ensure that the downstream Thames Water network are not affected. This indicated that the existing sewers have full bore capacity of 90 l/s and is considered to be a baseline for the surface water drainage design strategy.

An assessment on the storage volumes has been made for a restricted site discharge of 90 l/s which suggests the amount of storage required for 1 in 1, 1 in 30 and 1 in 100 year storm event is 90 m³, 330m³ and 465m³ respectively. It is noted that this is an increase of about 120% when compared to the storage requirements for the pre-development runoff to comply with NPPF. The proposed drainage strategy has been developed to demonstrate how the storage requirements have been met for the restricted flows of 90 l/s.

Appropriated SUDS techniques have been used for the proposed drainage design and to help achieve the storage requirements. However, the limitations posed by the size and nature of the development site dictate that application of many SUDS techniques is not practicable. The areas identified for the SUDS features include permeable car parks and walkways, soft landscaping and green space where the sub-surface storage can be achieved. Additional storage is provided in pipe networks.

A detailed drainage model incorporating SUDS facilities has been developed using WinDES package to design and check the network for 1 in 1, 1 in 3 and 1 in 100 year storm return period plus an allowance for the 30% climate change restricting the flows to 90 l/s.

6.5

Conclusions

This report has demonstrated that the development site is appropriately located in Flood Zone 1 for fluvial and tidal flooding, and that the risk of flooding from surface water, ground water and sewers is low.

The drainage strategy is based on restricting the flows from the drainage network to pre-development site conditions in line with the requirements for NPPF. The surface water drainage design has been adequately sized for contributing runoff for storms up to a 1 in 100 year storm event including an allowance of 30% for the climate change. An approval from EA is required for the drainage proposals and they will be consulted prior to development.

The report has demonstrated that the development will not have a net impact on the existing surface water drainage system, or the Thames Water's sewers as the outflow from the drainage network is restricted to the existing sewer's capacity. However, final agreement and approval of the proposed drainage discharge will be required prior to the commencement of the development.

The SUDS techniques have been included to achieve the required storage and will be implemented where possible to further reduce the surface water runoff as far as practicable. An integrated drainage model has been developed to support the design and has been checked for the drainage proposals provided in this report.

References

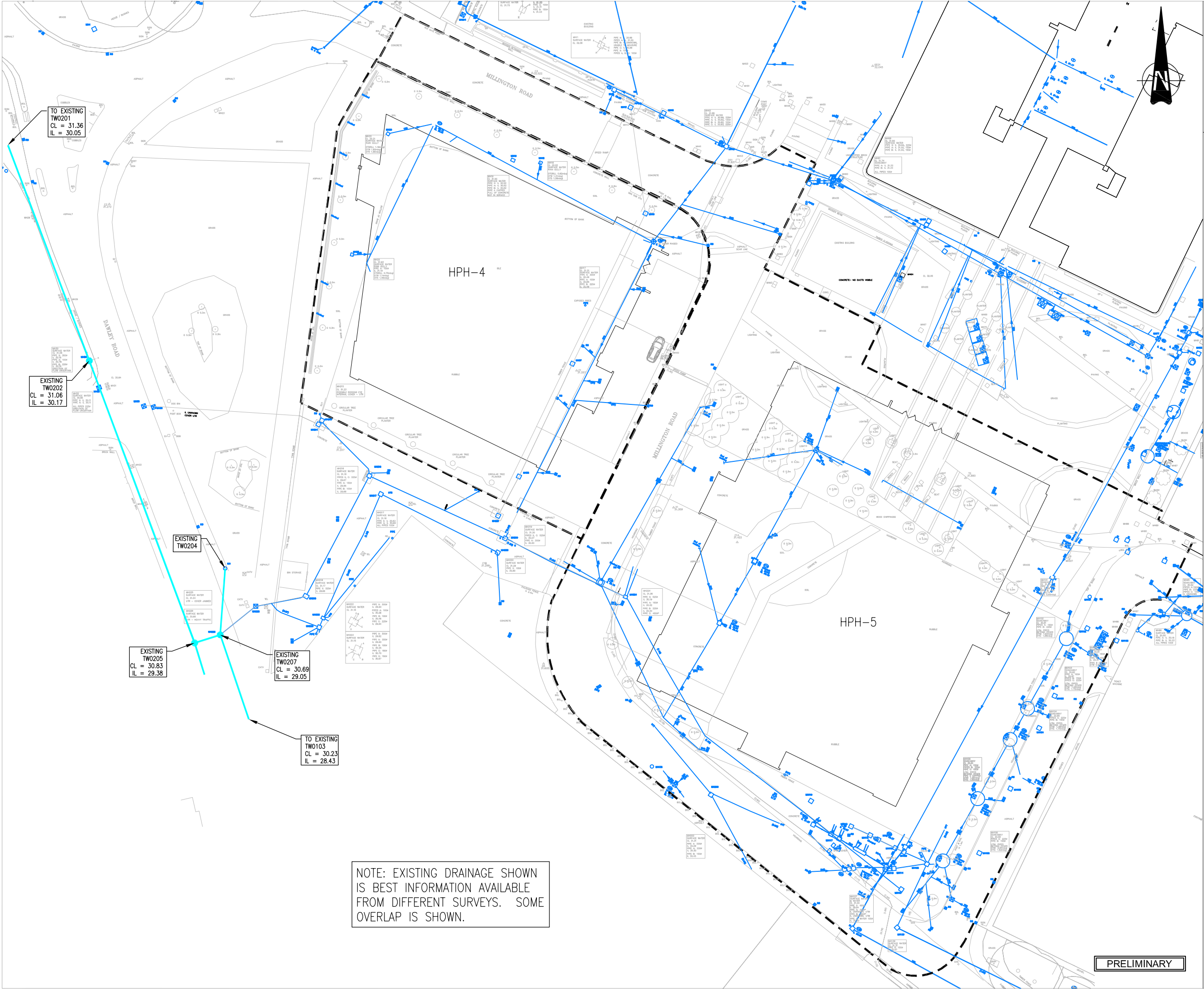
1. National Planning Policy Framework (NPPF) and Technical Guidance on NPPF published in March 2012 by Communities and Local Government
2. Building Research Establishment Environmental Assessment Method (BREEAM) Policy 5 (Flood Risk, Education, 2008) guidance
3. Planning Policy Statement 25: Development and Flood Risk (2010) Communities and Local Government (PPS25)
4. Planning Policy Statement 25: Development and Flood Risk (2009) – Practice Guide
5. Interim Code of Practice for Sustainable Drainage Systems (ICP)
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7. Code of sustainable homes (December 2006)
8. DEFRA/Environment Agency “Flood and Coastal Defence R&D Programme”, Preliminary Rainfall Runoff Management for Developments R&D Technical Reports W5-074/A/TR/1 – Revision D (DEFRA/EA) – September 2005
9. Institute of Hydrology (IOH) 124 – Flood Estimation for Small Catchments
10. Wallingford Procedures, Volume 3 - Maps for Average Annual Rainfalls
11. Hyde Park Hayes Stage D Report – May 2012, prepared by 3D Reid
12. Sewers for Adoption 7th Edition
13. Thames Water Asset Records
14. Topographical Survey Drawing No 10004-115_3DT

Figures

Figure 1- Existing Site Drainage Catchment

Figure 2- Proposed Development Plan

Figure 3 – Surface Water Drainage Strategy



Key Plan:

HPH4

HPH5

Notes:

- DO NOT SCALE FROM THIS DRAWING, WORK ONLY TO DIMENSIONS SHOWN.
- ALL DIMENSIONS ARE IN METERS UNLESS NOTED OTHERWISE.
- FOR ALL SETTING OUT OF BUILDING GEOMETRY REFER TO ARCHITECTURAL DRAWINGS.
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ARCHITECTURAL, MECHANICAL, ELECTRICAL DRAWINGS AND SPECIFICATIONS.
- IT IS UNDERSTOOD THAT THE ROADS WITHIN THE PROPOSED DEVELOPMENT ARE NOT ADOPTED AND THAT THE DRAINAGE IS PRIVATE. THIS IS TO BE CONFIRMED WITH THE LOCAL AUTHORITY.

Key:

EXISTING SITE DRAINAGE

PLANNING APPLICATION BOUNDARY

THAMES WATER FOUL SEWER

CL
COVER LEVEL

IL
INVERT LEVEL

Rev	By	Chkd	Apprvd	Date	Description

Client

3DReid

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Project

HYDE PARK HAYES
HPH4 & HPH5
HAYES

Drawing

EXISTING SITE DRAINAGE CATCHMENT

Drawn by: SAH

Checked by: AM

Approved by:

Drawing No.

Date: 23.07.12

Date: 23.07.12

Date:

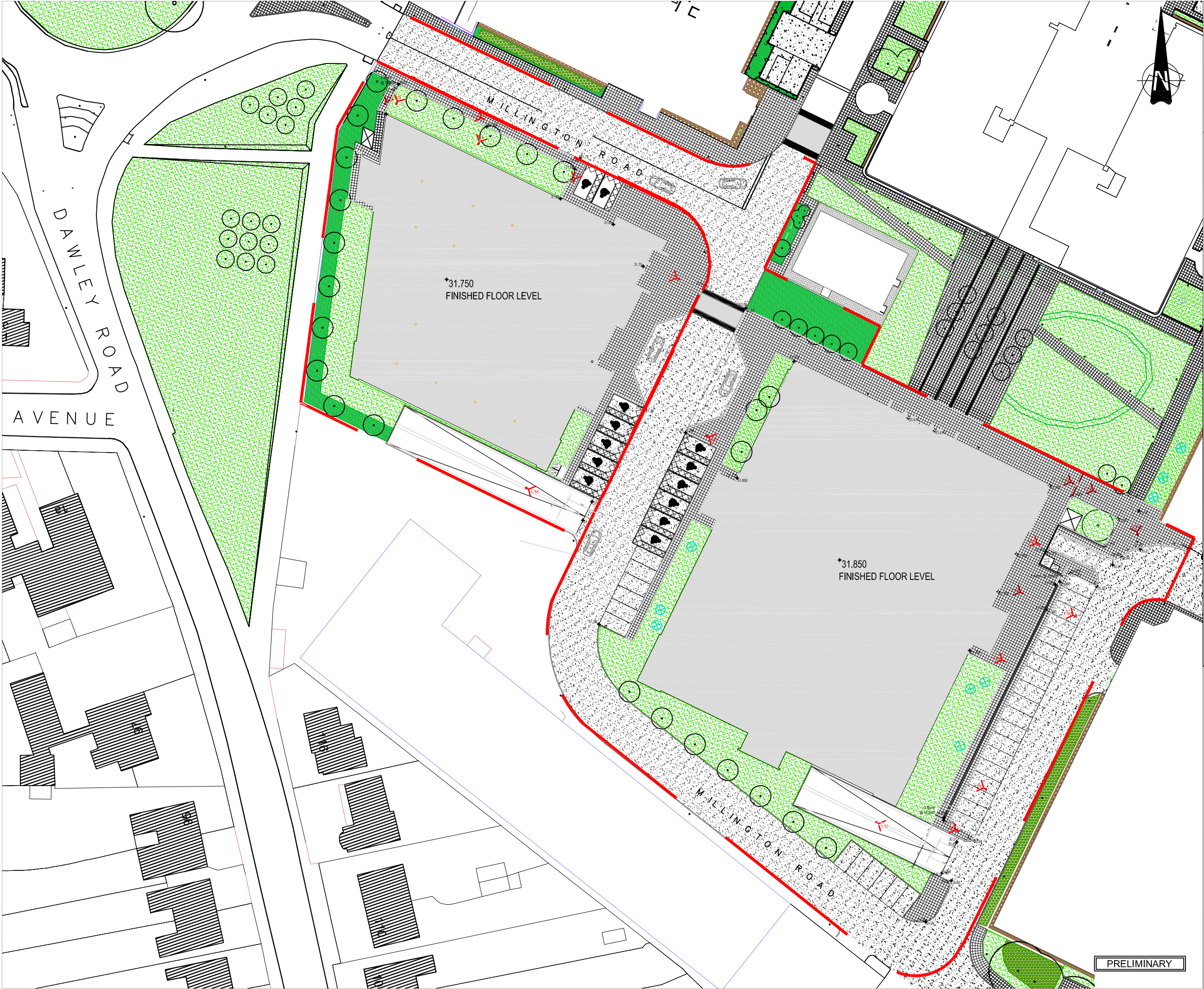
Revision

FIGURE 1

P01

Drawing Scale: NTS

NOTE: EXISTING DRAINAGE SHOWN IS BEST INFORMATION AVAILABLE FROM DIFFERENT SURVEYS. SOME OVERLAP IS SHOWN.



Key Plan:

HPH4

HPH5

Notes:

1. DO NOT SCALE FROM THIS DRAWING, WORK ONLY TO DIMENSIONS SHOWN.

2. ALL DIMENSIONS ARE IN METERS UNLESS NOTED OTHERWISE.

3. FOR ALL SETTING OUT OF BUILDING GEOMETRY REFER TO ARCHITECTURAL DRAWINGS.

4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ARCHITECTURAL, MECHANICAL, ELECTRICAL DRAWINGS AND SPECIFICATIONS.

5. ARCHITECT / TEAM TO CONFIRM NEED FOR FALLS OR DRAINAGE IN THE BASEMENT.

6. IT IS UNDERSTOOD THAT THE ROADS WITHIN THE PROPOSED DEVELOPMENT ARE NOT ADOPTED AND THAT THE DRAINAGE IS PRIVATE. THIS IS TO BE CONFIRMED WITH THE LOCAL AUTHORITY.

Key:

Ground Cover

Hedge

Grass

Specimen Shrub

Tree

Paving slabs to pedestrian walkways
450x450mm Marshalls Saxon textured to match exsting/ Natural or equivalent approved

Marshalls Concrete Textured Sett Paving
100x100mm - Silver grey

Marshalls Concrete Textured Sett Paving
100x100mm - Charcoal

Marshalls Keyblock, 200x100mm - Charcoal or equivalent approved - Herringbone pattern

Tarmac surface

Gravel edge strip

Rev	By	Chkd	Apprvl	Date	Description
Client					
3DReid					

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A CH2M HILL COMPANY

Project

HYDE PARK HAYES
HPH4 & HPH5
HAYES

Drawing

PROPOSED DEVELOPMENT
PLAN

Drawn by: SAH

Date: 23.07.12

Checked by: AM

Date: 23.07.12

Approved by:

Date:

Drawing No.

Revision

FIGURE 2

P01

Drawing Scale: NTS

Appendices

Appendix A: Calculation of pre-development and post-development site runoff and attenuation requirements

Halcrow		THIS IS A MANDATORY FORM		CALCULATION TITLE SHEET			
Project Title		Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)		Project Code:		GIB016300	
Calculation Title:		Calculation of Pre-development and Post-development site runoff		Serial No:		1	
Project Manager		Kerry Woods		No. of Sheets:		6 including cover	
Status				Prepared by:		SAH	
Schematic		Preliminary		Date:		20-Jun-12	
Tender		Yes		Checked by:		AM	
Final for Construction		Other (state)		Date:		26-Jun-12	
Levels of Verification				Approved by:			
1 Self-check by originator and approval		3B Comparison with similar proven designs and approval		Date:			
2 Calculation Review and approval		4 External check and internal approval		Computer Analysis: Yes: ☐ No: ☒ Program(s): Hardware:			
3 Detailed check and approval		5 Other verification as stated in Management Plan					
3A Alternative calculations and approval							
Contents (continue on calculation sheet if necessary)							
1 Calculation Cover Sheet 2 Site drainage catchment 3 Critical Storm Duration 4 Pre-development runoff rates 5 Post-development runoff rates 6 Attenuation Requirements							
NB: Calculations should state or refer to design input data and methodology							
CONTENTS AMENDMENT RECORD							
Rev	Status	Date	Description	Page	By	Chk'd	App'd
0		10-Jul-12	First Issue	6	SAH	AM	

File Name:

Path:

Rev 0

Calculation Title Sheet

No:	2	Rev:	0
By:	SAH	Date:	Jun-12
Check By:	AM	Date:	Jun-12

Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)

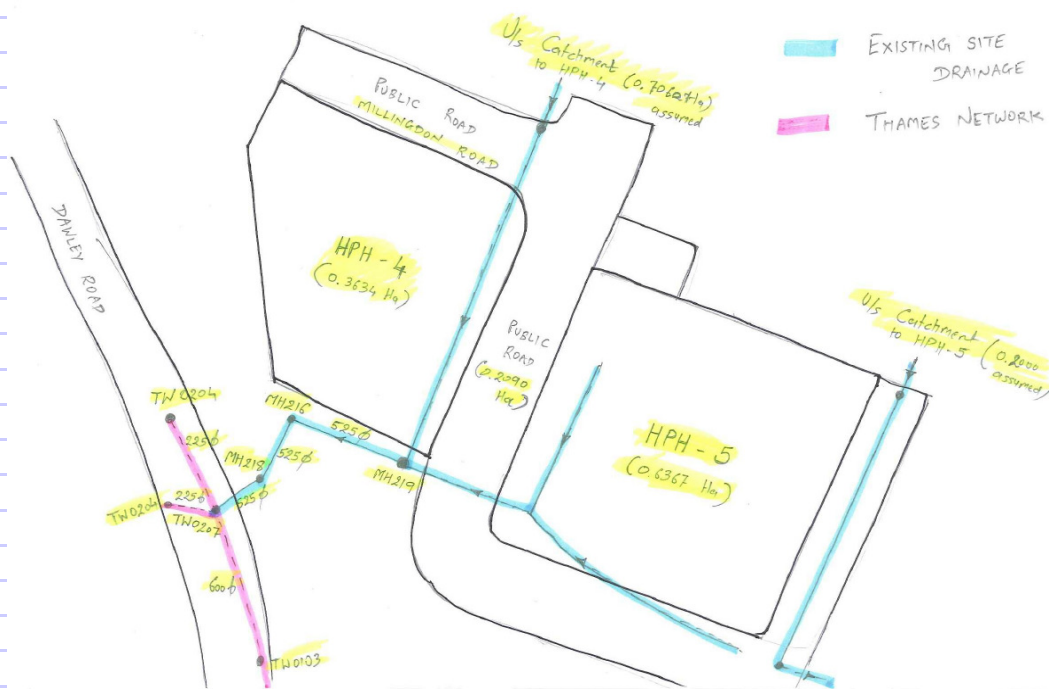
Subject: Calculation of Pre-development and Post-development site runoff

Site Drainage Catchment

The existing drainage network for the development sites has been reviewed to establish the extent of drainage catchment. Review of site drainage records indicate that surface water drainage exist across the development sites and connected to Thames Water's sewers offsite.

The site drainage also serves existing development north to HPH4 and HPH5. It is not possible to clearly identify associated catchment for these areas and hence assumed based on the survey records for the relevant calculations undertaken in this spreadsheet.

The schematic for the existing site drainage is shown in the figure below:



Refer Figure 1 - Existing Site Drainage, provided in Report on Flood Risk Assessment and Surface Water Drainage Strategy

The collective drainage for most of HPH4 and HPH5 sites including the associated catchment at north currently discharge into the manhole MH219 located at southern edge of HPH4 site. It is noted that part of HPH5 site currently drains through south-east. A 525mm diameter sewer runs further south-west from this manhole and connected to 600mm diameter Thames Water's sewer located on Dawley Road.

The drainage catchment for the calculation of site runoff is considered as below:

1	Hyde Park Hayes (HPH) - 4 : New development :	0.3634	ha		HPH4
2	Hyde Park Hayes (HIP) - 5 : New development	0.8457	ha	(0.21 for roads)	HPH5 includes roads within site
3	Existing development north of HPH4 -	0.7062	ha		Approx from surveys info
4	Existing development north of HPH5 -	0.2000	ha		Approx from surveys info
Total catchment area		2.1153	ha		

			CALCULATION SHEET			No: 3	Rev: 0						
Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)						By: SAH	Date: Jun-12						
Subject: Calculation of Pre-development and Post-development site runoff						Check By: AM	Date: Jun-12						
<u>Critical Storm Duration</u> Using Wallingford Procedure Volume 1 - Page 58 Time of concentration Tc is given by - $T_c = T_f + T_e$ Where, $T_f = \frac{\text{Length of pipe}}{\text{pipe full velocity}}$ $T_e = \text{time of entry}$ $= 7.44 \times \text{LENGTH}^{0.133} \times \text{SLOPE}^{-0.274}$ Where- $\text{LENGTH} = \text{Longest distance of overland flow}$ $\text{SLOPE} = \text{Slope of catchment (\%)}$ LENGTH = 60 m SLOPE = <table><tr><td>Ground Level at -</td><td>North East of HPH5 site</td><td>31.75</td></tr><tr><td>Ground Level at -</td><td>South West of HPH 4</td><td>31.15</td></tr></table> SLOPE= 1.00% Therefore Te = 13 Mins Te = 3 Mins <u>Time of concentration Tc = 16 Mins</u> Given that the FEH data is unreliable for storm duration of less than 30 minutes it has been determined, taking a slightly conservative approach, that critical storm duration of 30 minutes is appropriate for the design of the drainage system. However a sensitivity check has been made on the proposed drainage design for 15 minutes storm duration.						Ground Level at -	North East of HPH5 site	31.75	Ground Level at -	South West of HPH 4	31.15	<u>References/Results</u> Wallingford Procedures suggest the Time of entry for 1 year return period as 5-10 mins. Assumed from the catchment of HPH4 & HPH5. Assumed pipe velocity at connection point - 1 m/s, pipe length of 150m for HPH5 site main sewer length	
Ground Level at -	North East of HPH5 site	31.75											
Ground Level at -	South West of HPH 4	31.15											
						BPG121_F01(Excel)							

No:	4	Rev:	0
By:	SAH	Date:	Jun-12
Check By:	AM	Date:	Jun-12

Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)

Subject: Calculation of Pre-development and Post-development site runoff

Pre-development site runoff

The developments are proposed on brown filed sites and thus the catchment areas are considered to be impermeable to determine the pre-development runoff rates.

The impermeable runoff is calculated from "Modified Rational Method" as given below:

$$Q = 2.78CIA$$

Where, Q - Runoff or Flows (l/s)
C - Coefficient of runoff
I - Average rainfall intensity (mm/hr)
A - Contributing area (ha)

As a maximum the design need to accommodate the runoff associated with a 1: 100 years storm event. See below for the average rainfall intensity (mm/hr) for the varying storm durations :

Storm Duration (mins)	15	30	60	90	120
Return Period					
1:100	161	92	53	38	30
1:30	104	61	36	26	21
1:1	31	19	12	9	7

Using "Modified Rational Method" and average rainfall intensities provided in the table above, pre-development runoff for HPH4 and HPH5 sites are determined as below:

HPH4 predevelopment site runoff

	100 yr	30 yr	1 yr	
15	163	106	32	l/s
30	93	62	20	l/s
60	53	36	12	l/s
90	38	26	9	l/s
120	31	21	8	l/s

HPH5 predevelopment site runoff

	100 yr	30 yr	1 yr	
15	379	245	73	l/s
30	217	144	46	l/s
60	124	84	28	l/s
90	89	61	21	l/s
120	71	49	18	l/s

For the existing developments north of HPH4 and HPH5, pre-development runoff is calculated using similar approach as explained as above.

Runoff for the development north of HPH4 = 38 l/s A = 0.7062 ha
Runoff for the development north of HPH5 = 11 l/s A = 0.200 ha

Summary - predevelopment site runoff (30 mins storm duration)

Catchment	Runoff (l/s)		
	1 yr	30 yr	100 yr
HPH 4	20	62	93
HPH 5	46	144	217
Existing development north of HPH4	38	38	38
Existing development north of HPH5	11	11	11
Total	114	254	359

References/Results

Wallingford Procedures - Volume 4

FEH data

A = 0.3637 ha (HPH4)
C = 1 for impermeable area
I = average intensity (mm/hr) from the table

A = 0.8457 ha (HPH5)
C = 1 for impermeable area
I = average intensity (mm/hr) from the table

C = 1 for impermeable area
I = average intensity (mm/hr) for 30 min storm as 19.38 mm/hr from table 1yr 30 mins storm

For existing developments north of HPH4 & HPH5, pre-development flows assumed to be the same for all storms as they are equivalent to pipe full capacity

Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)

Subject: Calculation of Pre-development and Post-development site runoff

Post-development site runoff

Although the development plan includes soft landscaping, green spaces and permeable paving they are considered to be fully impermeable. As such the development will not have net impact on existing site characteristics, runoff from the post-development will be the same as calculated for original site conditions. However, an allowance of 30% climate change has been made to achieve wider benefits.

The average rainfall intensity (mm/hr) are increased by 30% to represent the effect of climate change and provided in the table below:

Storm Duration (mins)	15	30	60	90	120
Return Period					
1:100	210	120	69	49	39
1:30	136	79	46	34	27
1:1	41	25	16	12	10

Using "Modified Rational Method" and average rainfall intensities provided in the table above, post-development runoff for HPH4 and HPH5 sites are determined as below:

HPH4 post-development site runoff

	100 yr	30 yr	1 yr	
15	212	137	41	l/s
30	121	80	25	l/s
60	69	47	16	l/s
90	50	34	12	l/s
120	40	27	10	l/s

FEH data - values increased by 30%

A = 0.3637 ha,
C = 1 for impermeable area
I = average intensity (mm/hr) from the table

HPH5 post-development site runoff

	100 yr	30 yr	1 yr	
15	493	319	95	l/s
30	282	187	59	l/s
60	161	109	37	l/s
90	116	80	28	l/s
120	92	64	23	l/s

A = 0.8457 ha,
C = 1 for impermeable area
I = average intensity (mm/hr) from the table

Summary - post development site runoff (30 mins storm duration)

Catchment	Runoff (l/s)		
	1 yr	30 yr	100 yr
HPH 4	25	80	121
HPH 5	59	187	282
Existing development north of HPH4	38	38	38
Existing development north of HPH5	11	11	11
Total	134	316	452

For existing developments north of HPH4 & HPH5, pre-development flows assumed to be the same for all storms as they are equivalent to pipe full capacity

The increased runoff for relevant design storm events through the proposed development as summarised in the table above is required to be attenuated within the development site boundary to match the pre-development runoff rates.

 CALCULATION SHEET			No: 6	Rev: 0																																																												
Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)			By: SAH	Date: Jun-12																																																												
Subject: Calculation of Pre-development and Post-development site runoff			Check By: AM	Date: Jun-12																																																												
<u>Attenuation requirements</u> The guidance set out in National Planning Policy Frameworks and DEFRA/EA Flood risk user guide require 1:1, 1:30 and 1:100 return period runoff to be less than the equivalent existing event. The storage volumes has been determined using "Source Control" module of WinDES package. Minimum required storage to achieve the pre-development flows are : <table> <tr> <td>1:1</td><td>Pre-development rate for 30 min storm -</td><td>115</td><td>l/s</td><td></td></tr> <tr> <td></td><td>Storage Volume require =</td><td></td><td></td><td><u>55 m³</u></td></tr> <tr> <td>1:30</td><td>Pre-development rate for 30 min storm -</td><td>255</td><td>l/s</td><td></td></tr> <tr> <td></td><td>Storage Volume require =</td><td></td><td></td><td><u>150 m³</u></td></tr> <tr> <td>1:100</td><td>Pre-development rate for 30 min storm -</td><td>359</td><td>l/s</td><td></td></tr> <tr> <td></td><td>Storage Volume require =</td><td></td><td></td><td><u>195 m³</u></td></tr> </table> The surface water drainage strategy is planned to continue discharge to existing sewers, (MH216) located at southern edge of HPH4 site, which further connected to Thames Water's sewers. The existing sewers capacity check indicated the sewers capacity at MH216 is about 90 l/s and hence the discharge from the developments should be further restricted to 90 l/s for all design storm so that existing sewers and ultimately Thames Water's sewers are not affected. The storage volumes are further reviewed to meet these requirements. Minimum storage requirements to achieve discharge rate of 90 l/s are : <table> <tr> <td>1:1</td><td>Restricted outflow for 90 l/s</td><td></td><td></td><td></td></tr> <tr> <td></td><td>Storage Volume require=</td><td></td><td></td><td><u>90 m³</u></td></tr> <tr> <td>1:1</td><td>Restricted outflow for 90 l/s</td><td></td><td></td><td></td></tr> <tr> <td></td><td>Storage Volume require =</td><td></td><td></td><td><u>330 m³</u></td></tr> <tr> <td>1:1</td><td>Restricted outflow for 90 l/s</td><td></td><td></td><td></td></tr> <tr> <td></td><td>Storage Volume require =</td><td></td><td></td><td><u>465 m³</u></td></tr> </table>			1:1	Pre-development rate for 30 min storm -	115	l/s			Storage Volume require =			<u>55 m³</u>	1:30	Pre-development rate for 30 min storm -	255	l/s			Storage Volume require =			<u>150 m³</u>	1:100	Pre-development rate for 30 min storm -	359	l/s			Storage Volume require =			<u>195 m³</u>	1:1	Restricted outflow for 90 l/s					Storage Volume require=			<u>90 m³</u>	1:1	Restricted outflow for 90 l/s					Storage Volume require =			<u>330 m³</u>	1:1	Restricted outflow for 90 l/s					Storage Volume require =			<u>465 m³</u>	References/Results Refer summary table of pre-development flows and Appendix B - WinDES results for the storage requirements Refer to Appendix C for the existing sewers capacity check and permissible discharge rates. Appendix D- WinDES results for the storage requirements	
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Appendix B: WinDES Microdrainage Results – Attenuation for pre-development site runoff

1. Storage Volume for pre-development site runoff_1 yr storm event
2. Storage Volume for pre-development site runoff_30 yr storm event
3. Storage Volume for pre-development site runoff_100 yr storm event

Halcrow Group Limited				Page 1		
Burderop Park Swindon SN4 0QD		Storage Volume for pre-development discharge ... 1 yr storm				
Date 10.07.2012		Designed by ModiA				
File Storage Volume for Pr...		Checked by				
Micro Drainage		Source Control W.12.6.1				
Summary of Results for 1 year Return Period (+30%)						
	Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
	15 min Summer	30.937	0.637	115.0	44.6	O K
	30 min Summer	31.007	0.707	115.5	49.5	O K
	60 min Summer	31.086	0.786	115.5	55.0	O K
	120 min Summer	30.765	0.465	93.8	32.6	O K
	180 min Summer	30.664	0.364	67.6	25.5	O K
	240 min Summer	30.628	0.328	57.1	22.9	O K
	360 min Summer	30.602	0.302	49.6	21.1	O K
	480 min Summer	30.598	0.298	48.4	20.9	O K
	600 min Summer	30.596	0.296	47.8	20.7	O K
	720 min Summer	30.594	0.294	47.4	20.6	O K
	960 min Summer	30.592	0.292	46.8	20.5	O K
	1440 min Summer	30.590	0.290	46.3	20.3	O K
	2160 min Summer	30.589	0.289	46.0	20.2	O K
	2880 min Summer	30.588	0.288	45.7	20.2	O K
	4320 min Summer	30.588	0.288	45.5	20.1	O K
	5760 min Summer	30.587	0.287	45.4	20.1	O K
	7200 min Summer	30.587	0.287	45.4	20.1	O K
	8640 min Summer	30.587	0.287	45.4	20.1	O K
	10080 min Summer	30.587	0.287	45.3	20.1	O K
	15 min Winter	31.008	0.708	115.5	49.6	O K
	30 min Winter	31.068	0.768	115.6	53.8	O K
	60 min Winter	31.081	0.781	115.6	54.7	O K
	120 min Winter	30.792	0.492	99.5	34.4	O K
	180 min Winter	30.644	0.344	61.9	24.1	O K
	Storm Event		Rain (mm/hr)	Time-Peak (mins)		
	15 min Summer		43.070	18		
	30 min Summer		27.769	26		
	60 min Summer		17.298	44		
	120 min Summer		10.543	62		
	180 min Summer		7.850	100		
	240 min Summer		6.360	130		
	360 min Summer		4.698	60		
	480 min Summer		3.780	60		
	600 min Summer		3.192	60		
	720 min Summer		2.780	60		
	960 min Summer		2.236	60		
	1440 min Summer		1.645	60		
	2160 min Summer		1.211	60		
	2880 min Summer		0.975	60		
	4320 min Summer		0.716	60		
	5760 min Summer		0.576	56		
	7200 min Summer		0.487	56		
	8640 min Summer		0.424	56		
	10080 min Summer		0.377	56		
	15 min Winter		43.070	18		
	30 min Winter		27.769	28		
	60 min Winter		17.298	46		
	120 min Winter		10.543	60		
	180 min Winter		7.850	60		
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Burderop Park Swindon SN4 0QD	Storage Volume for pre-development discharge ... 1 yr storm	
Date 10.07.2012	Designed by ModiA	
File Storage Volume for Pr...	Checked by	
Micro Drainage		Source Control W.12.6.1

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.700	Shortest Storm (mins)	15
Ratio R	0.439	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 1.208

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-5	0.263	5-10	0.845	10-15	0.100

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Burderop Park Swindon SN4 0QD	Storage Volume for pre-development discharge ... 1 yr storm	
Date 10.07.2012 File Storage Volume for Pr...	Designed by ModiA Checked by	
Micro Drainage Source Control W.12.6.1		

Model Details

Storage is Online Cover Level (m) 31.300

Tank or Pond Structure

Invert Level (m) 30.300

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	70.0	0.300	70.0	0.600	70.0	0.900	70.0
0.100	70.0	0.400	70.0	0.700	70.0	1.000	70.0
0.200	70.0	0.500	70.0	0.800	70.0		

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md4 Invert Level (m) 30.300
Design Flow (l/s) 100.0 Diameter (mm) 320

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.0	1.200	95.3	3.000	138.2	7.000	211.1
0.200	22.5	1.400	97.4	3.500	149.3	7.500	218.5
0.300	49.1	1.600	102.0	4.000	159.6	8.000	225.7
0.400	77.6	1.800	107.5	4.500	169.3	8.500	232.6
0.500	100.9	2.000	113.0	5.000	178.4	9.000	239.4
0.600	113.2	2.200	118.4	5.500	187.1	9.500	246.0
0.800	110.8	2.400	123.6	6.000	195.5		
1.000	99.2	2.600	128.7	6.500	203.4		

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Burderop Park

Swindon

SN4 0QD

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Storage Volume for
pre-development discharge ...
1 yr storm
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Date	10.07.2012
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Designed by ModiA

File Storage Volume for Pr...

Checked by



Micro Drainage

Source Control W.12.6.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
5	0.0	15	10.0	25	20.0	35	35.0	45	45.0	55	45.0
10	5.0	20	15.0	30	30.0	40	40.0	50	45.0	60	45.0

Halcrow Group Limited				Page 1		
Burderop Park Swindon SN4 0QD		Storage Volume for pre-development discharge ... 30yr storm				
Date 10.07.2012		Designed by ModiA				
File Storage Volume for Pr...		Checked by				
Micro Drainage		Source Control W.12.6.1				
<u>Summary of Results for 30 year Return Period (+30%)</u>						
	Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
	15 min Summer	30.948	0.648	231.2	129.6	O K
	30 min Summer	31.004	0.704	242.0	140.8	O K
	60 min Summer	30.995	0.695	240.3	139.0	O K
	120 min Summer	30.806	0.506	188.3	101.1	O K
	180 min Summer	30.714	0.414	146.2	82.9	O K
	240 min Summer	30.668	0.368	122.8	73.6	O K
	360 min Summer	30.612	0.312	93.9	62.3	O K
	480 min Summer	30.577	0.277	76.7	55.4	O K
	600 min Summer	30.553	0.253	65.1	50.6	O K
	720 min Summer	30.535	0.235	56.8	46.9	O K
	960 min Summer	30.512	0.212	47.1	42.4	O K
	1440 min Summer	30.509	0.209	45.6	41.8	O K
	2160 min Summer	30.507	0.207	44.8	41.3	O K
	2880 min Summer	30.506	0.206	44.4	41.1	O K
	4320 min Summer	30.504	0.204	43.8	40.8	O K
	5760 min Summer	30.500	0.200	41.9	40.0	O K
	7200 min Summer	30.500	0.200	41.9	39.9	O K
	8640 min Summer	30.499	0.199	41.7	39.9	O K
	10080 min Summer	30.499	0.199	41.7	39.8	O K
	15 min Winter	31.015	0.715	244.0	143.0	O K
	30 min Winter	31.055	0.755	250.2	151.0	O K
	60 min Winter	30.991	0.691	239.5	138.2	O K
	120 min Winter	30.760	0.460	168.1	91.9	O K
	180 min Winter	30.665	0.365	121.3	73.0	O K
	Storm Event	Rain (mm/hr)		Time-Peak (mins)		
	15 min Summer	105.776		18		
	30 min Summer	67.784		26		
	60 min Summer	41.476		42		
	120 min Summer	24.630		70		
	180 min Summer	17.973		102		
	240 min Summer	14.315		132		
	360 min Summer	10.368		192		
	480 min Summer	8.243		252		
	600 min Summer	6.896		312		
	720 min Summer	5.959		374		
	960 min Summer	4.729		60		
	1440 min Summer	3.411		60		
	2160 min Summer	2.458		60		
	2880 min Summer	1.947		60		
	4320 min Summer	1.401		60		
	5760 min Summer	1.109		56		
	7200 min Summer	0.924		56		
	8640 min Summer	0.797		56		
	10080 min Summer	0.702		56		
	15 min Winter	105.776		19		
	30 min Winter	67.784		27		
	60 min Winter	41.476		44		
	120 min Winter	24.630		68		
	180 min Winter	17.973		102		
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Burderop Park Swindon SN4 0QD	Storage Volume for pre-development discharge ... 30yr storm	
Date 10.07.2012	Designed by ModiA	
File Storage Volume for Pr...	Checked by	
Micro Drainage		Source Control W.12.6.1

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.700	Shortest Storm (mins)	15
Ratio R	0.439	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 1.208

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-5	0.263	5-10	0.845	10-15	0.100

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Burderop Park

Swindon

SN4 0QD

Date 10.07.2012

File Storage Volume for Pr...

Storage Volume for pre-development discharge ...

30yr storm

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Checked by

Micro Drainage

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Micro Drainage®

Model Details

Storage is Online Cover Level (m) 31.300

Tank or Pond Structure

Invert Level (m) 30.300

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	0.300	200.0	0.600	200.0	0.900	200.0
0.100	200.0	0.400	200.0	0.700	200.0	1.000	200.0
0.200	200.0	0.500	200.0	0.800	200.0		

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md2 Invert Level (m) 30.300

Design Flow (l/s) 245.0 Diameter (mm) 447

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	10.4	1.200	239.2	3.000	361.2	7.000	551.7
0.200	42.0	1.400	249.3	3.500	390.1	7.500	571.1
0.300	88.0	1.600	264.4	4.000	417.1	8.000	589.8
0.400	139.0	1.800	279.9	4.500	442.4	8.500	608.0
0.500	185.9	2.000	294.9	5.000	466.3	9.000	625.6
0.600	220.7	2.200	309.3	5.500	489.1	9.500	642.7
0.800	254.2	2.400	323.1	6.000	510.8		
1.000	244.5	2.600	336.3	6.500	531.7		

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Burderop Park

Swindon

SN4 0QD

Storage Volume for pre-development discharge ... 30yr storm

Date	10.07.2012
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Designed by ModiA

File Storage Volume for Pr...

Checked by



Micro Drainage

Source Control W.12.6.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
5	0.0	15	10.0	25	20.0	35	35.0	45	45.0	55	45.0
10	5.0	20	15.0	30	30.0	40	40.0	50	45.0	60	45.0

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Burderop Park Swindon SN4 0QD		Storage Volume for pre-development discharge ... 100yr storm				
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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	30.977	0.677	307.4	169.2	O K
30 min	Summer	31.033	0.733	323.6	183.2	O K
60 min	Summer	31.012	0.712	318.3	177.9	O K
120 min	Summer	30.841	0.541	244.6	135.2	O K
180 min	Summer	30.751	0.451	191.0	112.6	O K
240 min	Summer	30.701	0.401	159.5	100.3	O K
360 min	Summer	30.640	0.340	121.4	84.9	O K
480 min	Summer	30.602	0.302	98.9	75.5	O K
600 min	Summer	30.576	0.276	83.7	68.9	O K
720 min	Summer	30.556	0.256	72.8	64.0	O K
960 min	Summer	30.528	0.228	58.4	56.9	O K
1440 min	Summer	30.499	0.199	44.9	49.7	O K
2160 min	Summer	30.496	0.196	43.5	49.0	O K
2880 min	Summer	30.494	0.194	42.9	48.6	O K
4320 min	Summer	30.493	0.193	42.2	48.2	O K
5760 min	Summer	30.487	0.187	39.7	46.7	O K
7200 min	Summer	30.486	0.186	39.5	46.5	O K
8640 min	Summer	30.486	0.186	39.2	46.5	O K
10080 min	Summer	30.486	0.186	39.2	46.4	O K
15 min	Winter	31.041	0.741	325.4	185.1	O K
30 min	Winter	31.081	0.781	335.1	195.3	O K
60 min	Winter	31.001	0.701	315.1	175.2	O K
120 min	Winter	30.793	0.493	217.0	123.3	O K
180 min	Winter	30.699	0.399	158.6	99.8	O K
Storm Event		Rain (mm/hr)		Time-Peak (mins)		
15 min	Summer	137.603		18		
30 min	Summer	88.845		26		
60 min	Summer	54.549		42		
120 min	Summer	32.353		70		
180 min	Summer	23.530		102		
240 min	Summer	18.670		132		
360 min	Summer	13.450		192		
480 min	Summer	10.655		252		
600 min	Summer	8.888		312		
720 min	Summer	7.661		374		
960 min	Summer	6.056		494		
1440 min	Summer	4.343		60		
2160 min	Summer	3.110		60		
2880 min	Summer	2.451		60		
4320 min	Summer	1.751		60		
5760 min	Summer	1.378		56		
7200 min	Summer	1.144		56		
8640 min	Summer	0.983		56		
10080 min	Summer	0.864		56		
15 min	Winter	137.603		19		
30 min	Winter	88.845		27		
60 min	Winter	54.549		42		
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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)	20.700	Shortest Storm (mins)	15
Ratio R	0.439	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 1.208

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-5	0.263	5-10	0.845	10-15	0.100

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Halcrow Group Limited		Page 4
Burderop Park Swindon SN4 0QD	Storage Volume for pre-development discharge ... 100yr storm	
Date 10.07.2012 File Storage Volume for Pr...	Designed by ModiA Checked by	
Micro Drainage Source Control W.12.6.1		

Model Details

Storage is Online Cover Level (m) 31.300

Tank or Pond Structure

Invert Level (m) 30.300

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	250.0	0.300	250.0	0.600	250.0	0.900	250.0
0.100	250.0	0.400	250.0	0.700	250.0	1.000	250.0
0.200	250.0	0.500	250.0	0.800	250.0		

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md2 Invert Level (m) 30.300
Design Flow (l/s) 359.0 Diameter (mm) 513

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	11.0	1.200	340.7	3.000	475.7	7.000	726.7
0.200	45.4	1.400	338.2	3.500	513.8	7.500	752.2
0.300	97.5	1.600	351.2	4.000	549.3	8.000	776.9
0.400	159.0	1.800	369.5	4.500	582.6	8.500	800.8
0.500	221.1	2.000	388.7	5.000	614.2	9.000	824.0
0.600	275.4	2.200	407.5	5.500	644.1	9.500	846.6
0.800	339.6	2.400	425.5	6.000	672.8		
1.000	358.7	2.600	442.9	6.500	700.2		

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Halcrow Group Limited		Page 5
Burderop Park Swindon SN4 0QD	Storage Volume for pre-development discharge ... 100yr storm	
Date 10.07.2012 File Storage Volume for Pr...	Designed by ModiA Checked by	
Micro Drainage		Source Control W.12.6.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
5	0.0	15	10.0	25	20.0	35	35.0	45	45.0	55	45.0
10	5.0	20	15.0	30	30.0	40	40.0	50	45.0	60	45.0

Appendix C: Existing Sewers Capacity Check

Halcrow		THIS IS A MANDATORY FORM		CALCULATION TITLE SHEET			
Project Title		Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)		Project Code:		GIB016300	
Calculation Title:		Existing Sewers Capacity Check and Permissible Discharge Rate		Serial No:		1	
Project Manager		Kerry Woods		No. of Sheets:		10 including cover sheet	
Status				Prepared by:		SAH	
Schematic		Preliminary		Date:		16-Jun-12	
Tender		Yes		Checked by:		AM	
Final for Construction		Other (state)		Date:		29-Jun-12	
Levels of Verification				Approved by:			
1 Self-check by originator and approval		3B Comparison with similar proven designs and approval		Date:			
2 Calculation Review and approval		4 External check and internal approval		Computer Analysis:			
3 Detailed check and approval		5 Other verification as stated in Management Plan		Yes: ☐ No: ☒			
3A Alternative calculations and approval				Program(s):			
				Hardware:			
Contents (continue on calculation sheet if necessary)							
1 Calculation Cover Sheet 2 Existing sewer capacity check - MH219 to EX MH216 3 Existing sewer capacity check - MH216 to EX MH218 4 Existing sewer capacity check - MH218 to TW 0207 5 Thames Network sewer capacity check - TW0204 to TW 0207 6 Thames Network sewer capacity check - TW0205 to TW 0207 7 Thames Network sewer capacity check - TW0207 to TW 0103 8 Thames Network sewer capacity check - TW0103 to TW 0004 9 Existing sewer capacity check - MH u/s to HPH4 to EX MH42 10 Permissible site discharge rate							
NB: Calculations should state or refer to design input data and methodology							
CONTENTS AMENDMENT RECORD							
Rev	Status	Date	Description	Page	By	Chk'd	App'd
		10-Jul-12	First Issue	10	SAH	AM	

File Name:

Path:

Rev 0

Calculation Title Sheet



Rev: 0

Date: Jun-12

Date: Jun-12

Pipe Flows Condition MH219-MH216

Colebrook-White Formula -

$$V = -2\sqrt{(2gDS)} \log \left(\frac{K_s}{3.70} + \frac{2.51\nu}{D\sqrt{(2gDS)}} \right)$$

$\nu =$	Kinematic Viscosity of fluid
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Pipe Roughness	1.5
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EXMH216 = 29.67m

Results -

Percent Depth	Depth of flow (mm)	Proportional Depth	Hydraulic Radius	Velocity (m/s)	Flow (l/s)	Pipe full Velocity (m/s)	Pipe Full Capacity (l/s)
5%	26	0.05	0.016931	0.6405	2.5553	2.4958	540.2792
10%	53	0.1	0.03365	1.0241	11.6994	2.4958	540.2792
15%	79	0.15	0.048903	1.3142	26.8826	2.4958	540.2792
20%	105	0.2	0.06331	1.5578	48.0136	2.4958	540.2792
25%	131	0.25	0.076853	1.768	74.6229	2.4958	540.2792
30%	158	0.3	0.089978	1.9586	107.4505	2.4958	540.2792
35%	184	0.35	0.101691	2.1197	143.3934	2.4958	540.2792
40%	210	0.4	0.112469	2.2617	182.8812	2.4958	540.2792
45%	236	0.45	0.12228	2.3864	225.1541	2.4958	540.2792
50%	263	0.5	0.13125	2.4971	270.2803	2.4958	540.2792
55%	289	0.55	0.139135	2.5919	316.5397	2.4958	540.2792
60%	315	0.6	0.145763	2.67	362.0929	2.4958	540.2792
65%	341	0.65	0.151231	2.7334	406.8048	2.4958	540.2792
70%	368	0.7	0.155591	2.7833	451.1609	2.4958	540.2792
75%	394	0.75	0.158406	2.8152	490.5988	2.4958	540.2792
80%	420	0.8	0.159701	2.8299	525.3821	2.4958	540.2792
85%	446	0.85	0.15923	2.8245	553.6581	2.4958	540.2792
90%	473	0.9	0.15639	2.7924	573.4648	2.4958	540.2792
95%	499	0.95	0.150305	2.7227	578.5353	2.4958	540.2792
100%	525	1	0.13125	2.4971	540.5606	2.4958	540.2792

Calculation Sheet (Excel)

Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)
Subject: Existing Sewers Capacity Check and Permissible Discharge Rate

By: SAH Date: Jun-12
Check By: AM Date: Jun-12

Pipe Flows Condition MH216-MH218

This calculation sheet uses the Colebrook - White formula to calculate pipe flows for full and partially full pipes assuming that there are no affects of downstream controls

Colebrook-White Formula -

$$V = -2\sqrt{(2gDS)} \log \left(\frac{K_s}{3.70D} + \frac{2.51\nu}{D\sqrt{(2gDS)}} \right)$$

V = Velocity (m/s)
g = Gravitational acceleration (9.81m/s²)
D = Pipe Diameter (mm)
S = Hydraulic Gradient
Ks = Effective pipe roughness (0.6 for surface sewers and 1.5 for foul sewers typically)
ν = Kinematic Viscosity of fluid

<u>Data inputs -</u>	Pipe Diameter	525	mm
	Gradient	2330	
	Pipe Roughness	1.5	

Sewer Length - 23.3m
Sewer Invert at outlet of
EX MH216 = 29.67m
Sewer Invert at inlet to
EXMH218 = 29.66m

Results -

Percent Depth	Depth of flow (mm)	Proportional Depth	Hydraulic Radius	Velocity (m/s)	Flow (l/s)	Pipe full Velocity (m/s)	Pipe Full Capacity (l/s)
5%	26	0.05	0.016931	0.1062	0.4237	0.4137	89.5559
10%	53	0.1	0.03365	0.1698	1.9398	0.4137	89.5559
15%	79	0.15	0.048903	0.2178	4.4552	0.4137	89.5559
20%	105	0.2	0.06331	0.2582	7.9581	0.4137	89.5559
25%	131	0.25	0.076853	0.293	12.3668	0.4137	89.5559
30%	158	0.3	0.089978	0.3246	17.8078	0.4137	89.5559
35%	184	0.35	0.101691	0.3513	23.7647	0.4137	89.5559
40%	210	0.4	0.112469	0.3749	30.3144	0.4137	89.5559
45%	236	0.45	0.12228	0.3955	37.315	0.4137	89.5559
50%	263	0.5	0.13125	0.4139	44.7996	0.4137	89.5559
55%	289	0.55	0.139135	0.4296	52.4656	0.4137	89.5559
60%	315	0.6	0.145763	0.4425	60.0098	0.4137	89.5559
65%	341	0.65	0.151231	0.453	67.4188	0.4137	89.5559
70%	368	0.7	0.155591	0.4613	74.7747	0.4137	89.5559
75%	394	0.75	0.158406	0.4666	81.3134	0.4137	89.5559
80%	420	0.8	0.159701	0.469	87.0717	0.4137	89.5559
85%	446	0.85	0.15923	0.4681	91.7569	0.4137	89.5559
90%	473	0.9	0.15639	0.4628	95.0435	0.4137	89.5559
95%	499	0.95	0.150305	0.4513	95.8949	0.4137	89.5559
100%	525	1	0.13125	0.4139	89.5992	0.4137	89.5559

Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)
 Subject: Existing Sewers Capacity Check and Permissible Discharge Rate

By: SAH Date: Jun-12
 Check By: AM Date: Jun-12

References/Results

Pipe Flows Condition MH218-TW0207

This calculation sheet uses the Colebrook - White formula to calculate pipe flows for full and partially full pipes assuming that there are no affects of downstream controls

Colebrook-White Formula -

$$V = -2\sqrt{(2gDS)} \log \left(\frac{K_s}{3.70D} + \frac{2.51\nu}{D\sqrt{(2gDS)}} \right)$$

V = Velocity (m/s)
 g = Gravitational acceleration (9.81m/s²)
 D = Pipe Diameter (mm)
 S = Hydraulic Gradient
 Ks = Effective pipe roughness (0.6 for surface sewers and 1.5 for foul sewers typically)
 ν = Kinematic Viscosity of fluid

<u>Data inputs -</u>	Pipe Diameter	525	mm
	Gradient	27	
	Pipe Roughness	1.5	

Sewer Length - 16.59m
 Sewer Invert at outlet of EX MH218 = 29.66m
 Sewer Invert at inlet to EXMH218 = 29.05m

Results -

Percent Depth	Depth of flow (mm)	Proportional Depth	Hydraulic Radius	Velocity (m/s)	Flow (l/s)	Pipe full Velocity (m/s)	Pipe Full Capacity (l/s)
5%	26	0.05	0.016931	0.9824	3.9193	3.8285	828.7759
10%	53	0.1	0.03365	1.571	17.9472	3.8285	828.7759
15%	79	0.15	0.048903	2.0159	41.2363	3.8285	828.7759
20%	105	0.2	0.06331	2.3896	73.6509	3.8285	828.7759
25%	131	0.25	0.076853	2.7121	114.4711	3.8285	828.7759
30%	158	0.3	0.089978	3.0044	164.8239	3.8285	828.7759
35%	184	0.35	0.101691	3.2515	219.9574	3.8285	828.7759
40%	210	0.4	0.112469	3.4694	280.5359	3.8285	828.7759
45%	236	0.45	0.12228	3.6607	345.3828	3.8285	828.7759
50%	263	0.5	0.13125	3.8304	414.5936	3.8285	828.7759
55%	289	0.55	0.139135	3.9759	485.5628	3.8285	828.7759
60%	315	0.6	0.145763	4.0958	555.4532	3.8285	828.7759
65%	341	0.65	0.151231	4.193	624.0333	3.8285	828.7759
70%	368	0.7	0.155591	4.2696	692.0838	3.8285	828.7759
75%	394	0.75	0.158406	4.3185	752.5756	3.8285	828.7759
80%	420	0.8	0.159701	4.341	805.9237	3.8285	828.7759
85%	446	0.85	0.15923	4.3328	849.3148	3.8285	828.7759
90%	473	0.9	0.15639	4.2835	879.6865	3.8285	828.7759
95%	499	0.95	0.150305	4.1766	887.4685	3.8285	828.7759
100%	525	1	0.13125	3.8304	829.1873	3.8285	828.7759

Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)
Subject: Existing Sewers Capacity Check and Permissible Discharge Rate

By: SAH Date: Jun-12
Check By: AM Date: Jun-12

References/Results

Pipe Flows Condition TW0204 -TW0207

This calculation sheet uses the Colebrook - White formula to calculate pipe flows for full and partially full pipes assuming that there are no affects of downstream controls

Colebrook-White Formula -

$$V = -2\sqrt{(2gDS)} \log \left(\frac{K_s}{3.70D} + \frac{2.51v}{D\sqrt{(2gDS)}} \right)$$

V = Velocity (m/s)
g = Gravitational acceleration (9.81m/s²)
D = Pipe Diameter (mm)
S = Hydraulic Gradient
Ks = Effective pipe roughness (0.6 for surface sewers and 1.5 for foul sewers typically)
v = Kinematic Viscosity of fluid

Data inputs -	Pipe Diameter	225	mm
	Gradient	9	
	Pipe Roughness	1.5	

Sewer Length - 11.50m
Sewer Invert at outlet of TW0204 = 30.32m
Sewer Invert at inlet to TW0207 = 29.05m

Results -

Percent Depth	Depth of flow (mm)	Proportional Depth	Hydraulic Radius	Velocity (m/s)	Flow (l/s)	Pipe full Velocity (m/s)	Pipe Full Capacity (l/s)
5%	11	0.05	0.007165	0.921	0.6621	3.8295	152.2639
10%	23	0.1	0.014593	1.5344	3.2792	3.8295	152.2639
15%	34	0.15	0.02104	1.9783	7.4782	3.8295	152.2639
20%	45	0.2	0.027133	2.3537	13.3245	3.8295	152.2639
25%	56	0.25	0.032865	2.6794	20.6973	3.8295	152.2639
30%	68	0.3	0.038696	2.9896	30.3011	3.8295	152.2639
35%	79	0.35	0.043644	3.2393	40.3481	3.8295	152.2639
40%	90	0.4	0.048201	3.46	51.3874	3.8295	152.2639
45%	101	0.45	0.052355	3.6544	63.2116	3.8295	152.2639
50%	113	0.5	0.05625	3.8315	76.1717	3.8295	152.2639
55%	124	0.55	0.059669	3.9831	89.4739	3.8295	152.2639
60%	135	0.6	0.06247	4.1048	102.2462	3.8295	152.2639
65%	146	0.65	0.064786	4.204	114.7901	3.8295	152.2639
70%	158	0.7	0.06672	4.2857	127.8489	3.8295	152.2639
75%	169	0.75	0.0679	4.3351	138.8801	3.8295	152.2639
80%	180	0.8	0.068443	4.3577	148.5963	3.8295	152.2639
85%	191	0.85	0.068249	4.3497	156.505	3.8295	152.2639
90%	203	0.9	0.066978	4.2965	162.23	3.8295	152.2639
95%	214	0.95	0.064369	4.1862	163.4373	3.8295	152.2639
100%	225	1	0.05625	3.8315	152.3434	3.8295	152.2639

Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)
 Subject: Existing Sewers Capacity Check and Permissible Discharge Rate

By: SAH Date: Jun-12
 Check By: AM Date: Jun-12

References/Results

Pipe Flows Condition TW0205 -TW0207

This calculation sheet uses the Colebrook - White formula to calculate pipe flows for full and partially full pipes assuming that there are no affects of downstream controls

Colebrook-White Formula -

$$V = -2\sqrt{(2gDS)} \log \left(\frac{K_s}{3.70D} + \frac{2.51v}{D\sqrt{(2gDS)}} \right)$$

V = Velocity (m/s)
 g = Gravitational acceleration (9.81m/s²)
 D = Pipe Diameter (mm)
 S = Hydraulic Gradient
 Ks = Effective pipe roughness (0.6 for surface sewers and 1.5 for foul sewers typically)
 v = Kinematic Viscosity of fluid

<u>Data inputs -</u>	Pipe Diameter	225	mm
	Gradient	20	
	Pipe Roughness	1.5	

Sewer Length - 6.50m
 Sewer Invert at outlet of TW0205 = 29.38m
 Sewer Invert at inlet to TW0207 = 29.05m

Results -

Percent Depth	Depth of flow (mm)	Proportional Depth	Hydraulic Radius	Velocity (m/s)	Flow (l/s)	Pipe full Velocity (m/s)	Pipe Full Capacity (l/s)
5%	11	0.05	0.007165	0.6246	0.449	2.5967	103.2468
10%	23	0.1	0.014593	1.0405	2.2237	2.5967	103.2468
15%	34	0.15	0.02104	1.3415	5.0711	2.5967	103.2468
20%	45	0.2	0.027133	1.5961	9.0356	2.5967	103.2468
25%	56	0.25	0.032865	1.8169	14.0348	2.5967	103.2468
30%	68	0.3	0.038696	2.0272	20.5467	2.5967	103.2468
35%	79	0.35	0.043644	2.1965	27.3592	2.5967	103.2468
40%	90	0.4	0.048201	2.3462	34.8454	2.5967	103.2468
45%	101	0.45	0.052355	2.478	42.863	2.5967	103.2468
50%	113	0.5	0.05625	2.598	51.6493	2.5967	103.2468
55%	124	0.55	0.059669	2.7008	60.6691	2.5967	103.2468
60%	135	0.6	0.06247	2.7834	69.3315	2.5967	103.2468
65%	146	0.65	0.064786	2.8506	77.8355	2.5967	103.2468
70%	158	0.7	0.06672	2.906	86.6904	2.5967	103.2468
75%	169	0.75	0.0679	2.9395	94.1704	2.5967	103.2468
80%	180	0.8	0.068443	2.9548	100.7578	2.5967	103.2468
85%	191	0.85	0.068249	2.9494	106.1213	2.5967	103.2468
90%	203	0.9	0.066978	2.9133	110.0022	2.5967	103.2468
95%	214	0.95	0.064369	2.8385	110.8205	2.5967	103.2468
100%	225	1	0.05625	2.598	103.2985	2.5967	103.2468

Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)
Subject: Existing Sewers Capacity Check and Permissible Discharge Rate

By: SAH Date: Jun-12
Check By: AM Date: Jun-12

Pipe Flows Condition TW0207 -TW0103

This calculation sheet uses the Colebrook - White formula to calculate pipe flows for full and partially full pipes assuming that there are no affects of downstream controls

Colebrook-White Formula -

$$V = -2\sqrt{(2gDS)} \log \left(\frac{K_s}{3.70D} + \frac{2.51\nu}{D\sqrt{(2gDS)}} \right)$$

V = Velocity (m/s)
g = Gravitational acceleration (9.81m/s²)
D = Pipe Diameter (mm)
S = Hydraulic Gradient
Ks = Effective pipe roughness (0.6 for surface sewers and 1.5 for foul sewers typically)
ν = Kinematic Viscosity of fluid

Data inputs -	Pipe Diameter	600	mm
	Gradient	129	
	Pipe Roughness	1.5	

Sewer Length - 80m
Sewer Invert at outlet of TW0207 = 29.05m
Sewer Invert at inlet to TW0103 = 28.43m

Results -

Percent Depth	Depth of flow (mm)	Proportional Depth	Hydraulic Radius	Velocity (m/s)	Flow (l/s)	Pipe full Velocity (m/s)	Pipe Full Capacity (l/s)
5%	30	0.05	0.019531	0.498	2.6321	1.9141	541.199
10%	60	0.1	0.038112	0.7841	11.5381	1.9141	541.199
15%	90	0.15	0.055727	1.0089	26.8316	1.9141	541.199
20%	120	0.2	0.072355	1.1972	48.1952	1.9141	541.199
25%	150	0.25	0.087975	1.3594	75.1431	1.9141	541.199
30%	180	0.3	0.102565	1.5011	107.0894	1.9141	541.199
35%	210	0.35	0.116095	1.6257	143.3753	1.9141	541.199
40%	240	0.4	0.128536	1.7353	183.2705	1.9141	541.199
45%	270	0.45	0.139851	1.8314	225.9979	1.9141	541.199
50%	300	0.5	0.15	1.9151	270.7409	1.9141	541.199
55%	330	0.55	0.158932	1.9869	316.5959	1.9141	541.199
60%	360	0.6	0.166587	2.0472	362.621	1.9141	541.199
65%	390	0.65	0.172889	2.096	407.7776	1.9141	541.199
70%	420	0.7	0.177741	2.1331	450.9432	1.9141	541.199
75%	450	0.75	0.181012	2.1579	490.8504	1.9141	541.199
80%	480	0.8	0.182516	2.1693	526.0265	1.9141	541.199
85%	510	0.85	0.18196	2.1651	554.587	1.9141	541.199
90%	540	0.9	0.178822	2.1413	573.9289	1.9141	541.199
95%	570	0.95	0.171871	2.0882	579.3878	1.9141	541.199
100%	600	1	0.15	1.9151	541.4818	1.9141	541.199

 CALCULATION SHEET		No: 8	Rev: 0																																																																																																																																																																								
Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)		By: SAH	Date: Jun-12																																																																																																																																																																								
Subject: Existing Sewers Capacity Check and Permissible Discharge Rate		Check By: AM	Date: Jun-12																																																																																																																																																																								
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80%	120	0.8	0.045629	0.7101	10.7619	0.6227	11.004																																																																																																																																																																				
85%	128	0.85	0.04546	0.7083	11.3771	0.6227	11.004																																																																																																																																																																				
90%	135	0.9	0.044706	0.7005	11.7346	0.6227	11.004																																																																																																																																																																				
95%	143	0.95	0.0428	0.6805	11.8225	0.6227	11.004																																																																																																																																																																				
100%	150	1	0.0375	0.623	11.0093	0.6227	11.004																																																																																																																																																																				
Rev 0		Calculation Sheet (Excel)																																																																																																																																																																									

Project: Hyde Park Hayes Development 4 & 5 (HPH4 & HPH5)

By: SAH Date: Jun-12

Subject: Existing Sewers Capacity Check and Permissible Discharge Rate

Check By: AM Date: Jun-12

Existing Sewers Capacity and Permissible Discharge Rate

Existing MH219 is considered to be connection point for the drainage and therefore sewers capacity for the section of the network downstream to MH219 upto Thames network TW0207 are determined. They are summarised as below:

U/S Ref	D/S Ref	Dia (mm)	Pipe Full Capacity (l/s)
MH219	MH216	525	540.00
MH216	MH218	525	89.56
MH218	TW 0207	525	828.78

Summary - It can be seen that the section of pipe between MH216 and MH218 is the limiting section with full bore capacity of about 90 l/s and provides the acceptable discharge for the development sites and associated catchment.

A check on Thames Water's sewers at the connection point TW0207 has been made to ensure the sewers are sufficient to drain as a minimum 90 l/s.

U/S Ref	D/S Ref	Dia (mm)	Pipe Full Capacity (l/s)
TW 0204	TW 0207	225	152.26
TW 0205	TW 0207	225	103.25
TW 0207	TW 0103	600	541.20
TW 0103	TW 0004	600	568.26

Summary - It appears that the existing 600mm dia Thames Water's sewer at TW0207 has spare capacity of about 285 l/s for the section of sewers connected through MH218. This is well above the restricted site flows of 90 l/s.

Conclusion - The permissible discharge rate at connection to MH219 should be limited to 90 l/s. The proposed storm water drainage design will need to demonstrate this for various storms upto 100 yr return period including climate change.

References/Results

No information for manhole between MH 218 & TW0207 and assumed to average across these manholes

225mm dia assumed for TW0204 to TW0207
225 mm and 600mm two parallel pipes run along the Dawley Road and 600mm assumed to collecting the site runoff

Appendix D: WinDES Microdrainage Results – Attenuation for permissible site discharge

1. Storage Volume for permissible discharge rate _1 yr storm event
2. Storage Volume for permissible discharge rate_30 yr storm event
3. Storage Volume for permissible discharge rate_100 yr storm event

Halcrow Group Limited				Page 1	
Burderop Park Swindon SN4 0QD		Storage Volume for permissible discharge rate 1 yr storm			
Date 10.07.2012 File Storage Volume for pe...		Designed by ModiA Checked by			
Micro Drainage		Source Control W.12.6.1			
Summary of Results for 1 year Return Period (+30%)					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	30.845	0.545	88.7	54.5	O K
30 min Summer	30.951	0.651	88.7	65.1	O K
60 min Summer	31.114	0.814	88.7	81.4	Flood Risk
120 min Summer	30.764	0.464	84.4	46.4	O K
180 min Summer	30.624	0.324	63.9	32.4	O K
240 min Summer	30.587	0.287	54.8	28.7	O K
360 min Summer	30.565	0.265	49.0	26.4	O K
480 min Summer	30.560	0.260	47.8	26.0	O K
600 min Summer	30.558	0.258	47.3	25.8	O K
720 min Summer	30.557	0.257	46.9	25.7	O K
960 min Summer	30.555	0.255	46.4	25.5	O K
1440 min Summer	30.553	0.253	45.8	25.3	O K
2160 min Summer	30.551	0.251	45.4	25.2	O K
2880 min Summer	30.551	0.251	45.3	25.0	O K
4320 min Summer	30.550	0.250	45.0	25.0	O K
5760 min Summer	30.548	0.248	44.5	24.8	O K
7200 min Summer	30.548	0.248	44.5	24.8	O K
8640 min Summer	30.547	0.247	44.3	24.7	O K
10080 min Summer	30.547	0.247	44.3	24.7	O K
15 min Winter	30.918	0.618	88.7	61.8	O K
30 min Winter	31.040	0.740	88.7	74.0	O K
60 min Winter	31.174	0.874	88.6	87.4	Flood Risk
120 min Winter	30.787	0.487	86.4	48.7	O K
180 min Winter	30.608	0.308	60.0	30.8	O K
Storm Event		Rain (mm/hr)		Time-Peak (mins)	
15 min Summer		43.070		19	
30 min Summer		27.769		29	
60 min Summer		17.298		48	
120 min Summer		10.543		70	
180 min Summer		7.850		102	
240 min Summer		6.360		132	
360 min Summer		4.698		60	
480 min Summer		3.780		60	
600 min Summer		3.192		60	
720 min Summer		2.780		60	
960 min Summer		2.236		60	
1440 min Summer		1.645		60	
2160 min Summer		1.211		60	
2880 min Summer		0.975		60	
4320 min Summer		0.716		60	
5760 min Summer		0.576		56	
7200 min Summer		0.487		56	
8640 min Summer		0.424		56	
10080 min Summer		0.377		56	
15 min Winter		43.070		20	
30 min Winter		27.769		30	
60 min Winter		17.298		50	
120 min Winter		10.543		62	
180 min Winter		7.850		60	
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Burderop Park Swindon SN4 0QD	Storage Volume for permissible discharge rate 1 yr storm	
Date 10.07.2012 File Storage Volume for pe...	Designed by ModiA Checked by	
Micro Drainage Source Control W.12.6.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.700	Shortest Storm (mins)	15
Ratio R	0.439	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 1.208

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-5	0.263	5-10	0.845	10-15	0.100

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Burderop Park Swindon SN4 0QD	Storage Volume for permissible discharge rate 1 yr storm	
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Micro Drainage Source Control W.12.6.1		

Model Details

Storage is Online Cover Level (m) 31.300

Tank or Pond Structure

Invert Level (m) 30.300

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	100.0	0.300	100.0	0.600	100.0	0.900	100.0
0.100	100.0	0.400	100.0	0.700	100.0	1.000	100.0
0.200	100.0	0.500	100.0	0.800	100.0		

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md2 Invert Level (m) 30.300
Design Flow (l/s) 90.0 Diameter (mm) 293

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.6	1.200	98.2	3.000	155.2	7.000	237.1
0.200	31.5	1.400	106.0	3.500	167.6	7.500	245.4
0.300	58.1	1.600	113.3	4.000	179.2	8.000	253.4
0.400	77.7	1.800	120.2	4.500	190.1	8.500	261.2
0.500	87.4	2.000	126.7	5.000	200.3	9.000	268.8
0.600	87.5	2.200	132.9	5.500	210.1	9.500	276.2
0.800	83.4	2.400	138.8	6.000	219.5		
1.000	90.0	2.600	144.5	6.500	228.4		

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Burderop Park
Swindon
SN4 0QD

Storage Volume for permissible discharge rate 1 yr storm
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Date	10.07.2012
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File Storage Volume for pe...

Checked by



Micro Drainage

Source Control W.12.6.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
5	0.0	15	10.0	25	20.0	35	35.0	45	45.0	55	45.0
10	5.0	20	15.0	30	30.0	40	40.0	50	45.0	60	45.0

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Burderop Park Swindon SN4 0QD		Storage Volume for permissible discharge rate 30yr storm			
Date 10.07.2012 File Storage Volume for pe...		Designed by ModiA Checked by			
Micro Drainage		Source Control W.12.6.1			
Summary of Results for 30 year Return Period (+30%)					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	30.780	0.480	85.9	196.9	O K
30 min Summer	30.894	0.594	88.7	243.7	O K
60 min Summer	31.027	0.727	88.7	298.0	O K
120 min Summer	30.946	0.646	88.7	264.7	O K
180 min Summer	30.810	0.510	87.9	209.0	O K
240 min Summer	30.742	0.442	82.1	181.2	O K
360 min Summer	30.666	0.366	72.4	149.9	O K
480 min Summer	30.622	0.322	63.3	131.9	O K
600 min Summer	30.592	0.292	56.1	119.6	O K
720 min Summer	30.569	0.269	50.2	110.4	O K
960 min Summer	30.538	0.238	41.7	97.5	O K
1440 min Summer	30.500	0.200	31.4	82.0	O K
2160 min Summer	30.482	0.182	26.8	74.8	O K
2880 min Summer	30.481	0.181	26.4	74.1	O K
4320 min Summer	30.479	0.179	25.9	73.3	O K
5760 min Summer	30.466	0.166	22.7	67.9	O K
7200 min Summer	30.465	0.165	22.5	67.6	O K
8640 min Summer	30.465	0.165	22.4	67.4	O K
10080 min Summer	30.464	0.164	22.3	67.3	O K
15 min Winter	30.838	0.538	88.7	220.8	O K
30 min Winter	30.976	0.676	88.7	277.3	O K
60 min Winter	31.116	0.816	88.7	334.5	Flood Risk
120 min Winter	30.980	0.680	88.7	278.6	O K
180 min Winter	30.800	0.500	87.3	204.8	O K
Storm Event	Rain (mm/hr)		Time-Peak (mins)		
15 min Summer	105.776		22		
30 min Summer	67.784		35		
60 min Summer	41.476		60		
120 min Summer	24.630		80		
180 min Summer	17.973		112		
240 min Summer	14.315		142		
360 min Summer	10.368		202		
480 min Summer	8.243		262		
600 min Summer	6.896		322		
720 min Summer	5.959		382		
960 min Summer	4.729		504		
1440 min Summer	3.411		744		
2160 min Summer	2.458		60		
2880 min Summer	1.947		60		
4320 min Summer	1.401		60		
5760 min Summer	1.109		64		
7200 min Summer	0.924		64		
8640 min Summer	0.797		64		
10080 min Summer	0.702		64		
15 min Winter	105.776		22		
30 min Winter	67.784		36		
60 min Winter	41.476		60		
120 min Winter	24.630		86		
180 min Winter	17.973		116		
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Burderop Park Swindon SN4 0QD	Storage Volume for permissible discharge rate 30yr storm	
Date 10.07.2012 File Storage Volume for pe...	Designed by ModiA Checked by	
Micro Drainage Source Control W.12.6.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.700	Shortest Storm (mins)	15
Ratio R	0.439	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 1.208

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-5	0.263	5-10	0.845	10-15	0.100

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Burderop Park Swindon SN4 0QD	Storage Volume for permissible discharge rate 30yr storm	
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Model Details

Storage is Online Cover Level (m) 31.300

Tank or Pond Structure

Invert Level (m) 30.300

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	410.0	0.300	410.0	0.600	410.0	0.900	410.0
0.100	410.0	0.400	410.0	0.700	410.0	1.000	410.0
0.200	410.0	0.500	410.0	0.800	410.0		

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md2 Invert Level (m) 30.300
Design Flow (l/s) 90.0 Diameter (mm) 293

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.6	1.200	98.2	3.000	155.2	7.000	237.1
0.200	31.5	1.400	106.0	3.500	167.6	7.500	245.4
0.300	58.1	1.600	113.3	4.000	179.2	8.000	253.4
0.400	77.7	1.800	120.2	4.500	190.1	8.500	261.2
0.500	87.4	2.000	126.7	5.000	200.3	9.000	268.8
0.600	87.5	2.200	132.9	5.500	210.1	9.500	276.2
0.800	83.4	2.400	138.8	6.000	219.5		
1.000	90.0	2.600	144.5	6.500	228.4		

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Burderop Park
Swindon
SN4 0QD

Storage Volume for permissible discharge rate 30yr storm
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Date	10.07.2012
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File Storage Volume for pe...

Checked by

Micro Drainage

Source Control W.12.6.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
5	0.0	15	10.0	25	20.0	35	35.0	45	45.0	55	45.0
10	5.0	20	15.0	30	30.0	40	40.0	50	45.0	60	45.0

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Burderop Park Swindon SN4 0QD		Storage Volume for permissible discharge rate 100yr storm				
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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	30.768	0.468	84.8	269.2	O K	
30 min Summer	30.889	0.589	88.7	338.6	O K	
60 min Summer	31.021	0.721	88.7	414.6	O K	
120 min Summer	30.975	0.675	88.7	388.4	O K	
180 min Summer	30.875	0.575	88.7	330.6	O K	
240 min Summer	30.807	0.507	87.7	291.5	O K	
360 min Summer	30.722	0.422	80.2	242.8	O K	
480 min Summer	30.670	0.370	73.1	212.7	O K	
600 min Summer	30.634	0.334	66.1	192.3	O K	
720 min Summer	30.608	0.308	60.2	177.1	O K	
960 min Summer	30.571	0.271	50.6	155.8	O K	
1440 min Summer	30.526	0.226	38.6	130.2	O K	
2160 min Summer	30.490	0.190	28.8	109.2	O K	
2880 min Summer	30.468	0.168	23.3	96.6	O K	
4320 min Summer	30.448	0.148	18.3	84.8	O K	
5760 min Summer	30.438	0.138	16.1	79.3	O K	
7200 min Summer	30.437	0.137	16.0	78.8	O K	
8640 min Summer	30.437	0.137	15.9	78.5	O K	
10080 min Summer	30.436	0.136	15.7	78.3	O K	
15 min Winter	30.825	0.525	88.5	301.7	O K	
30 min Winter	30.968	0.668	88.7	384.0	O K	
60 min Winter	31.109	0.809	88.7	465.4	Flood Risk	
120 min Winter	31.031	0.731	88.7	420.3	O K	
180 min Winter	30.893	0.593	88.7	340.7	O K	
Storm Event	Rain (mm/hr)		Time-Peak (mins)			
15 min Summer	137.603		23			
30 min Summer	88.845		36			
60 min Summer	54.549		60			
120 min Summer	32.353		84			
180 min Summer	23.530		116			
240 min Summer	18.670		148			
360 min Summer	13.450		208			
480 min Summer	10.655		268			
600 min Summer	8.888		328			
720 min Summer	7.661		390			
960 min Summer	6.056		508			
1440 min Summer	4.343		752			
2160 min Summer	3.110		1112			
2880 min Summer	2.451		1476			
4320 min Summer	1.751		64			
5760 min Summer	1.378		64			
7200 min Summer	1.144		64			
8640 min Summer	0.983		64			
10080 min Summer	0.864		64			
15 min Winter	137.603		23			
30 min Winter	88.845		37			
60 min Winter	54.549		60			
120 min Winter	32.353		92			
180 min Winter	23.530		124			
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10080 min Winter	0.864	64																																																																																																																																										
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Burderop Park Swindon SN4 0QD	Storage Volume for permissible discharge rate 100yr storm	
Date 10.07.2012 File Storage Volume for pe...	Designed by ModiA Checked by	
Micro Drainage Source Control W.12.6.1		

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)	20.700	Shortest Storm (mins)	15
Ratio R	0.439	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 1.208

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-5	0.263	5-10	0.845	10-15	0.100

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Burderop Park Swindon SN4 0QD	Storage Volume for permissible discharge rate 100yr storm	
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Model Details

Storage is Online Cover Level (m) 31.300

Tank or Pond Structure

Invert Level (m) 30.300

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	575.0	0.300	575.0	0.600	575.0	0.900	575.0
0.100	575.0	0.400	575.0	0.700	575.0	1.000	575.0
0.200	575.0	0.500	575.0	0.800	575.0		

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md2 Invert Level (m) 30.300
Design Flow (l/s) 90.0 Diameter (mm) 293

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.6	1.200	98.2	3.000	155.2	7.000	237.1
0.200	31.5	1.400	106.0	3.500	167.6	7.500	245.4
0.300	58.1	1.600	113.3	4.000	179.2	8.000	253.4
0.400	77.7	1.800	120.2	4.500	190.1	8.500	261.2
0.500	87.4	2.000	126.7	5.000	200.3	9.000	268.8
0.600	87.5	2.200	132.9	5.500	210.1	9.500	276.2
0.800	83.4	2.400	138.8	6.000	219.5		
1.000	90.0	2.600	144.5	6.500	228.4		

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Burderop Park

Swindon

SN4 0QD

Storage Volume for permissible discharge rate 100yr storm

Date	10.07.2012
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File Storage Volume for pe...

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Source Control W.12.6.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
5	0.0	15	10.0	25	20.0	35	35.0	45	45.0	55	45.0
10	5.0	20	15.0	30	30.0	40	40.0	50	45.0	60	45.0

Appendix E: WinDES Microdrainage Results for Proposed Surface Water Drainage Strategy

1. Drainage Network_HPH4 and HPH5_ 1 yr storm event
2. Drainage Network_HPH4 and HPH5_ 30 yr storm event
3. Drainage Network_HPH4 and HPH5_ 100yr storm event

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Burderop Park Swindon SN4 0QD	Hyde Park Hayes HPH4 & HPH5 Drainage Design for 1 yr, ... 100 yr storm plus 30%C																																																																																																																																																																																																																																																																											
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<u>Existing Network Details for Existing</u> * - Indicates pipe has been modified outside of System 1 <table><tr><td>PN</td><td>Length (m)</td><td>Fall (m)</td><td>Slope (1:X)</td><td>I.Area (ha)</td><td>T.E. (mins)</td><td>k (mm)</td><td>HYD SECT</td><td>DIA (mm)</td></tr><tr><td>* E1.000</td><td>7.500</td><td>0.037</td><td>202.7</td><td>0.000</td><td>10.00</td><td>0.600</td><td>o</td><td>300</td></tr><tr><td>* E2.000</td><td>50.000</td><td>0.200</td><td>250.0</td><td>0.020</td><td>5.00</td><td>0.600</td><td>o</td><td>300</td></tr><tr><td>* E3.000</td><td>5.933</td><td>0.012</td><td>500.0</td><td>0.000</td><td>5.00</td><td>0.600</td><td>o</td><td>225</td></tr><tr><td>* E1.001</td><td>13.000</td><td>0.052</td><td>250.0</td><td>0.210</td><td>0.00</td><td>0.600</td><td>o</td><td>450</td></tr><tr><td>* E4.000</td><td>8.344</td><td>0.017</td><td>500.0</td><td>0.000</td><td>5.00</td><td>0.600</td><td>o</td><td>225</td></tr><tr><td>* E1.002</td><td>20.000</td><td>0.080</td><td>250.0</td><td>0.020</td><td>0.00</td><td>0.600</td><td>o</td><td>450</td></tr><tr><td>* E1.003</td><td>20.000</td><td>0.080</td><td>250.0</td><td>0.210</td><td>0.00</td><td>0.600</td><td>o</td><td>450</td></tr><tr><td>* E1.004</td><td>20.000</td><td>0.080</td><td>250.0</td><td>0.040</td><td>0.00</td><td>0.600</td><td>o</td><td>450</td></tr><tr><td>* E5.000</td><td>16.000</td><td>0.053</td><td>300.0</td><td>0.000</td><td>10.00</td><td>0.600</td><td>o</td><td>225</td></tr><tr><td>* E6.000</td><td>7.457</td><td>0.015</td><td>500.0</td><td>0.000</td><td>5.00</td><td>0.600</td><td>o</td><td>225</td></tr><tr><td>* E5.001</td><td>25.000</td><td>0.083</td><td>300.0</td><td>0.100</td><td>0.00</td><td>0.600</td><td>o</td><td>225</td></tr><tr><td>* E7.000</td><td>5.878</td><td>0.012</td><td>500.0</td><td>0.000</td><td>5.00</td><td>0.600</td><td>o</td><td>225</td></tr><tr><td>* E5.002</td><td>35.000</td><td>0.088</td><td>400.0</td><td>0.200</td><td>0.00</td><td>0.600</td><td>o</td><td>225</td></tr></table> <table><tr><td>PN</td><td>US/MH Name</td><td>US/CL (m)</td><td>US/IL (m)</td><td>US C.Depth (m)</td><td>DS/CL (m)</td><td>DS/IL (m)</td><td>DS C.Depth (m)</td><td>Ctrl</td><td>US/MH (mm)</td></tr><tr><td>* E1.000</td><td>EX MH42</td><td>31.980</td><td>30.500</td><td>1.180</td><td>31.700</td><td>30.463</td><td>0.937</td><td></td><td>1200</td></tr><tr><td>* E2.000</td><td>SW.MH.1004</td><td>31.650</td><td>30.335</td><td>1.015</td><td>31.700</td><td>30.135</td><td>1.265</td><td></td><td>1200</td></tr><tr><td>* E3.000</td><td>Storage-1</td><td>31.650</td><td>30.200</td><td>1.225</td><td>31.700</td><td>30.188</td><td>1.287</td><td></td><td>1200</td></tr><tr><td>* E1.001</td><td>SW.MH.1000</td><td>31.700</td><td>30.135</td><td>1.115</td><td>31.540</td><td>30.083</td><td>1.007</td><td></td><td>1350</td></tr><tr><td>* E4.000</td><td>Storage -2</td><td>31.550</td><td>30.125</td><td>1.200</td><td>31.540</td><td>30.108</td><td>1.207</td><td></td><td>1200</td></tr><tr><td>* E1.002</td><td>SW.MH.1001</td><td>31.540</td><td>30.083</td><td>1.007</td><td>31.450</td><td>30.003</td><td>0.997</td><td></td><td>1350</td></tr><tr><td>* E1.003</td><td>SW.MH.1002</td><td>31.450</td><td>30.003</td><td>0.997</td><td>31.350</td><td>29.923</td><td>0.977</td><td></td><td>1350</td></tr><tr><td>* E1.004</td><td>SW.MH.1003</td><td>31.350</td><td>29.923</td><td>0.977</td><td>31.310</td><td>29.843</td><td>1.017</td><td></td><td>1350</td></tr><tr><td>* E5.000</td><td>EX MH</td><td>31.150</td><td>30.150</td><td>0.775</td><td>31.100</td><td>30.097</td><td>0.778</td><td></td><td>1200</td></tr><tr><td>* E6.000</td><td>Storage-3</td><td>31.100</td><td>30.200</td><td>0.675</td><td>31.100</td><td>30.185</td><td>0.690</td><td></td><td>1200</td></tr><tr><td>* E5.001</td><td>SW.MH.2000</td><td>31.100</td><td>30.097</td><td>0.778</td><td>31.100</td><td>30.014</td><td>0.861</td><td></td><td>1200</td></tr><tr><td>* E7.000</td><td>Storage -4</td><td>31.100</td><td>30.150</td><td>0.725</td><td>31.100</td><td>30.138</td><td>0.737</td><td></td><td>1200</td></tr><tr><td>* E5.002</td><td>SW.MH.2001</td><td>31.100</td><td>30.014</td><td>0.861</td><td>31.310</td><td>29.927</td><td>1.159</td><td></td><td>1200</td></tr></table>			PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)	* E1.000	7.500	0.037	202.7	0.000	10.00	0.600	o	300	* E2.000	50.000	0.200	250.0	0.020	5.00	0.600	o	300	* E3.000	5.933	0.012	500.0	0.000	5.00	0.600	o	225	* E1.001	13.000	0.052	250.0	0.210	0.00	0.600	o	450	* E4.000	8.344	0.017	500.0	0.000	5.00	0.600	o	225	* E1.002	20.000	0.080	250.0	0.020	0.00	0.600	o	450	* E1.003	20.000	0.080	250.0	0.210	0.00	0.600	o	450	* E1.004	20.000	0.080	250.0	0.040	0.00	0.600	o	450	* E5.000	16.000	0.053	300.0	0.000	10.00	0.600	o	225	* E6.000	7.457	0.015	500.0	0.000	5.00	0.600	o	225	* E5.001	25.000	0.083	300.0	0.100	0.00	0.600	o	225	* E7.000	5.878	0.012	500.0	0.000	5.00	0.600	o	225	* E5.002	35.000	0.088	400.0	0.200	0.00	0.600	o	225	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)	* E1.000	EX MH42	31.980	30.500	1.180	31.700	30.463	0.937		1200	* E2.000	SW.MH.1004	31.650	30.335	1.015	31.700	30.135	1.265		1200	* E3.000	Storage-1	31.650	30.200	1.225	31.700	30.188	1.287		1200	* E1.001	SW.MH.1000	31.700	30.135	1.115	31.540	30.083	1.007		1350	* E4.000	Storage -2	31.550	30.125	1.200	31.540	30.108	1.207		1200	* E1.002	SW.MH.1001	31.540	30.083	1.007	31.450	30.003	0.997		1350	* E1.003	SW.MH.1002	31.450	30.003	0.997	31.350	29.923	0.977		1350	* E1.004	SW.MH.1003	31.350	29.923	0.977	31.310	29.843	1.017		1350	* E5.000	EX MH	31.150	30.150	0.775	31.100	30.097	0.778		1200	* E6.000	Storage-3	31.100	30.200	0.675	31.100	30.185	0.690		1200	* E5.001	SW.MH.2000	31.100	30.097	0.778	31.100	30.014	0.861		1200	* E7.000	Storage -4	31.100	30.150	0.725	31.100	30.138	0.737		1200	* E5.002	SW.MH.2001	31.100	30.014	0.861	31.310	29.927	1.159		1200
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* E2.000	SW.MH.1004	31.650	30.335	1.015	31.700	30.135	1.265		1200																																																																																																																																																																																																																																																																			
* E3.000	Storage-1	31.650	30.200	1.225	31.700	30.188	1.287		1200																																																																																																																																																																																																																																																																			
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(mins)</th><th>k (mm)</th><th>HYD SECT</th><th>DIA (mm)</th><th></th></tr></thead><tbody><tr><td></td><td>* E8.000</td><td>7.043</td><td>0.014</td><td>500.0</td><td>0.000</td><td>5.00</td><td>0.600</td><td>o</td><td>225</td><td></td></tr><tr><td></td><td>* E5.003</td><td>55.000</td><td>0.110</td><td>500.0</td><td>0.150</td><td>0.00</td><td>0.600</td><td>o</td><td>300</td><td></td></tr><tr><td></td><td>* E5.004</td><td>42.000</td><td>0.060</td><td>700.0</td><td>0.200</td><td>0.00</td><td>0.600</td><td>o</td><td>450</td><td></td></tr><tr><td></td><td>* E5.005</td><td>19.000</td><td>0.027</td><td>703.7</td><td>0.040</td><td>0.00</td><td>0.600</td><td>o</td><td>450</td><td></td></tr><tr><td></td><td>* E9.000</td><td>9.731</td><td>0.019</td><td>500.0</td><td>0.000</td><td>5.00</td><td>0.600</td><td>o</td><td>300</td><td></td></tr><tr><td></td><td>* E1.005</td><td>18.000</td><td>0.022</td><td>818.2</td><td>0.015</td><td>0.00</td><td>0.600</td><td>o</td><td>525</td><td></td></tr><tr><td></td><td>* E1.006</td><td>25.000</td><td>0.028</td><td>892.9</td><td>0.000</td><td>0.00</td><td>0.600</td><td>o</td><td>525</td><td></td></tr><tr><td></td><td>* E1.007</td><td>23.000</td><td>0.010</td><td>2300.0</td><td>0.042</td><td>0.00</td><td>0.600</td><td>o</td><td>525</td><td></td></tr><tr><td></td><td>E1.008</td><td>9.000</td><td>0.320</td><td>28.1</td><td>0.022</td><td>0.00</td><td>0.600</td><td>o</td><td>525</td><td></td></tr><tr><td></td><td>E1.009</td><td>8.000</td><td>0.290</td><td>27.6</td><td>0.105</td><td>0.00</td><td>0.600</td><td>o</td><td>525</td><td></td></tr><tr><td></td><td>* E10.000</td><td>11.500</td><td>1.270</td><td>9.1</td><td>0.000</td><td>5.00</td><td>0.600</td><td>o</td><td>225</td><td></td></tr><tr><td></td><td>* E1.010</td><td>80.000</td><td>0.510</td><td>156.9</td><td>0.000</td><td>0.00</td><td>0.600</td><td>o</td><td>600</td><td></td></tr><tr><td></td><td>PN</td><td>US/MH Name</td><td>US/CL (m)</td><td>US/IL (m)</td><td>US C.Depth (m)</td><td>DS/CL (m)</td><td>DS/IL (m)</td><td>DS C.Depth (m)</td><td>Ctrl</td><td>US/MH (mm)</td></tr><tr><td></td><td>* E8.000</td><td>Storage-5</td><td>31.310</td><td>30.100</td><td>0.985</td><td>31.310</td><td>30.086</td><td>0.999</td><td></td><td>1200</td></tr><tr><td></td><td>* E5.003</td><td>SW.MH.2002</td><td>31.310</td><td>29.927</td><td>1.083</td><td>31.350</td><td>29.817</td><td>1.233</td><td></td><td>1200</td></tr><tr><td></td><td>* E5.004</td><td>SW.MH.2003</td><td>31.350</td><td>29.817</td><td>1.083</td><td>31.420</td><td>29.757</td><td>1.213</td><td></td><td>1350</td></tr><tr><td></td><td>* E5.005</td><td>SW.MH.2004</td><td>31.420</td><td>29.757</td><td>1.213</td><td>31.310</td><td>29.730</td><td>1.130</td><td></td><td>1350</td></tr><tr><td></td><td>* E9.000</td><td>Storage -6</td><td>31.310</td><td>30.000</td><td>1.010</td><td>31.310</td><td>29.981</td><td>1.029</td><td></td><td>1200</td></tr><tr><td></td><td>* E1.005</td><td>SW.MH.1005</td><td>31.310</td><td>29.730</td><td>1.055</td><td>31.300</td><td>29.708</td><td>1.067</td><td></td><td>1500</td></tr><tr><td></td><td>* E1.006</td><td>EX MH219</td><td>31.300</td><td>29.708</td><td>1.067</td><td>31.160</td><td>29.680</td><td>0.955</td><td></td><td>1500</td></tr><tr><td></td><td>* E1.007</td><td>EX MH216</td><td>31.160</td><td>29.670</td><td>0.965</td><td>31.170</td><td>29.660</td><td>0.985</td><td>Hydro-Brake®</td><td>3000</td></tr><tr><td></td><td>E1.008</td><td>EX MH218</td><td>31.170</td><td>29.660</td><td>0.985</td><td>31.040</td><td>29.340</td><td>1.175</td><td></td><td>1200</td></tr><tr><td></td><td>E1.009</td><td>EX MH225</td><td>31.040</td><td>29.340</td><td>1.175</td><td>30.690</td><td>29.050</td><td>1.115</td><td></td><td>1200</td></tr><tr><td></td><td>* E10.000</td><td>TW MH.0204</td><td>30.860</td><td>30.320</td><td>0.315</td><td>30.690</td><td>29.050</td><td>1.415</td><td></td><td>1200</td></tr><tr><td></td><td>* E1.010</td><td>TW MH.0207</td><td>30.690</td><td>29.050</td><td>1.040</td><td>30.230</td><td>28.540</td><td>1.090</td><td></td><td>1200</td></tr></tbody></table>												PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)			* E8.000	7.043	0.014	500.0	0.000	5.00	0.600	o	225			* E5.003	55.000	0.110	500.0	0.150	0.00	0.600	o	300			* E5.004	42.000	0.060	700.0	0.200	0.00	0.600	o	450			* E5.005	19.000	0.027	703.7	0.040	0.00	0.600	o	450			* E9.000	9.731	0.019	500.0	0.000	5.00	0.600	o	300			* E1.005	18.000	0.022	818.2	0.015	0.00	0.600	o	525			* E1.006	25.000	0.028	892.9	0.000	0.00	0.600	o	525			* E1.007	23.000	0.010	2300.0	0.042	0.00	0.600	o	525			E1.008	9.000	0.320	28.1	0.022	0.00	0.600	o	525			E1.009	8.000	0.290	27.6	0.105	0.00	0.600	o	525			* E10.000	11.500	1.270	9.1	0.000	5.00	0.600	o	225			* E1.010	80.000	0.510	156.9	0.000	0.00	0.600	o	600			PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)		* E8.000	Storage-5	31.310	30.100	0.985	31.310	30.086	0.999		1200		* E5.003	SW.MH.2002	31.310	29.927	1.083	31.350	29.817	1.233		1200		* E5.004	SW.MH.2003	31.350	29.817	1.083	31.420	29.757	1.213		1350		* E5.005	SW.MH.2004	31.420	29.757	1.213	31.310	29.730	1.130		1350		* E9.000	Storage -6	31.310	30.000	1.010	31.310	29.981	1.029		1200		* E1.005	SW.MH.1005	31.310	29.730	1.055	31.300	29.708	1.067		1500		* E1.006	EX MH219	31.300	29.708	1.067	31.160	29.680	0.955		1500		* E1.007	EX MH216	31.160	29.670	0.965	31.170	29.660	0.985	Hydro-Brake®	3000		E1.008	EX MH218	31.170	29.660	0.985	31.040	29.340	1.175		1200		E1.009	EX MH225	31.040	29.340	1.175	30.690	29.050	1.115		1200		* E10.000	TW MH.0204	30.860	30.320	0.315	30.690	29.050	1.415		1200		* E1.010	TW MH.0207	30.690	29.050	1.040	30.230	28.540	1.090		1200
	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)																																																																																																																																																																																																																																																																																															
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	* E10.000	11.500	1.270	9.1	0.000	5.00	0.600	o	225																																																																																																																																																																																																																																																																																															
	* E1.010	80.000	0.510	156.9	0.000	0.00	0.600	o	600																																																																																																																																																																																																																																																																																															
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	* E8.000	Storage-5	31.310	30.100	0.985	31.310	30.086	0.999		1200																																																																																																																																																																																																																																																																																														
	* E5.003	SW.MH.2002	31.310	29.927	1.083	31.350	29.817	1.233		1200																																																																																																																																																																																																																																																																																														
	* E5.004	SW.MH.2003	31.350	29.817	1.083	31.420	29.757	1.213		1350																																																																																																																																																																																																																																																																																														
	* E5.005	SW.MH.2004	31.420	29.757	1.213	31.310	29.730	1.130		1350																																																																																																																																																																																																																																																																																														
	* E9.000	Storage -6	31.310	30.000	1.010	31.310	29.981	1.029		1200																																																																																																																																																																																																																																																																																														
	* E1.005	SW.MH.1005	31.310	29.730	1.055	31.300	29.708	1.067		1500																																																																																																																																																																																																																																																																																														
	* E1.006	EX MH219	31.300	29.708	1.067	31.160	29.680	0.955		1500																																																																																																																																																																																																																																																																																														
	* E1.007	EX MH216	31.160	29.670	0.965	31.170	29.660	0.985	Hydro-Brake®	3000																																																																																																																																																																																																																																																																																														
	E1.008	EX MH218	31.170	29.660	0.985	31.040	29.340	1.175		1200																																																																																																																																																																																																																																																																																														
	E1.009	EX MH225	31.040	29.340	1.175	30.690	29.050	1.115		1200																																																																																																																																																																																																																																																																																														
	* E10.000	TW MH.0204	30.860	30.320	0.315	30.690	29.050	1.415		1200																																																																																																																																																																																																																																																																																														
	* E1.010	TW MH.0207	30.690	29.050	1.040	30.230	28.540	1.090		1200																																																																																																																																																																																																																																																																																														
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Burderop Park Swindon SN4 0QD	Hyde Park Hayes HPH4 & HPH5 Drainage Design for 1 yr, ... 100 yr storm plus 30%C							
Date 10.07.2012 File Drainage Network_HPH4...	Designed by Modia Checked by							
Micro Drainage	Network W.12.6.1							
PIPELINE SCHEDULES for Existing								
Upstream Manhole								
PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
E1.000	o	300	EEX MH42	31.980	30.500	1.180	Open Manhole	1200
E2.000	o	300	ESW.MH.1004	31.650	30.335	1.015	Open Manhole	1200
E3.000	o	225	EStorage-1	31.650	30.200	1.225	Open Manhole	1200
E1.001	o	450	ESW.MH.1000	31.700	30.135	1.115	Open Manhole	1350
E4.000	o	225	EStorage -2	31.550	30.125	1.200	Open Manhole	1200
E1.002	o	450	ESW.MH.1001	31.540	30.083	1.007	Open Manhole	1350
E1.003	o	450	ESW.MH.1002	31.450	30.003	0.997	Open Manhole	1350
E1.004	o	450	ESW.MH.1003	31.350	29.923	0.977	Open Manhole	1350
E5.000	o	225	EEX MH	31.150	30.150	0.775	Open Manhole	1200
E6.000	o	225	EStorage-3	31.100	30.200	0.675	Open Manhole	1200
E5.001	o	225	ESW.MH.2000	31.100	30.097	0.778	Open Manhole	1200
E7.000	o	225	EStorage -4	31.100	30.150	0.725	Open Manhole	1200
Downstream Manhole								
PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
E1.000	7.500	202.7	ESW.MH.1000	31.700	30.463	0.937	Open Manhole	1350
E2.000	50.000	250.0	ESW.MH.1000	31.700	30.135	1.265	Open Manhole	1350
E3.000	5.933	500.0	ESW.MH.1000	31.700	30.188	1.287	Open Manhole	1350
E1.001	13.000	250.0	ESW.MH.1001	31.540	30.083	1.007	Open Manhole	1350
E4.000	8.344	500.0	ESW.MH.1001	31.540	30.108	1.207	Open Manhole	1350
E1.002	20.000	250.0	ESW.MH.1002	31.450	30.003	0.997	Open Manhole	1350
E1.003	20.000	250.0	ESW.MH.1003	31.350	29.923	0.977	Open Manhole	1350
E1.004	20.000	250.0	ESW.MH.1005	31.310	29.843	1.017	Open Manhole	1500
E5.000	16.000	300.0	ESW.MH.2000	31.100	30.097	0.778	Open Manhole	1200
E6.000	7.457	500.0	ESW.MH.2000	31.100	30.185	0.690	Open Manhole	1200
E5.001	25.000	300.0	ESW.MH.2001	31.100	30.014	0.861	Open Manhole	1200
E7.000	5.878	500.0	ESW.MH.2001	31.100	30.138	0.737	Open Manhole	1200
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Burderop Park Swindon SN4 0QD			Hyde Park Hayes HPH4 & HPH5 Drainage Design for 1 yr, ... 100 yr storm plus 30%C					
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Micro Drainage			Network W.12.6.1					
<u>PIPELINE SCHEDULES for Existing</u>								
<u>Upstream Manhole</u>								
PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
E5.002	o	225	ESW.MH.2001	31.100	30.014	0.861	Open Manhole	1200
E8.000	o	225	EStorage-5	31.310	30.100	0.985	Open Manhole	1200
E5.003	o	300	ESW.MH.2002	31.310	29.927	1.083	Open Manhole	1200
E5.004	o	450	ESW.MH.2003	31.350	29.817	1.083	Open Manhole	1350
E5.005	o	450	ESW.MH.2004	31.420	29.757	1.213	Open Manhole	1350
E9.000	o	300	EStorage -6	31.310	30.000	1.010	Open Manhole	1200
E1.005	o	525	ESW.MH.1005	31.310	29.730	1.055	Open Manhole	1500
E1.006	o	525	EEX MH219	31.300	29.708	1.067	Open Manhole	1500
E1.007	o	525	EEX MH216	31.160	29.670	0.965	Open Manhole	3000
E1.008	o	525	EEX MH218	31.170	29.660	0.985	Open Manhole	1200
E1.009	o	525	EEX MH225	31.040	29.340	1.175	Open Manhole	1200
E10.000	o	225	ETW MH.0204	30.860	30.320	0.315	Open Manhole	1200
E1.010	o	600	ETW MH.0207	30.690	29.050	1.040	Open Manhole	1200
<u>Downstream Manhole</u>								
PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
E5.002	35.000	400.0	ESW.MH.2002	31.310	29.927	1.159	Open Manhole	1200
E8.000	7.043	500.0	ESW.MH.2002	31.310	30.086	0.999	Open Manhole	1200
E5.003	55.000	500.0	ESW.MH.2003	31.350	29.817	1.233	Open Manhole	1350
E5.004	42.000	700.0	ESW.MH.2004	31.420	29.757	1.213	Open Manhole	1350
E5.005	19.000	703.7	ESW.MH.1005	31.310	29.730	1.130	Open Manhole	1500
E9.000	9.731	500.0	ESW.MH.1005	31.310	29.981	1.029	Open Manhole	1500
E1.005	18.000	818.2	EEX MH219	31.300	29.708	1.067	Open Manhole	1500
E1.006	25.000	892.9	EEX MH216	31.160	29.680	0.955	Open Manhole	3000
E1.007	23.000	2300.0	EEX MH218	31.170	29.660	0.985	Open Manhole	1200
E1.008	9.000	28.1	EEX MH225	31.040	29.340	1.175	Open Manhole	1200
E1.009	8.000	27.6	ETW MH.0207	30.690	29.050	1.115	Open Manhole	1200
E10.000	11.500	9.1	ETW MH.0207	30.690	29.050	1.415	Open Manhole	1200
E1.010	80.000	156.9	E	30.230	28.540	1.090	Open Manhole	0
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Date 10.07.2012 File Drainage Network_HPH4...	Designed by ModiA Checked by																																																																							
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<u>Free Flowing Outfall Details for Existing</u> <table><thead><tr><th>Outfall Pipe Number</th><th>Outfall Name</th><th>C. Level (m)</th><th>I. Level (m)</th><th>Min I. Level (m)</th><th>D,L (mm)</th><th>W (mm)</th></tr></thead><tbody><tr><td>E1.010</td><td>E</td><td>30.230</td><td>28.540</td><td>0.000</td><td>0</td><td>0</td></tr></tbody></table> <u>Simulation Criteria for Existing</u> <table><tbody><tr><td>Volumetric Runoff Coeff</td><td>0.750</td><td>Additional Flow - % of Total Flow</td><td>0.000</td></tr><tr><td>Areal Reduction Factor</td><td>1.000</td><td>MADD Factor * 10m³/ha Storage</td><td>2.000</td></tr><tr><td>Hot Start (mins)</td><td>0</td><td>Inlet Coeffiecient</td><td>0.800</td></tr><tr><td>Hot Start Level (mm)</td><td>0</td><td>Flow per Person per Day (l/per/day)</td><td>0.000</td></tr><tr><td>Manhole Headloss Coeff (Global)</td><td>0.500</td><td>Run Time (mins)</td><td>60</td></tr><tr><td>Foul Sewage per hectare (l/s)</td><td>0.000</td><td>Output Interval (mins)</td><td>1</td></tr><tr><td>Number of Input Hydrographs</td><td>0</td><td>Number of Storage Structures</td><td>6</td></tr><tr><td>Number of Online Controls</td><td>1</td><td>Number of Time/Area Diagrams</td><td>0</td></tr><tr><td>Number of Offline Controls</td><td>0</td><td>Number of Real Time Controls</td><td>0</td></tr></tbody></table> <u>Synthetic Rainfall Details</u> <table><tbody><tr><td>Rainfall Model</td><td>FSR</td><td>Profile Type</td><td>Summer</td></tr><tr><td>Return Period (years)</td><td>1</td><td>Cv (Summer)</td><td>0.750</td></tr><tr><td>Region</td><td>England and Wales</td><td>Cv (Winter)</td><td>0.840</td></tr><tr><td>M5-60 (mm)</td><td>20.400</td><td>Storm Duration (mins)</td><td>30</td></tr><tr><td>Ratio R</td><td>0.435</td><td></td><td></td></tr></tbody></table>			Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)	E1.010	E	30.230	28.540	0.000	0	0	Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000	Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000	Hot Start (mins)	0	Inlet Coeffiecient	0.800	Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000	Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60	Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1	Number of Input Hydrographs	0	Number of Storage Structures	6	Number of Online Controls	1	Number of Time/Area Diagrams	0	Number of Offline Controls	0	Number of Real Time Controls	0	Rainfall Model	FSR	Profile Type	Summer	Return Period (years)	1	Cv (Summer)	0.750	Region	England and Wales	Cv (Winter)	0.840	M5-60 (mm)	20.400	Storm Duration (mins)	30	Ratio R	0.435		
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Burderop Park Swindon SN4 0QD	Hyde Park Hayes HPH4 & HPH5 Drainage Design for 1 yr, ... 100 yr storm plus 30%C						
Date 10.07.2012 File Drainage Network_HPH4...	Designed by ModiA Checked by						
Micro Drainage Network W.12.6.1							
<u>Online Controls for Existing</u>							
<u>Hydro-Brake® Manhole: EEX MH216, DS/PN: E1.007, Volume (m³): 15.5</u>							
Design Head (m) 1.000 Hydro-Brake® Type Md4 Invert Level (m) 29.670 Design Flow (l/s) 80.0 Diameter (mm) 296							
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.9	1.200	78.8	3.000	118.3	7.000	180.6
0.200	21.7	1.400	82.2	3.500	127.7	7.500	187.0
0.300	46.2	1.600	86.8	4.000	136.6	8.000	193.1
0.400	70.8	1.800	91.8	4.500	144.8	8.500	199.1
0.500	88.4	2.000	96.6	5.000	152.7	9.000	204.8
0.600	94.9	2.200	101.3	5.500	160.1	9.500	210.4
0.800	87.7	2.400	105.8	6.000	167.2		
1.000	79.5	2.600	110.1	6.500	174.1		
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Burderop Park Swindon SN4 0QD	Hyde Park Hayes HPH4 & HPH5 Drainage Design for 1 yr, ... 100 yr storm plus 30%C	
Date 10.07.2012 File Drainage Network_HPH4...	Designed by ModiA Checked by	
Micro Drainage Network W.12.6.1		

Storage Structures for Existing

Cellular Storage Manhole: EStorage-1, DS/PN: E3.000

Invert Level (m) 30.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	20.0	0.0	1.300	20.0	0.0
0.100	20.0	0.0	1.400	20.0	0.0
0.200	20.0	0.0	1.500	20.0	0.0
0.300	20.0	0.0	1.600	20.0	0.0
0.400	20.0	0.0	1.700	20.0	0.0
0.500	20.0	0.0	1.800	20.0	0.0
0.600	20.0	0.0	1.900	20.0	0.0
0.700	20.0	0.0	2.000	20.0	0.0
0.800	20.0	0.0	2.100	20.0	0.0
0.900	20.0	0.0	2.200	20.0	0.0
1.000	20.0	0.0	2.300	20.0	0.0
1.100	20.0	0.0	2.400	20.0	0.0
1.200	20.0	0.0	2.500	20.0	0.0

Cellular Storage Manhole: EStorage -2, DS/PN: E4.000

Invert Level (m) 30.125 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	25.0	0.0	1.300	25.0	0.0
0.100	25.0	0.0	1.400	25.0	0.0
0.200	25.0	0.0	1.500	25.0	0.0
0.300	25.0	0.0	1.600	25.0	0.0
0.400	25.0	0.0	1.700	25.0	0.0
0.500	25.0	0.0	1.800	25.0	0.0
0.600	25.0	0.0	1.900	25.0	0.0
0.700	25.0	0.0	2.000	25.0	0.0
0.800	25.0	0.0	2.100	25.0	0.0
0.900	25.0	0.0	2.200	25.0	0.0
1.000	25.0	0.0	2.300	25.0	0.0
1.100	25.0	0.0	2.400	25.0	0.0
1.200	25.0	0.0	2.500	25.0	0.0

Cellular Storage Manhole: EStorage-3, DS/PN: E6.000

Invert Level (m) 30.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	150.0	0.0	0.200	150.0	0.0
0.100	150.0	0.0	0.300	150.0	0.0

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Burderop Park Swindon SN4 0QD		Hyde Park Hayes HPH4 & HPH5 Drainage Design for 1 yr, ... 100 yr storm plus 30%C			
Date 10.07.2012		Designed by ModiA			
File Drainage Network_HPH4...		Checked by			
Micro Drainage			Network W.12.6.1		
<u>Cellular Storage Manhole: EStorage-3, DS/PN: E6.000</u>					
Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.400	150.0	0.0	1.500	150.0	0.0
0.500	150.0	0.0	1.600	150.0	0.0
0.600	150.0	0.0	1.700	150.0	0.0
0.700	150.0	0.0	1.800	150.0	0.0
0.800	150.0	0.0	1.900	150.0	0.0
0.900	150.0	0.0	2.000	150.0	0.0
1.000	150.0	0.0	2.100	150.0	0.0
1.100	150.0	0.0	2.200	150.0	0.0
1.200	150.0	0.0	2.300	150.0	0.0
1.300	150.0	0.0	2.400	150.0	0.0
1.400	150.0	0.0	2.500	150.0	0.0
<u>Cellular Storage Manhole: EStorage -4, DS/PN: E7.000</u>					
Invert Level (m) 30.150 Safety Factor 2.0					
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95					
Infiltration Coefficient Side (m/hr) 0.00000					
Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	125.0	0.0	1.300	125.0	0.0
0.100	125.0	0.0	1.400	125.0	0.0
0.200	125.0	0.0	1.500	125.0	0.0
0.300	125.0	0.0	1.600	125.0	0.0
0.400	125.0	0.0	1.700	125.0	0.0
0.500	125.0	0.0	1.800	125.0	0.0
0.600	125.0	0.0	1.900	125.0	0.0
0.700	125.0	0.0	2.000	125.0	0.0
0.800	125.0	0.0	2.100	125.0	0.0
0.900	125.0	0.0	2.200	125.0	0.0
1.000	125.0	0.0	2.300	125.0	0.0
1.100	125.0	0.0	2.400	125.0	0.0
1.200	125.0	0.0	2.500	125.0	0.0
<u>Cellular Storage Manhole: EStorage-5, DS/PN: E8.000</u>					
Invert Level (m) 30.100 Safety Factor 2.0					
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95					
Infiltration Coefficient Side (m/hr) 0.00000					
Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	100.0	0.0	1.100	100.0	0.0
0.100	100.0	0.0	1.200	100.0	0.0
0.200	100.0	0.0	1.300	100.0	0.0
0.300	100.0	0.0	1.400	100.0	0.0
0.400	100.0	0.0	1.500	100.0	0.0
0.500	100.0	0.0	1.600	100.0	0.0
0.600	100.0	0.0	1.700	100.0	0.0
0.700	100.0	0.0	1.800	100.0	0.0
0.800	100.0	0.0	1.900	100.0	0.0
0.900	100.0	0.0	2.000	100.0	0.0
1.000	100.0	0.0	2.100	100.0	0.0

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Date 10.07.2012 File Drainage Network_HPH4...	Designed by ModiA Checked by							
Micro Drainage	Network W.12.6.1							
<u>1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Existing</u>								
Margin for Flood Risk Warning (mm)		300.0						
Analysis Timestep 2.5 Second Increment (Extended)								
DTS Status		ON						
DVD Status		ON						
Inertia Status		ON						
Profile(s)		Summer and Winter						
Duration(s) (mins)		15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080						
Return Period(s) (years)		1, 30, 100						
Climate Change (%)		30, 30, 30						
PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
E1.000	60 Winter	1	+30%	30/15 Summer				
E2.000	120 Winter	1	+30%	1/30 Summer				
E3.000	60 Winter	1	+30%	1/15 Summer				
E1.001	60 Winter	1	+30%	1/15 Winter				
E4.000	60 Winter	1	+30%	1/15 Summer				
E1.002	60 Winter	1	+30%	1/15 Winter				
E1.003	60 Winter	1	+30%	1/15 Summer				
E1.004	60 Winter	1	+30%	1/15 Summer				
E5.000	15 Winter	1	+30%	1/15 Summer				
E6.000	600 Winter	1	+30%	30/15 Winter				
E5.001	15 Winter	1	+30%	1/15 Summer				
E7.000	480 Winter	1	+30%	30/15 Summer				
E5.002	15 Winter	1	+30%	1/15 Summer				
E8.000	240 Winter	1	+30%	30/15 Summer				
E5.003	15 Winter	1	+30%	1/15 Summer				
E5.004	15 Winter	1	+30%	1/15 Summer				
E5.005	15 Winter	1	+30%	1/15 Summer				
E9.000	120 Winter	1	+30%	30/15 Summer				
E1.005	15 Winter	1	+30%	1/15 Summer				
E1.006	15 Winter	1	+30%	1/15 Summer				
E1.007	15 Winter	1	+30%	1/15 Summer	100/15 Summer			2
E1.008	15 Winter	1	+30%					
E1.009	15 Winter	1	+30%					
E10.000	360 Winter	1	+30%					
E1.010	15 Winter	1	+30%					
PN	US/MH Name	Water Level (m)	Surch'd Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
E1.000	EEX MH42	30.704	-0.096	0.000	0.65	0.0	37.4	OK
E2.000	ESW.MH.1004	30.684	0.049	0.000	0.04	0.0	2.4	SURCHARGED
E3.000	EStorage-1	30.683	0.258	0.000	1.12	0.0	25.5	SURCHARGED
E1.001	ESW.MH.1000	30.684	0.099	0.000	0.61	0.0	92.6	SURCHARGED
E4.000	EStorage -2	30.606	0.256	0.000	1.70	0.0	29.5	SURCHARGED
E1.002	ESW.MH.1001	30.609	0.076	0.000	0.51	0.0	84.4	SURCHARGED
E1.003	ESW.MH.1002	30.508	0.055	0.000	0.50	0.0	82.5	SURCHARGED
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Hyde Park Hayes HPH4 & HPH5
Drainage Design for 1 yr, ...
100 yr storm plus 30%C



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Checked by

Network W.12.6.1

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

PN	US/MH Name	Water	Surch'd Depth (m)	Flooded	Flow / Cap.	O'flow (l/s)	Pipe	Status
		Level (m)		Volume (m³)			Flow (l/s)	
E1.004	ESW.MH.1003	30.408	0.035	0.000	0.47	0.0	76.8	SURCHARGED
E5.000	EEX MH	30.470	0.095	0.000	0.41	0.0	10.9	SURCHARGED
E6.000	EStorage-3	30.354	-0.071	0.000	-0.13	0.0	-2.5	OK
E5.001	ESW.MH.2000	30.451	0.129	0.000	0.53	0.0	14.5	SURCHARGED
E7.000	EStorage -4	30.333	-0.042	0.000	-0.13	0.0	-2.9	OK
E5.002	ESW.MH.2001	30.431	0.192	0.000	1.14	0.0	27.6	SURCHARGED
E8.000	EStorage-5	30.301	-0.024	0.000	-0.56	0.0	-11.1	OK
E5.003	ESW.MH.2002	30.403	0.176	0.000	0.76	0.0	35.6	SURCHARGED
E5.004	ESW.MH.2003	30.404	0.137	0.000	0.54	0.0	58.2	SURCHARGED
E5.005	ESW.MH.2004	30.379	0.172	0.000	0.86	0.0	61.4	SURCHARGED
E9.000	EStorage -6	30.282	-0.018	0.000	-0.53	0.0	-16.2	OK
E1.005	ESW.MH.1005	30.355	0.100	0.000	1.23	0.0	104.8	SURCHARGED
E1.006	EEX MH219	30.341	0.108	0.000	1.01	0.0	98.3	SURCHARGED
E1.007	EEX MH216	30.319	0.124	0.000	1.03	0.0	85.2	SURCHARGED
E1.008	EEX MH218	29.821	-0.364	0.000	0.20	0.0	86.9	OK
E1.009	EEX MH225	29.517	-0.348	0.000	0.24	0.0	99.8	OK
E10.000	ETW MH.0204	30.456	-0.089	0.000	0.68	0.0	100.0	OK
E1.010	ETW MH.0207	29.313	-0.337	0.000	0.39	0.0	196.4	OK

Halcrow Group Limited		Page 12						
Burderop Park Swindon SN4 0QD	Hyde Park Hayes HPH4 & HPH5 Drainage Design for 1 yr, ... 100 yr storm plus 30%C							
Date 10.07.2012 File Drainage Network_HPH4...	Designed by ModiA Checked by							
Micro Drainage	Network W.12.6.1							
<u>30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Existing</u>								
Margin for Flood Risk Warning (mm)		300.0						
Analysis Timestep 2.5 Second Increment (Extended)								
DTS Status		ON						
DVD Status		ON						
Inertia Status		ON						
Profile(s)		Summer and Winter						
Duration(s) (mins)		15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080						
Return Period(s) (years)		1, 30, 100						
Climate Change (%)		30, 30, 30						
PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
E1.000	15 Winter	30	+30%	30/15 Summer				
E2.000	15 Winter	30	+30%	1/30 Summer				
E3.000	60 Winter	30	+30%	1/15 Summer				
E1.001	15 Winter	30	+30%	1/15 Winter				
E4.000	30 Winter	30	+30%	1/15 Summer				
E1.002	30 Winter	30	+30%	1/15 Winter				
E1.003	15 Summer	30	+30%	1/15 Summer				
E1.004	15 Winter	30	+30%	1/15 Summer				
E5.000	15 Winter	30	+30%	1/15 Summer				
E6.000	120 Winter	30	+30%	30/15 Winter				
E5.001	15 Winter	30	+30%	1/15 Summer				
E7.000	120 Winter	30	+30%	30/15 Summer				
E5.002	15 Summer	30	+30%	1/15 Summer				
E8.000	60 Winter	30	+30%	30/15 Summer				
E5.003	15 Summer	30	+30%	1/15 Summer				
E5.004	15 Summer	30	+30%	1/15 Summer				
E5.005	15 Summer	30	+30%	1/15 Summer				
E9.000	60 Winter	30	+30%	30/15 Summer				
E1.005	15 Summer	30	+30%	1/15 Summer				
E1.006	15 Summer	30	+30%	1/15 Summer				
E1.007	15 Summer	30	+30%	1/15 Summer	100/15 Summer			2
E1.008	30 Summer	30	+30%					
E1.009	15 Winter	30	+30%					
E10.000	360 Winter	30	+30%					
E1.010	15 Summer	30	+30%					
PN	US/MH Name	Water Level (m)	Surch'd Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
E1.000	EEX MH42	31.214	0.414	0.000	0.71	0.0	40.6	SURCHARGED
E2.000	ESW.MH.1004	31.146	0.511	0.000	0.14	0.0	8.9	SURCHARGED
E3.000	EStorage-1	31.109	0.684	0.000	-1.25	0.0	-28.3	SURCHARGED
E1.001	ESW.MH.1000	31.128	0.543	0.000	0.76	0.0	115.6	SURCHARGED
E4.000	EStorage -2	31.077	0.727	0.000	-2.68	0.0	-46.4	SURCHARGED
E1.002	ESW.MH.1001	31.087	0.554	0.000	0.52	0.0	86.3	SURCHARGED
E1.003	ESW.MH.1002	31.091	0.638	0.000	0.82	0.0	134.6	SURCHARGED
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Hyde Park Hayes HPH4 & HPH5
Drainage Design for 1 yr, ...
100 yr storm plus 30%C

Drainage Design for 1 yr, ...
100 yr storm plus 30%C

100 yr storm plus 30%C

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Checked by



Network W.12.6.1

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

PN	US/MH Name	Water	Surch'd Depth (m)	Flooded	Flow / Cap.	O'flow	Pipe	Status
		Level (m)		Volume (m³)		Flow (l/s)	Flow (l/s)	
E1.004	ESW.MH.1003	31.053	0.680	0.000	0.82	0.0	134.8	FLOOD RISK
E5.000	EEX MH	30.777	0.402	0.000	0.50	0.0	13.2	SURCHARGED
E6.000	EStorage-3	30.685	0.260	0.000	-1.76	0.0	-33.5	SURCHARGED
E5.001	ESW.MH.2000	30.756	0.434	0.000	-0.68	0.0	-18.7	SURCHARGED
E7.000	EStorage -4	30.669	0.294	0.000	-1.48	0.0	-33.7	SURCHARGED
E5.002	ESW.MH.2001	30.857	0.618	0.000	1.23	0.0	29.8	FLOOD RISK
E8.000	EStorage-5	30.694	0.369	0.000	-2.77	0.0	-55.1	SURCHARGED
E5.003	ESW.MH.2002	30.969	0.742	0.000	0.92	0.0	43.1	SURCHARGED
E5.004	ESW.MH.2003	31.113	0.846	0.000	0.98	0.0	106.4	FLOOD RISK
E5.005	ESW.MH.2004	31.067	0.860	0.000	1.54	0.0	109.3	SURCHARGED
E9.000	EStorage -6	30.814	0.514	0.000	-2.55	0.0	-77.7	SURCHARGED
E1.005	ESW.MH.1005	31.025	0.770	0.000	2.21	0.0	188.3	FLOOD RISK
E1.006	EEX MH219	31.046	0.813	0.000	1.37	0.0	134.2	FLOOD RISK
E1.007	EEX MH216	31.048	0.853	0.000	1.14	0.0	94.2	FLOOD RISK
E1.008	EEX MH218	29.832	-0.353	0.000	0.24	0.0	102.5	OK
E1.009	EEX MH225	29.558	-0.307	0.000	0.36	0.0	147.9	OK
E10.000	ETW MH.0204	30.456	-0.089	0.000	0.68	0.0	100.0	OK
E1.010	ETW MH.0207	29.349	-0.301	0.000	0.47	0.0	238.3	OK

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Burderop Park Swindon SN4 0QD	Hyde Park Hayes HPH4 & HPH5 Drainage Design for 1 yr, ... 100 yr storm plus 30%C							
Date 10.07.2012 File Drainage Network_HPH4...	Designed by ModiA Checked by							
Micro Drainage	Network W.12.6.1							
100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Existing								
Margin for Flood Risk Warning (mm) 300.0								
Analysis Timestep 2.5 Second Increment (Extended)								
DTS Status ON								
DVD Status ON								
Inertia Status ON								
Profile(s) Summer and Winter								
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080								
Return Period(s) (years) 1, 30, 100								
Climate Change (%) 30, 30, 30								
PN	Storm	Return Climate Period Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.	
E1.000	60 Winter	100	+30%	30/15 Summer				
E2.000	60 Winter	100	+30%	1/30 Summer				
E3.000	60 Winter	100	+30%	1/15 Summer				
E1.001	60 Winter	100	+30%	1/15 Winter				
E4.000	60 Winter	100	+30%	1/15 Summer				
E1.002	60 Winter	100	+30%	1/15 Winter				
E1.003	60 Winter	100	+30%	1/15 Summer				
E1.004	60 Winter	100	+30%	1/15 Summer				
E5.000	120 Winter	100	+30%	1/15 Summer				
E6.000	120 Winter	100	+30%	30/15 Winter				
E5.001	120 Winter	100	+30%	1/15 Summer				
E7.000	120 Winter	100	+30%	30/15 Summer				
E5.002	15 Summer	100	+30%	1/15 Summer				
E8.000	120 Winter	100	+30%	30/15 Summer				
E5.003	15 Winter	100	+30%	1/15 Summer				
E5.004	15 Winter	100	+30%	1/15 Summer				
E5.005	15 Summer	100	+30%	1/15 Summer				
E9.000	60 Winter	100	+30%	30/15 Summer				
E1.005	60 Winter	100	+30%	1/15 Summer				
E1.006	60 Winter	100	+30%	1/15 Summer				
E1.007	15 Summer	100	+30%	1/15 Summer	100/15 Summer		2	
E1.008	30 Summer	100	+30%					
E1.009	15 Summer	100	+30%					
E10.000	360 Winter	100	+30%					
E1.010	15 Winter	100	+30%					
PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
E1.000	EEX MH42	31.561	0.761	0.000	0.67	0.0	38.1	SURCHARGED
E2.000	ESW.MH.1004	31.488	0.853	0.000	0.07	0.0	4.5	FLOOD RISK
E3.000	EStorage-1	31.481	1.056	0.000	-1.14	0.0	-26.0	FLOOD RISK
E1.001	ESW.MH.1000	31.484	0.899	0.000	0.53	0.0	80.4	FLOOD RISK
E4.000	EStorage -2	31.427	1.077	0.000	-1.81	0.0	-31.3	FLOOD RISK
E1.002	ESW.MH.1001	31.458	0.925	0.000	0.49	0.0	80.3	FLOOD RISK
E1.003	ESW.MH.1002	31.352	0.899	0.000	0.71	0.0	117.5	FLOOD RISK
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Burderop Park Swindon SN4 0QD	Hyde Park Hayes HPH4 & HPH5 Drainage Design for 1 yr, ... 100 yr storm plus 30%C	
Date 10.07.2012 File Drainage Network_HPH4...	Designed by ModiA Checked by	
Micro Drainage		Network W.12.6.1

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Existing								
PN	US/MH Name	Water Level (m)	Surch'd Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
E1.004	ESW.MH.1003	31.274	0.901	0.000	0.75	0.0	124.1	FLOOD RISK
E5.000	EEX MH	31.015	0.640	0.000	0.40	0.0	10.7	FLOOD RISK
E6.000	EStorage-3	30.984	0.559	0.000	-2.25	0.0	-42.8	FLOOD RISK
E5.001	ESW.MH.2000	30.995	0.673	0.000	0.82	0.0	22.5	FLOOD RISK
E7.000	EStorage -4	30.971	0.596	0.000	-1.65	0.0	-37.5	FLOOD RISK
E5.002	ESW.MH.2001	31.091	0.852	0.000	1.24	0.0	30.1	FLOOD RISK
E8.000	EStorage-5	30.976	0.651	0.000	-2.02	0.0	-40.2	SURCHARGED
E5.003	ESW.MH.2002	31.160	0.933	0.000	-1.32	0.0	-61.7	FLOOD RISK
E5.004	ESW.MH.2003	31.290	1.023	0.000	1.04	0.0	112.7	FLOOD RISK
E5.005	ESW.MH.2004	31.223	1.016	0.000	1.94	0.0	138.3	FLOOD RISK
E9.000	EStorage -6	31.131	0.831	0.000	-3.31	0.0	-100.9	FLOOD RISK
E1.005	ESW.MH.1005	31.178	0.923	0.000	1.29	0.0	110.0	FLOOD RISK
E1.006	EEX MH219	31.166	0.933	0.000	1.07	0.0	104.9	FLOOD RISK
E1.007	EEX MH216	31.161	0.966	0.742	1.15	0.0	94.5	FLOOD
E1.008	EEX MH218	29.835	-0.350	0.000	0.24	0.0	105.2	OK
E1.009	EEX MH225	29.574	-0.291	0.000	0.40	0.0	167.1	OK
E10.000	ETW MH.0204	30.456	-0.089	0.000	0.68	0.0	100.0	OK
E1.010	ETW MH.0207	29.361	-0.289	0.000	0.52	0.0	261.4	OK

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