APPENDIX 10.2: FLOOD RISK ASSESSMENT AND HYDROLOGY REPORT 2015

Proposed Redevelopment of North London Business Park (Royal Brunswick Park)

Comer Homes Group

Environmental Statement Appendix 12.1

Flood Risk Assessment

Proposed Redevelopment of North London Business Park (Royal Brunswick Park)

Environmental Statement Appendix 12.1

Flood Risk Assessment

Job Title	Proposed Redevelopment of North London Business Park (Royal Brunswick Park)
Project Number	0031
Date	17 December 2015
Client	Comer Homes Group
Prepared by	G Jane
Checked by	C Yalden
Authorised by	R Ward
File Reference	p:\0031 royal brunswick park\c documents\reports\0031 royal brunswick park - fra.docx

Kensington Court
Woodwater Park
Pynes Hill
Exeter
EX2 5TY
Tel: 01392 409007
www.awpexeter.com

Contents

1 Introduction

1.1. This site-specific Flood Risk Assessment (FRA) has been prepared on behalf of Comer Homes Group by Awcock Ward Partnership (AWP) to assess the potential flood risks that may affect the hybrid application for the redevelopment of North London Business Park to provide a mixed use development of up to 1,200 dwellings, 3,214sqm office space, 1,153sqm retail space, 510sqm community space, 300sqm nursery and a 1,050 pupil capacity school.

1.2. The mixed use development will be delivered across a number of phases. The detailed application covers Phase 1 of the site, which includes the school site and 376 new residential dwellings, whilst the remaining phases of development will be covered by an outline application.

1.3. This FRA has been prepared to *"identify and assess the risks of all forms of flooding to and from the development and demonstrate how these flood risks will be managed so that the development remains safe throughout its lifetime, taking climate change into account"* as required by the National Planning Policy Framework (NPPF).

National Planning Policy Framework

1.4. The NPPF and the accompanying National Planning Practice Guidance (NPPG) were published by the Department for Communities and Local Government in March 2012 and March 2014 respectively. As a consequence PPS25 "Development and Flood Risk" was replaced, although its key elements were retained.

Structure and limitations of this FRA

1.5. This site-specific FRA has been written in accordance with the guidance set by the NPPF and NPPG, using the information that is currently available.

1.6. The report has been structured to describe the existing site parameters, the proposed development and to offer a Surface Water Management Plan (SWMP), indicating how surface water runoff can be managed so that it does not increase flood risk within the downstream catchment.

1.7. It is important to note that this FRA does not attempt to present a final design of the surface water drainage system nor the most value engineered design. This will be left until the detailed design stage when further work can be undertaken and all other types of systems can be evaluated. This evaluation will also need to include other assessments, including health and safety, CDM etc.

Consultation

1.8. To scope any site specific or catchment specific flood risks or drainage requirements we have engaged with Barnet Council, as the Lead Local Flood Authority, and Thames Water's Development Engineer and Technical Coordinator.

1.9. Furthermore, a public consultation was held which provided an opportunity for members of the public to review the proposals and share any thoughts or concerns relating to the existing site or the outline drainage strategy.

1.10. The output of the above consultation process has helped to inform the FRA and the inherent Surface Water Management Plan (SWMP).

Reference

1.11. This FRA has been prepared by reference to the following documents:

- National Planning Policy Framework (March 2012);
- National Planning Practice Guidance (March 2014);
- The London Plan (March 2015);
- Barnet's Surface Water Management Plan (October 2011);
- North London SFRA (August 2008);
- Groundsure Enviroinsight report (November 2015);
- CIRIA Guide 753 'The SuDS Manual';
- Thames Water's Asset Record Plans; and
- Environment Agency mapping.

2 Existing Site

Site location

2.1. The existing site is located off Brunswick Park Road in East Barnet, at national grid reference TQ 280 934. Figure 1 below shows the extents of the application site.

Figure 1 – Site Location Plan

Existing land uses

2.2. The existing site comprises a series of operational uses within the North London Business Park site. The site comprises a number of buildings, internal access roads and car parking, with areas of undeveloped green space to the east and north.

2.3. Within the eastern green space there is an existing attenuation pond which receives runoff from the existing brownfield site.

Surrounding land use

2.4. The site is bordered by residential development to the north and south, Brunswick Park Road and further residential development to the east, and a railway line to the west, with residential development beyond.

Topographic survey

2.5. A topographic survey has been undertaken and indicates that the existing site generally falls towards its most easterly extents, from a high point of approximately 72m above ordnance datum (AOD) at its north-western corner, to a low point of approximately 48m AOD near the south-east corner.

2.6. A copy of the existing site survey has been included as drawing 0031-XS-001 within Appendix A of this report.

Existing flood risk

2.7. An extract of the EA's 'Flood Map for Planning' for the East Barnet area is reproduced below as Figure 2. This mapping shows the site to be wholly within 'Flood Zone 1 – Low Risk' from fluvial flooding. This means that the site located is not at risk of flooding from fluvial sources in up to the 1 in 1000 year return period flood (<0.1%).

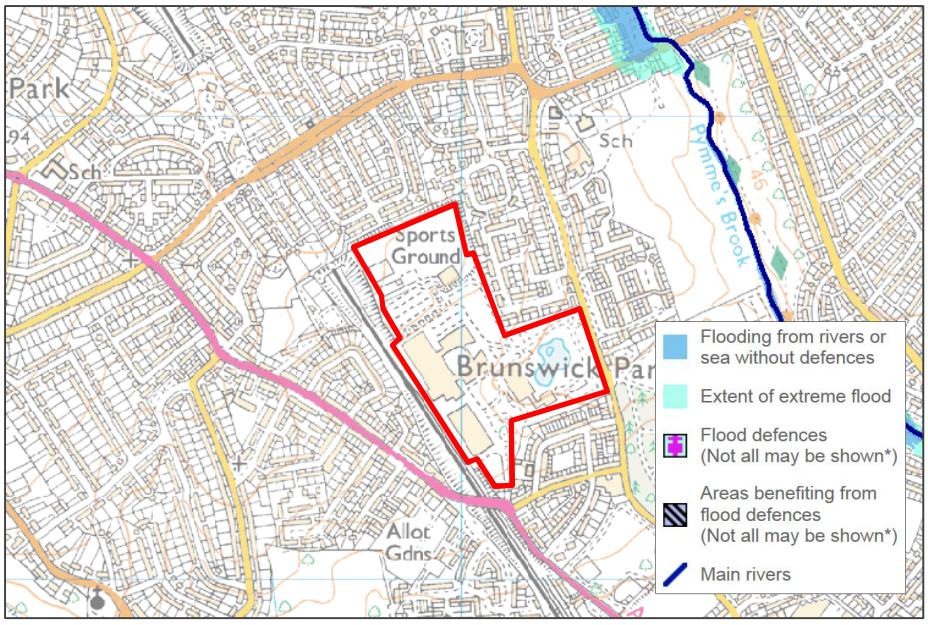


Figure 2 – Flood Map for Planning

2.8. A copy of the EA's 'Flooding from Surface Water' map has been reproduced as Figure 3. This mapping is based on LIDAR data and indicates the typical conveyance routes of concentrated surface water runoff.

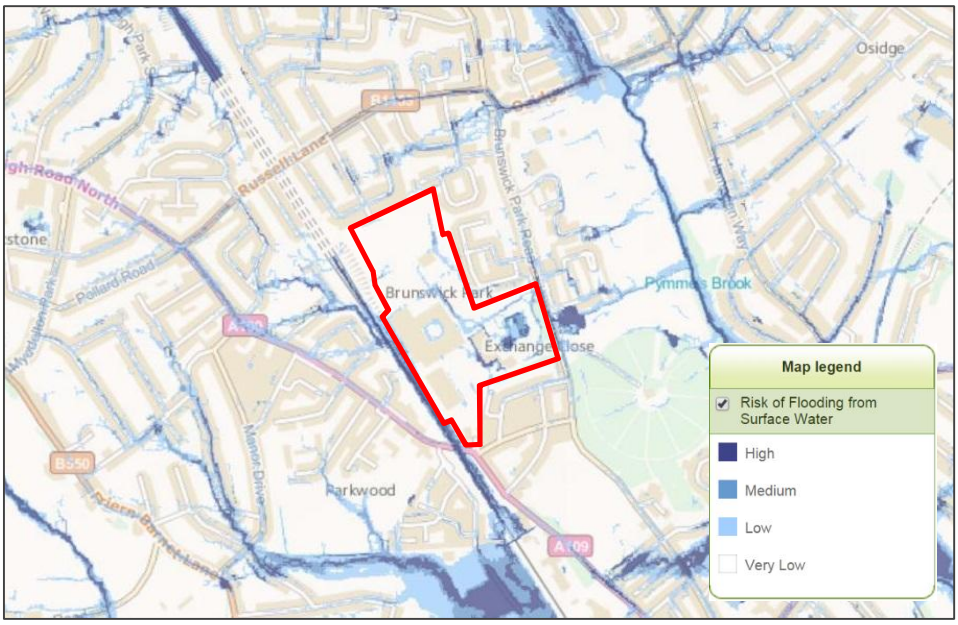


Figure 3 – Flooding from Surface Water

2.9. This mapping extract highlights the location of the existing attenuation pond and indicates that any overland exceedance routes within the site follow the existing road network, before crossing the green landscaped areas towards the pond.

Existing site drainage / drainage infrastructure

2.10. The existing drainage regime is typical of an existing brownfield site. A number of private and adoptable surface and foul water networks have been identified.

2.11. Thames Water's (TW) asset records indicate public surface and foul sewerage networks beneath Brunswick Park Road to the east of the site. The records also illustrate that surface water sewers run west to east beneath the site towards Brunswick Park Road.

2.12. Historic drainage records (including as-built plans) identify existing private surface and foul water networks serving the site.

2.13. The records indicate that storm flows are conveyed to the existing attenuation pond, with a positive discharge to the public surface water sewer beneath Brunswick Park Road.

2.14. Similarly, the records indicate on-site private foul water drains routing to the public foul water sewers beneath Brunswick Park Road.

2.15. The existing alignments of adoptable sewers within the site and its local vicinity have been identified on the site survey drawing (ref. 0031-XS-001) included within Appendix A of this report.

Ground conditions

2.16. A desk-top assessment has been undertaken using the DEFRA Soilscape dataset and is included within Appendix B of this report.

2.17. The desktop assessment indicates that the soils underlying the site suffer from “impeded drainage” and on this basis the use of infiltration features has been disregarded. Instead the proposed drainage strategy will utilise on-site attenuation with restricted discharges to the existing downstream receptors.

3 Proposed Development

3.1. The proposed development comprises the redevelopment of the North London Business Park to provide a mixed use development of up to 1,200 dwellings, 3,214sqm office space, 1,153sqm retail space, 510sqm community space, 300sqm nursery and a 1,050 pupil capacity school.

3.2. The mixed use development will be delivered across a number of phases. The detailed application covers Phase 1 of the site, which includes the school site and 376 new residential dwellings, whilst the remaining phases of development will be covered by an outline application.

3.3. The scheme also comprises internal access roads, garaging and parking and associated landscaping, drainage and engineering works.

3.4. A copy of the proposed masterplan for the development is provided within Appendix C of this report.

Vulnerability

3.5. In accordance with the NPPG, the most vulnerable form of development being promoted is the residential elements, which are classified as “More Vulnerable”. However as the scheme is entirely within ‘Flood Zone 1 – Low Risk’, Table 3 in the NPPG concludes that residential use is appropriate for this site.

Sequential Test

3.6. The site is located within ‘Flood Zone 1 – Low Risk’ and would therefore pass the Sequential Test, as there are no competing sites with a lower flood risk classification.

Cross sections and finished levels

3.7. It is anticipated that the existing ground profile will be modified locally to reflect the requirements of the new development.

3.8. Any future level design should aim to minimise the extent of any re-profiling works and wherever possible should look to retain existing watershed catchments.

Safe access and egress

3.9. The full extents of the site and all roads surrounding the site are within 'Flood Zone 1 – Low Risk' and hence access and egress for motorised and non-motorised vehicles will not be affected during any fluvial flood events.

Climate change impacts

3.10. The NPPF requires that the impact of climate change be considered. The NPPG states "In making an assessment of the impacts of climate change on flooding from the land, rivers and sea as part of a flood risk assessment, the sensitivity ranges in Table 5 may provide an appropriate precautionary response to the uncertainty about climate change impacts on rainfall intensities, river flow, wave height and wind speed."

3.11. Table 5 in the former Technical Guidance to the NPPF detailed the latest UKCIP climate change predictions on future weather conditions: peak rainfall is predicted to increase by approximately 30% during the next 100 years and river flows will increase by approximately 20% over the same period. A copy of this table can be seen below as Figure 4.

Parameter	**1990 to 2025**	**2025 to 2055**	**2055 to 2085**	**2085 to 2115**
Peak rainfall intensity	*+5%*	*+10%*	*+20%*	*+30%*
Peak river flow	*+10%*	*+20%*		
Offshore wind speed	*+5%*		*+10%*	
Extreme wave height	*+5%*		*+10%*	

Figure 4 – Recommended national precautionary ranges

3.12. The on-site attenuation has been sized to offer flood protection for the development and its downstream catchment throughout its 100 year design life, with an allowance for the predicted effects of climate change.

4 Surface Water Management Plan

Existing surface water runoff

4.1. Surface water runoff generated by the existing brownfield site is predominantly routed towards the on-site attenuation pond. The as-built drainage records identify piped connections between this pond and the Thames Water surface water sewer beneath Brunswick Park Road; the records do not identify any form of hydraulic control indicating that peak flows are likely to be unrestricted.

4.2. In line with the requirements of the London Plan (Policy 5.13), the proposed development must ensure that future discharges are restricted to the equivalent greenfield runoff rates, providing a significant level of betterment over the existing scenario and thus reducing flood risk within the downstream catchment.

4.3. The MicroDrainage Source Control module has been used to assess the equivalent greenfield runoff rates for the site. In accordance with best practice, the assessment is based on the IH 124 methodology.

4.4. A copy of this assessment can be seen within Appendix D of this report, with the results summarised in Table 1 below.

Return Period	Greenfield Runoff Rates (l/s)					
	Ph1	Ph2	Ph3	Ph4	Ph5	TOTAL
2 year	21.5	16.3	4.6	10.0	10.9	63.3
30 year	46.0	41.7	11.4	26.0	27.8	152.9
100 year	75.5	57.2	15.9	36.0	38.1	222.7

Table 1 – Greenfield Runoff Rates

Surface Water Strategy

4.5. The surface water strategy for the site has been developed to respect the masterplan, accounting for runoff in up to the 100 year (+30% climate change) critical storm event.

4.6. A review of the proposed masterplan in conjunction with the alignment of Thames Water's existing surface water sewers has identified potential conflicts. Through consultation with Thames Water we have received confirmation that a build-over

agreement will not be acceptable and that asset protection should be secured through suitable diversionary works.

4.7. A diversion corridor has been agreed with Thames Water and will be implemented by the proposed development to ensure that those served by the existing networks will be uninterrupted. It is proposed to unify the two existing Thames Water sewers with a single diversion sewer of equal hydraulic capacity.

4.8. The Soilscape desktop assessment indicates that the soils underlying the site suffer from "impeded drainage" and on this basis the use of infiltration features has been disregarded. Instead, the surface water strategy for the proposed development will comprise a network of:

- Adoptable and non-adoptable underground pipework;
- Rainwater harvesting systems;
- SuDS Attenuation Pond;
- Cellular Storage;
- Hydraulic controls; and,
- Overland exceedance measures.

Phase 1 Strategy (Detailed Application)

4.9. The proposed school site will benefit from its own on-site attenuation system, whilst the balance of Phase 1 will be served by a private communal drainage network.

4.10. Runoff generated by the school site will be intercepted by new private storm drainage which will convey flows to a cellular storage attenuation feature, with greenfield discharge to the Thames Water surface water sewers beneath Brunswick Park Road.

4.11. Roof level runoff from residential buildings within Phase 1 will feed into rainwater harvesting tanks. These tanks will seek to intercept the first 5mm of runoff for re-use for toilet flushing, thus reducing the level of pollutants being discharged to downstream surface water sewers and reducing potable water demand throughout the development.

4.12. Beyond the capacity of the rainwater harvesting tanks, any further inflow of runoff will overflow to an external storm drainage network which will route flows to the on-site attenuation pond.

4.13. Whilst they share a similar location within the site, the proposed attenuation pond will replace the existing pond and form part of a wider Public Open Space. The pond will provide water quality enhancement whilst also offering ecological and biodiversity benefits.

4.14. The outflow from the pond will be restricted to the equivalent greenfield runoff rate for the respective catchment and will discharge to the Thames Water surface water sewers beneath Brunswick Park Road.

4.15. Thames Water have confirmed through a pre-application enquiry that they agree with the principles of the proposed drainage strategy. A copy of this correspondence is included within Appendix F of this report.

4.16. The drawing included in Appendix E (reference 0031-PDL-100) shows a Preliminary Drainage Layout for the Phase 1 site, including the proposed diversion of Thames Water's sewers.

Phase 2-5 Strategy (Outline Application)

4.17. The surface water strategy for each future phase of development will include rainwater harvesting with on-site attenuation to restrict any residual flows to the equivalent greenfield runoff rate.

4.18. Restricted flows will be discharged to the Phase 1 network, passing through the pond before outfalling to the Thames Water surface water sewers beneath Brunswick Park Road.

4.19. The drawing included in Appendix E (reference 0031-PDL-200) shows the Preliminary Drainage Layout for the later development phases.

Attenuation storage volumes

4.20. The MicroDrainage Source Control module has been used to determine the storage requirements for each phase of the proposed development.

4.21. The output of these models can be seen within Appendix D of this report, with the results summarised in Table 2:

Proposed Storage Feature	Proposed 100yr+30% Volume (m^3)
Phase 1 Attenuation Pond	768
Phase 1 School Attenuation	356
Phase 2 Attenuation	920
Phase 3 Attenuation	160
Phase 4 Attenuation	722
Phase 5 Attenuation	799
Total	3725

Table 2 – Attenuation Storage Requirements

4.22. The drawing included in Appendix E (reference 0031-PDL-101) shows the proposed arrangement of the Phase 1 attenuation pond.

4.23. The attenuation pond includes a permanently wet base with 1m depth of available storage above. The available storage will be split between two stages, the first 600mm depth caters for runoff from storms up to the 5 year return period (20% of occurrence in any given year), whilst runoff up to the 100 year return period (with 30% allowance for climate change) will be attenuated within a wider storage area, to a depth of 250mm, leaving 150mm of freeboard for exceedance storage.

Exceedance events

4.24. It is considered that the proposed drainage network will offer a significant level of betterment when compared to the existing site. The scheme will restrict the peak rate of discharge to the equivalent greenfield rates and will be designed to cater for runoff from all storms up to the 100 year return period, with 30% allowance for climate change.

4.25. During exceedance events, beyond the schemes 100 year design life, surface water runoff will overflow from the aforementioned systems and wherever possible will be directed away from buildings, towards areas of public open space. Any residual overland flows will then be routed towards the attenuation pond, as per the pre-development scenario.

Proposed foul water strategy

4.26. The existing site is served by private foul drains which can be diverted to accommodate the proposed development. Any diversionary works will retain the existing points of connectivity with Thames Waters public foul sewerage network beneath Brunswick Park Road.

4.27. Foul flows generated by the proposed development will be intercepted by new private foul networks within the site, prior to being discharged to Thames Waters public foul sewerage network beneath Brunswick Park Road.

4.28. The proposed development includes a series of basement car parks. Given that these areas are not exposed to rainfall it is considered that any drainage requirements will be limited to potential wash-down, spillages or other potential contaminants. It is therefore proposed to utilise private package pumps to transfer any basement drainage to the external foul water network.

4.29. A pre-development capacity enquiry has been submitted to Thames Water. The enquiry seeks to establish whether the existing points of connectivity can be retained for the proposed development, otherwise it will outline alternative points of adequacy or potential reinforcement requirements to accommodate any increased foul flows.

4.30. The drawings included within Appendix E (reference 0031-PDL-100 and 200) show the proposed foul drainage arrangements for the detailed and outline application sites.

Maintenance

4.31. The on-site sewer diversions will be designed in accordance with Sewers for Adoption (SfA) and will be offered to Thames Water for adoption.

4.32. All private drainage and SuDS features will be designed in accordance with Building Regulations Part H and CIRIA C753 and will become the responsibility of a 3rd party Management Company, or each respective homeowner / landlord / building management company.

5 Miscellaneous Issues

Construction issues

5.1. It is good practice to offer a Construction Environmental Management Plan (CEMP) to allow the construction and phasing of drainage works to be closely monitored. Prior to the commencement of construction, the contractor will produce a CEMP and agree it with the EA / LLFA.

5.2. Any facilities for the storage of oils, fuels or chemicals need to be situated in suitable bunded bases that will be equivalent to at least the volume of the tank plus 10%.

Residual flood risks

5.3. It has been established that the proposed developable area is wholly within 'Flood Zone 1 – Low Risk'. There is no habitable development within Flood Zones 2 or 3. There are therefore no residual flood risks with regard to high risk flood zones.

5.4. Safe access and egress has been identified.

Health and safety

5.5. Until such time as the hazards relating to the site or location are known, we are unable to confirm that our recommendations will be acceptable in terms of safe buildability / maintainability.

5.6. Under the CDM Regulations, adequate information about the site must be provided by the client in order to allow the potential hazards to be reviewed by the designer, and avoidance / mitigation measures taken where reasonably practicable.

6 Mitigation, Conclusions and Recommendations

Mitigation

6.1. The proposed development has been assessed in line with the NPPF, to allow the planning application to be progressed and to show that the development can be undertaken in an acceptable manner from a flood risk perspective.

6.2. In line with policy requirements the proposed development will restrict runoff from the site to the equivalent greenfield runoff rates. This will enable a significant reduction in surface water runoff being discharged off-site, freeing up capacity within Thames Waters surface water sewers and thus reducing flood risk within the downstream catchment.

6.3. The proposed drainage strategy promotes the use of rainwater harvesting. This will reduce the demand for potable water supply and will help to capture the first 5mm of runoff, reducing the level of pollutants being discharged off-site.

6.4. The inclusion of a SuDS attenuation pond will offer water quality enhancement as well as other ecological and biodiversity benefits.

6.5. Exceedance flows beyond the 100 year plus 30% critical storm event will be routed towards convenient holding points within the confines of the development area, away from properties and primary access routes.

6.6. Foul flows from the development will discharge to the existing foul sewerage network beneath Brunswick Park Road, retaining existing drainage connections wherever possible.

Conclusions

6.7. The proposed development has been assessed in line with the NPPF and other relevant policies, to allow the planning application to be progressed and to show that the development can be undertaken in an acceptable manner from a flood risk perspective.

This Flood Risk Assessment has been assessed in line with the NPPF. It is concluded that the development can be undertaken in a sustainable manner with the ability to provide a significant reduction in flood risk to existing properties in the downstream catchment.

The FRA does not attempt to present a final design of the surface water system. Detailed design of the surface water network and inherent features will commence upon approval of the outline strategy and will include assessments due to further site investigations, health and safety, CDM etc.

Recommendations

6.8. As the development will be safe from flooding for its design life and will reduce flood risk to properties in the downstream catchment, it is recommended that the Local Planning Authority confirm they have no objections to the proposed development.

Appendices

Appendix A – Topographic Survey

General Key

- Phase 1 Boundary (Detailed Application)
- Phase 2-5 Boundary (Outline Application)

Existing Drainage

- Thames Water Surface Water Sewer
- Thames Water Foul Water Sewer
- Overland Flood Flow Route

Notes

1. Topographic survey undertaken by B.W Surveys on 06/03/2007.
2. Alignment of existing drainage taken from Thames Water asset record plans and historical as-built drainage records.

REV	DATE	DESCRIPTION	BY	CHK	APD
A	16.12.2015	INITIAL ISSUE	JR	CPY	RPW

CLIENT: COMER HOMES GROUP

DRAWING STATUS: FOR INFORMATION ONLY

PROJECT: ROYAL BRUNSWICK PARK

TITLE: EXISTING TOPOGRAPHIC SURVEY

PROJECT No:	DRAWING No:	REV:
0031	XS-001	A

SCALE @ A1: 0 1:1000 50 metres

DESIGN BY:

awcockward partnership

Awcock Ward Partnership, Kensington Court, Woodwater Park, Pynes Hill, Exeter, EX2 5TY
Tel: 01392 409007 Web: www.awpexeter.com

Appendix B – Soilscape Report

0031 - Royal Brunswick Park - Site Check Map

Legend

Projection = OSGB36
xmin = 525400
ymin = 192200
xmax = 530200
ymax = 194900
Map produced by MAGIC on 30 November, 2015.

Site Check Report Report generated on Mon Nov 30 2015
You selected the location: Centroid Grid Ref: TQ280935
The following features have been found in your search area:

Soilscape (England)

Reference	18
Name	SLOWLY PERMEABLE SEASONALLY WET SLIGHTLY ACID BUT BASE-RICH LOAMY AND CLAYEY SOILS
Main Surface Texture Class	LOAMY
Natural Drainage Type	IMPEDED DRAINAGE
Natural Fertility	MODERATE
Characteristic Semi-natural Habitats	LOWLAND SEASONALLY WET PASTURES AND WOODLANDS
Main Land Cover	GRASSLAND AND ARABLE SOME WOODLAND
Hyperlink	/Metadata_for_magic/soilscape_summary.pdf

Appendix C – Proposed Masterplan

north

NOTES:

This drawing is the copyright of Hyland Edgar Driver. It must not be copied or reproduced without written consent. Only figured dimensions are to be taken from this drawing. All contractors must visit the site and be responsible for taking and checking all dimensions related to the works shown on this drawing.

SAFETY, HEALTH AND ENVIRONMENT INFORMATION

Unusual residual hazards / risks, based on experienced and competent contractors working to approved method statements.

UNUSUAL RISKS

Construction:	Unusual Risks (list)/No unusual risks
Operations:	Unusual Risks (list)/No unusual risks
Maintenance:	Unusual Risks (list)/No unusual risks
Dismantling/Demolition:	Unusual Risks (list)/No unusual risks

REVISIONS

REVISIONS

DATE 24.08.15 | DRAWN BY EHdM | CHECKED BY DC

DRAWING STATUS PLANNING | SCALE at A1/A3 1:1000

PROJECT
Royal Brunswick Park

DRAWING TITLE
Illustrative Landscape Masterplan

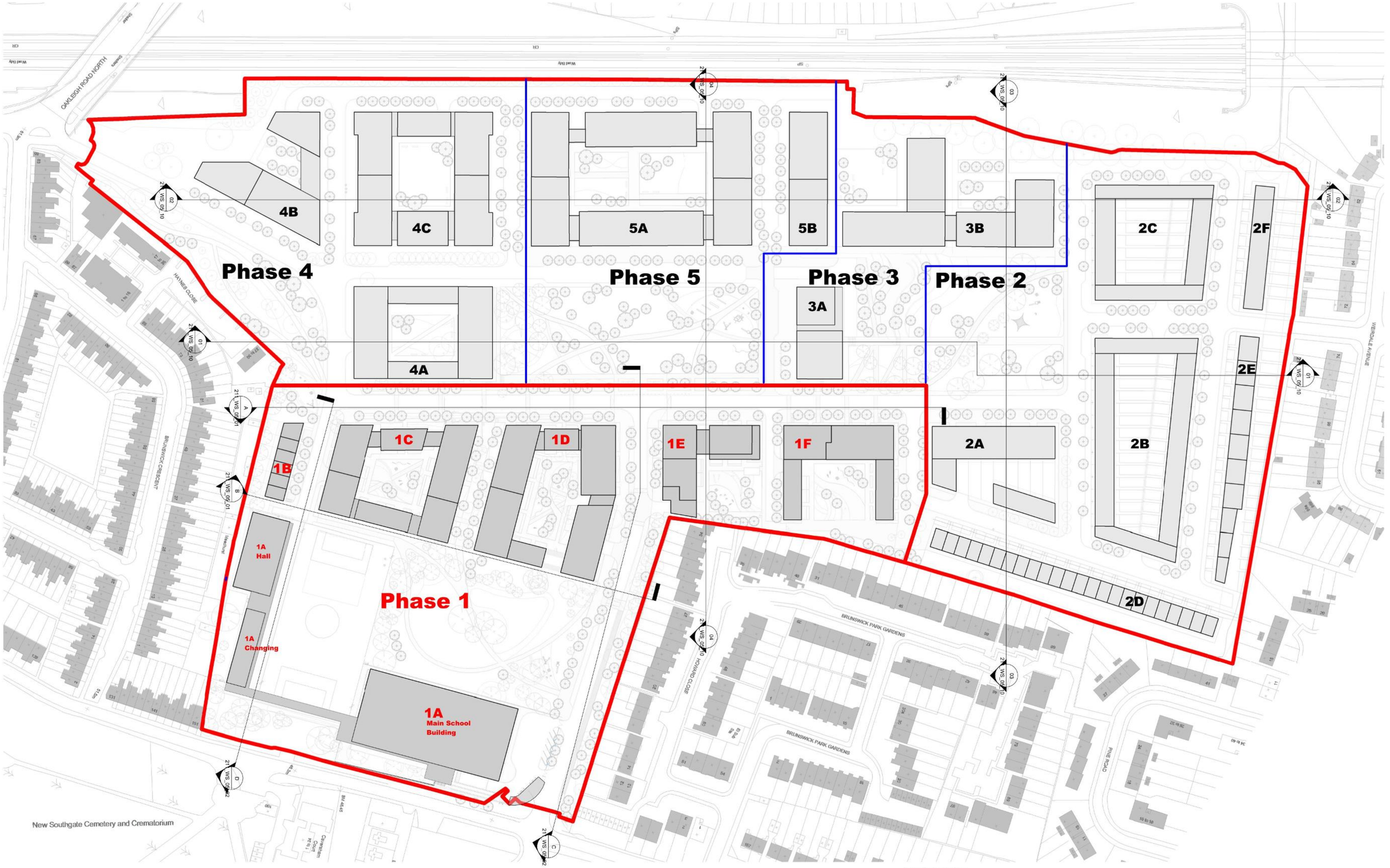
DRAWING NUMBER HED-1140-RBP-LA-0001 | REVISION P00

CLIENT
COMER GROUP

H E D
Hyland Edgar Driver
Landscape Architects & Urban Designers
London & Winchester

Waterloo Court 10 Theed Street London SE1 8ST t. 020 7803 9636
One Wessex Way Colden Common Winchester SO21 1WG t. 01962 711 600

18 Dec, 2015 - 3:37pm Q:\Jobs\1140 Royal Brunswick Park\CAD\Drawings\OUTLINE PLANNING\ HED-1140-RBP-00-0003.dwg



General Notes

1. Developmentment Zones (within which development can occur) and public open spaces are identified on drawing number 211_WS_02_01
2. Access and circulation routes are identified on Drawing number 211_WS_02_02.
3. Landscape treatments are identified on drawing number 211_WS_02_03
4. Allowable uses at ground floor frontages are identified on Drawing number 211_WS_02_04
4. Allowable uses at ground floor frontages are idnetified on Drawing number 211_WS_02_04
5. Allowable horizontal limits of deviations are identified on Drawing number 211_WS_02_05
6. Proposed site ground levels and allowable vertical deviations are identified on Drawing number 211_WS_02_06
7. Heights and allowable vertical deviations are identified on Drawing number 211_WS_02_07
8. Basement extents and allowable horizontal and vertical deviation are identified on drawing number 211_WS_02_08

Additional Notes

1. Refer to Section 5 of the Design Principles Document for further guidance on the Development Zone.
2. Refer to section 4 of the Design Principles Document for further guidance on the Public Open Space Zones, access routes typologies , and landscaping treatments of streets and spaces.
3. Refer to section 3 of the Design Principles Document for further guidance on the streets and circulation routes.

Legend

- Planning Application Boundary
- Detailed Application Zone Blocks
- Phase 1 — Detailed Application Zone Reference
- 1A — Detailed Application Zone Block Reference

NOTES:

REV.	DATE:	DETAILS:	INITIALS:

NORTH POINT:

KEY PLAN:

PLUS ARCHITECTURE
Exchequer Chambers, Exchequer Street, Dublin 2, Ireland. W: www.plusarchitecture.ie T: 353 (0) 1 521 3378

PROJECT:	North London Business Park	PROJECT: 211	DATE: 14/12/15
CLIENT:	The Corner Group	DRAWING NO.: 211_WS_02_09	REVISION NO.:
TITLE:	Site Plan	DRAWN BY.: DW	SCALE AT A1 .: 1 : 1000
ISSUE TYPE:	Planning	CHECKED BY.: DT	SCALE AT A3 .: 1 : 2000

Appendix D – MicroDrainage Output

ICP SUDS Mean Annual Flood

Input

Return Period (years) 2 SAAR (mm) 700 Urban 0.000
Area (ha) 1.000 Soil 0.450 Region Number Region 6

Results l/s

QBAR Rural 4.4
QBAR Urban 4.4

Q2 years 3.9

Q1 year 3.7
Q30 years 10.0
Q100 years 14.0

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	49.267	0.267	19.4	0.0	19.4	142.9	O K
30 min Summer	49.321	0.321	19.4	0.0	19.4	175.0	O K
60 min Summer	49.359	0.359	19.4	0.0	19.4	198.2	O K
120 min Summer	49.374	0.374	19.4	0.0	19.4	207.8	O K
180 min Summer	49.374	0.374	19.4	0.0	19.4	208.1	O K
240 min Summer	49.369	0.369	19.4	0.0	19.4	204.6	O K
360 min Summer	49.350	0.350	19.4	0.0	19.4	192.6	O K
480 min Summer	49.326	0.326	19.4	0.0	19.4	178.0	O K
600 min Summer	49.302	0.302	19.4	0.0	19.4	163.6	O K
720 min Summer	49.279	0.279	19.4	0.0	19.4	150.2	O K
960 min Summer	49.241	0.241	19.3	0.0	19.3	127.8	O K
1440 min Summer	49.193	0.193	18.4	0.0	18.4	100.4	O K
2160 min Summer	49.161	0.161	14.8	0.0	14.8	82.9	O K
2880 min Summer	49.142	0.142	12.4	0.0	12.4	72.6	O K
4320 min Summer	49.120	0.120	9.4	0.0	9.4	60.8	O K
5760 min Summer	49.106	0.106	7.7	0.0	7.7	53.6	O K
7200 min Summer	49.097	0.097	6.6	0.0	6.6	48.7	O K
8640 min Summer	49.089	0.089	5.7	0.0	5.7	45.0	O K
10080 min Summer	49.084	0.084	5.1	0.0	5.1	42.0	O K
15 min Winter	49.298	0.298	19.4	0.0	19.4	161.0	O K
30 min Winter	49.358	0.358	19.4	0.0	19.4	198.0	O K
60 min Winter	49.403	0.403	19.4	0.0	19.4	226.2	O K
120 min Winter	49.420	0.420	19.4	0.0	19.4	237.1	O K
180 min Winter	49.416	0.416	19.4	0.0	19.4	234.2	O K
240 min Winter	49.405	0.405	19.4	0.0	19.4	227.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	41.734	0.0	150.7	0.0	18
30 min Summer	26.594	0.0	192.9	0.0	32
60 min Summer	16.285	0.0	238.9	0.0	60
120 min Summer	9.752	0.0	286.4	0.0	96
180 min Summer	7.183	0.0	316.5	0.0	130
240 min Summer	5.773	0.0	339.3	0.0	164
360 min Summer	4.234	0.0	373.4	0.0	230
480 min Summer	3.389	0.0	398.7	0.0	296
600 min Summer	2.851	0.0	419.2	0.0	362
720 min Summer	2.475	0.0	436.8	0.0	422
960 min Summer	1.980	0.0	465.7	0.0	540
1440 min Summer	1.445	0.0	509.5	0.0	766
2160 min Summer	1.055	0.0	559.8	0.0	1124
2880 min Summer	0.844	0.0	596.8	0.0	1496
4320 min Summer	0.616	0.0	652.2	0.0	2204
5760 min Summer	0.492	0.0	697.4	0.0	2936
7200 min Summer	0.414	0.0	732.7	0.0	3672
8640 min Summer	0.359	0.0	762.7	0.0	4408
10080 min Summer	0.319	0.0	788.3	0.0	5136
15 min Winter	41.734	0.0	169.1	0.0	18
30 min Winter	26.594	0.0	216.4	0.0	32
60 min Winter	16.285	0.0	267.7	0.0	60
120 min Winter	9.752	0.0	320.9	0.0	114
180 min Winter	7.183	0.0	354.7	0.0	140
240 min Winter	5.773	0.0	380.3	0.0	178

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Detention Basin
Date 16/12/2015 15:37 File 0031-SW-01-F-PH1 DETENTION BA...	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	49.371	0.371	19.4	0.0	19.4	206.2	O K
480 min Winter	49.333	0.333	19.4	0.0	19.4	182.4	O K
600 min Winter	49.296	0.296	19.4	0.0	19.4	159.9	O K
720 min Winter	49.262	0.262	19.4	0.0	19.4	140.1	O K
960 min Winter	49.211	0.211	19.0	0.0	19.0	110.5	O K
1440 min Winter	49.167	0.167	15.6	0.0	15.6	86.5	O K
2160 min Winter	49.138	0.138	11.8	0.0	11.8	70.5	O K
2880 min Winter	49.121	0.121	9.6	0.0	9.6	61.5	O K
4320 min Winter	49.101	0.101	7.1	0.0	7.1	51.0	O K
5760 min Winter	49.089	0.089	5.7	0.0	5.7	44.9	O K
7200 min Winter	49.081	0.081	4.8	0.0	4.8	40.7	O K
8640 min Winter	49.075	0.075	4.2	0.0	4.2	37.6	O K
10080 min Winter	49.071	0.071	3.7	0.0	3.7	35.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
360 min Winter	4.234	0.0	418.5	0.0	252
480 min Winter	3.389	0.0	446.7	0.0	320
600 min Winter	2.851	0.0	469.8	0.0	384
720 min Winter	2.475	0.0	489.4	0.0	442
960 min Winter	1.980	0.0	521.9	0.0	550
1440 min Winter	1.445	0.0	571.0	0.0	780
2160 min Winter	1.055	0.0	627.2	0.0	1144
2880 min Winter	0.844	0.0	668.7	0.0	1500
4320 min Winter	0.616	0.0	730.9	0.0	2208
5760 min Winter	0.492	0.0	781.2	0.0	2944
7200 min Winter	0.414	0.0	820.7	0.0	3672
8640 min Winter	0.359	0.0	854.4	0.0	4408
10080 min Winter	0.319	0.0	883.4	0.0	5120

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.970

Time (mins) From:	To:	Area (ha)
0	4	1.970

Model Details

Storage is Online Cover Level (m) 50.000

Tank or Pond Structure

Invert Level (m) 49.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	487.0	0.600	720.0	0.601	1650.0	1.000	1879.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0202-1950-0500-1950
Design Head (m)	0.500
Design Flow (l/s)	19.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	202
Invert Level (m)	49.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	19.4	Kick-Flo®	0.428	18.0
Flush-Flo™	0.282	19.4	Mean Flow over Head Range	-	14.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.9	0.800	24.3	2.000	37.7	4.000	52.7	7.000	69.0
0.200	18.8	1.000	27.0	2.200	39.4	4.500	55.8	7.500	71.4
0.300	19.4	1.200	29.4	2.400	41.1	5.000	58.7	8.000	73.8
0.400	18.5	1.400	31.7	2.600	42.7	5.500	61.0	8.500	76.1
0.500	19.4	1.600	33.8	3.000	45.8	6.000	63.8	9.000	78.3
0.600	21.1	1.800	35.8	3.500	49.4	6.500	66.4	9.500	80.5

Orifice Overflow Control

Diameter (m) 0.210 Discharge Coefficient 0.600 Invert Level (m) 49.500

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	49.527	0.527	19.9	0.5	20.4	308.3	O K
30 min Summer	49.613	0.613	21.4	8.8	30.1	380.2	O K
60 min Summer	49.643	0.643	21.8	13.1	35.0	430.7	O K
120 min Summer	49.654	0.654	22.0	14.5	36.6	448.6	O K
180 min Summer	49.654	0.654	22.0	14.5	36.6	449.1	O K
240 min Summer	49.651	0.651	22.0	14.2	36.1	443.7	O K
360 min Summer	49.640	0.640	21.8	12.8	34.6	426.0	O K
480 min Summer	49.629	0.629	21.6	11.3	32.9	407.1	O K
600 min Summer	49.618	0.618	21.4	9.7	31.2	389.1	O K
720 min Summer	49.608	0.608	21.3	8.0	29.3	372.8	O K
960 min Summer	49.580	0.580	20.8	4.3	25.1	345.3	O K
1440 min Summer	49.499	0.499	19.4	0.0	19.4	289.3	O K
2160 min Summer	49.358	0.358	19.4	0.0	19.4	197.8	O K
2880 min Summer	49.259	0.259	19.4	0.0	19.4	138.2	O K
4320 min Summer	49.181	0.181	17.2	0.0	17.2	94.2	O K
5760 min Summer	49.155	0.155	14.1	0.0	14.1	79.7	O K
7200 min Summer	49.138	0.138	11.9	0.0	11.9	70.7	O K
8640 min Summer	49.126	0.126	10.3	0.0	10.3	64.3	O K
10080 min Summer	49.117	0.117	9.1	0.0	9.1	59.5	O K
15 min Winter	49.580	0.580	20.8	4.3	25.1	345.5	O K
30 min Winter	49.640	0.640	21.8	12.8	34.6	426.1	O K
60 min Winter	49.675	0.675	22.4	17.7	40.1	485.1	O K
120 min Winter	49.686	0.686	22.5	19.7	42.2	504.0	O K
180 min Winter	49.686	0.686	22.5	19.6	42.1	502.9	O K
240 min Winter	49.680	0.680	22.4	18.6	41.1	493.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	87.227	0.0	318.3	0.3	18
30 min Summer	55.777	0.0	407.9	16.8	32
60 min Summer	34.065	0.0	501.4	47.1	62
120 min Summer	20.201	0.0	595.0	77.3	100
180 min Summer	14.736	0.0	651.2	90.8	132
240 min Summer	11.736	0.0	691.6	96.2	166
360 min Summer	8.483	0.0	750.0	92.4	234
480 min Summer	6.739	0.0	794.4	78.9	304
600 min Summer	5.634	0.0	830.1	64.3	372
720 min Summer	4.865	0.0	860.2	50.3	440
960 min Summer	3.858	0.0	909.5	24.4	578
1440 min Summer	2.780	0.0	982.5	0.0	864
2160 min Summer	2.001	0.0	1062.9	0.0	1216
2880 min Summer	1.584	0.0	1121.5	0.0	1552
4320 min Summer	1.138	0.0	1207.8	0.0	2208
5760 min Summer	0.900	0.0	1275.6	0.0	2936
7200 min Summer	0.750	0.0	1328.4	0.0	3672
8640 min Summer	0.646	0.0	1372.7	0.0	4408
10080 min Summer	0.569	0.0	1410.3	0.0	5136
15 min Winter	87.227	0.0	356.9	4.6	18
30 min Winter	55.777	0.0	457.3	35.0	32
60 min Winter	34.065	0.0	561.8	74.1	60
120 min Winter	20.201	0.0	666.6	113.4	100
180 min Winter	14.736	0.0	729.6	130.9	138
240 min Winter	11.736	0.0	774.8	138.0	176

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	49.664	0.664	22.2	15.9	38.1	466.2	O K
480 min Winter	49.647	0.647	21.9	13.7	35.6	438.0	O K
600 min Winter	49.632	0.632	21.7	11.7	33.4	411.9	O K
720 min Winter	49.618	0.618	21.4	9.6	31.1	388.9	O K
960 min Winter	49.589	0.589	21.0	5.3	26.3	352.0	O K
1440 min Winter	49.476	0.476	19.4	0.0	19.4	273.6	O K
2160 min Winter	49.268	0.268	19.4	0.0	19.4	143.3	O K
2880 min Winter	49.187	0.187	17.9	0.0	17.9	97.4	O K
4320 min Winter	49.147	0.147	13.1	0.0	13.1	75.6	O K
5760 min Winter	49.127	0.127	10.4	0.0	10.4	64.8	O K
7200 min Winter	49.114	0.114	8.7	0.0	8.7	57.8	O K
8640 min Winter	49.105	0.105	7.5	0.0	7.5	52.8	O K
10080 min Winter	49.097	0.097	6.6	0.0	6.6	48.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
360 min Winter	8.483	0.0	840.2	137.1	252
480 min Winter	6.739	0.0	889.9	123.8	324
600 min Winter	5.634	0.0	930.0	103.0	396
720 min Winter	4.865	0.0	963.7	81.4	466
960 min Winter	3.858	0.0	1018.9	39.2	614
1440 min Winter	2.780	0.0	1100.8	0.0	920
2160 min Winter	2.001	0.0	1190.6	0.0	1232
2880 min Winter	1.584	0.0	1256.2	0.0	1504
4320 min Winter	1.138	0.0	1353.2	0.0	2208
5760 min Winter	0.900	0.0	1428.8	0.0	2936
7200 min Winter	0.750	0.0	1488.0	0.0	3672
8640 min Winter	0.646	0.0	1537.7	0.0	4408
10080 min Winter	0.569	0.0	1580.1	0.0	5136

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.970

Time (mins) From:	To:	Area (ha)
0	4	1.970

Model Details

Storage is Online Cover Level (m) 50.000

Tank or Pond Structure

Invert Level (m) 49.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	487.0	0.600	720.0	0.601	1650.0	1.000	1879.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0202-1950-0500-1950
Design Head (m)	0.500
Design Flow (l/s)	19.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	202
Invert Level (m)	49.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	19.4	Kick-Flo®	0.428	18.0
Flush-Flo™	0.282	19.4	Mean Flow over Head Range	-	14.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.9	0.800	24.3	2.000	37.7	4.000	52.7	7.000	69.0
0.200	18.8	1.000	27.0	2.200	39.4	4.500	55.8	7.500	71.4
0.300	19.4	1.200	29.4	2.400	41.1	5.000	58.7	8.000	73.8
0.400	18.5	1.400	31.7	2.600	42.7	5.500	61.0	8.500	76.1
0.500	19.4	1.600	33.8	3.000	45.8	6.000	63.8	9.000	78.3
0.600	21.1	1.800	35.8	3.500	49.4	6.500	66.4	9.500	80.5

Orifice Overflow Control

Diameter (m) 0.210 Discharge Coefficient 0.600 Invert Level (m) 49.500

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Detention Basin
Date 16/12/2015 15:36 File 0031-SW-01-F-PH1 DETENTION BA...	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow Σ (l/s)	Max Volume (m³)	Status
15 min Summer	49.668	0.668	22.2	16.4	38.6	472.5	O K
30 min Summer	49.734	0.734	23.3	28.3	51.6	585.2	Flood Risk
60 min Summer	49.778	0.778	23.9	36.6	60.5	662.2	Flood Risk
120 min Summer	49.793	0.793	24.2	39.4	63.6	688.8	Flood Risk
180 min Summer	49.794	0.794	24.2	39.5	63.7	689.6	Flood Risk
240 min Summer	49.788	0.788	24.1	38.5	62.6	680.2	Flood Risk
360 min Summer	49.772	0.772	23.8	35.4	59.2	650.8	Flood Risk
480 min Summer	49.754	0.754	23.6	32.1	55.7	620.8	Flood Risk
600 min Summer	49.738	0.738	23.3	29.2	52.5	592.3	Flood Risk
720 min Summer	49.723	0.723	23.1	26.3	49.4	566.3	Flood Risk
960 min Summer	49.697	0.697	22.7	21.5	44.3	521.2	O K
1440 min Summer	49.655	0.655	22.0	14.7	36.7	450.2	O K
2160 min Summer	49.611	0.611	21.3	8.4	29.8	376.8	O K
2880 min Summer	49.557	0.557	20.4	2.2	22.6	329.2	O K
4320 min Summer	49.351	0.351	19.4	0.0	19.4	193.6	O K
5760 min Summer	49.222	0.222	19.1	0.0	19.1	117.0	O K
7200 min Summer	49.182	0.182	17.3	0.0	17.3	94.6	O K
8640 min Summer	49.162	0.162	15.0	0.0	15.0	83.8	O K
10080 min Summer	49.149	0.149	13.3	0.0	13.3	76.5	O K
15 min Winter	49.701	0.701	22.8	22.3	45.1	529.3	Flood Risk
30 min Winter	49.775	0.775	23.9	36.0	59.8	656.5	Flood Risk
60 min Winter	49.826	0.826	24.6	43.2	67.9	746.5	Flood Risk
120 min Winter	49.842	0.842	24.9	44.8	69.7	775.8	Flood Risk
180 min Winter	49.840	0.840	24.8	44.6	69.5	771.5	Flood Risk
240 min Winter	49.830	0.830	24.7	43.6	68.3	752.8	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	133.985	0.0	490.7	52.2	18
30 min Summer	86.337	0.0	633.4	122.7	32
60 min Summer	52.933	0.0	780.1	202.4	60
120 min Summer	31.380	0.0	925.3	278.8	94
180 min Summer	22.833	0.0	1010.0	315.2	128
240 min Summer	18.130	0.0	1069.4	333.5	162
360 min Summer	13.031	0.0	1153.1	343.7	230
480 min Summer	10.316	0.0	1217.2	339.3	298
600 min Summer	8.601	0.0	1268.4	324.7	366
720 min Summer	7.410	0.0	1311.4	302.5	434
960 min Summer	5.854	0.0	1381.2	259.7	568
1440 min Summer	4.194	0.0	1483.9	188.1	824
2160 min Summer	3.001	0.0	1594.7	95.3	1212
2880 min Summer	2.364	0.0	1675.1	20.0	1616
4320 min Summer	1.688	0.0	1792.5	0.0	2340
5760 min Summer	1.328	0.0	1882.6	0.0	2992
7200 min Summer	1.102	0.0	1952.7	0.0	3672
8640 min Summer	0.946	0.0	2011.1	0.0	4408
10080 min Summer	0.831	0.0	2060.5	0.0	5136
15 min Winter	133.985	0.0	550.0	80.6	18
30 min Winter	86.337	0.0	709.8	168.4	32
60 min Winter	52.933	0.0	874.0	263.8	60
120 min Winter	31.380	0.0	1036.6	353.5	98
180 min Winter	22.833	0.0	1131.5	398.1	136
240 min Winter	18.130	0.0	1198.0	422.8	174

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Detention Basin
Date 16/12/2015 15:36 File 0031-SW-01-F-PH1 DETENTION BA...	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	49.802	0.802	24.3	40.9	65.2	704.4	Flood Risk
480 min Winter	49.777	0.777	23.9	36.4	60.3	660.9	Flood Risk
600 min Winter	49.755	0.755	23.6	32.2	55.8	621.6	Flood Risk
720 min Winter	49.735	0.735	23.3	28.5	51.8	586.7	Flood Risk
960 min Winter	49.701	0.701	22.8	22.3	45.0	528.5	Flood Risk
1440 min Winter	49.649	0.649	21.9	13.9	35.8	440.5	O K
2160 min Winter	49.598	0.598	21.1	6.3	27.4	358.5	O K
2880 min Winter	49.494	0.494	19.4	0.0	19.4	286.1	O K
4320 min Winter	49.205	0.205	18.9	0.0	18.9	107.2	O K
5760 min Winter	49.165	0.165	15.3	0.0	15.3	85.1	O K
7200 min Winter	49.145	0.145	12.7	0.0	12.7	74.3	O K
8640 min Winter	49.131	0.131	11.0	0.0	11.0	67.1	O K
10080 min Winter	49.121	0.121	9.6	0.0	9.6	61.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
360 min Winter	13.031	0.0	1291.7	440.5	246
480 min Winter	10.316	0.0	1363.5	437.9	318
600 min Winter	8.601	0.0	1420.9	423.8	386
720 min Winter	7.410	0.0	1469.1	401.2	456
960 min Winter	5.854	0.0	1547.3	340.7	594
1440 min Winter	4.194	0.0	1662.3	232.2	864
2160 min Winter	3.001	0.0	1786.3	84.2	1256
2880 min Winter	2.364	0.0	1876.4	0.0	1756
4320 min Winter	1.688	0.0	2008.1	0.0	2288
5760 min Winter	1.328	0.0	2108.7	0.0	2944
7200 min Winter	1.102	0.0	2187.2	0.0	3672
8640 min Winter	0.946	0.0	2252.7	0.0	4408
10080 min Winter	0.831	0.0	2308.3	0.0	5144

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.970

Time (mins) From:	To:	Area (ha)
0	4	1.970

Model Details

Storage is Online Cover Level (m) 50.000

Tank or Pond Structure

Invert Level (m) 49.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	487.0	0.600	720.0	0.601	1650.0	1.000	1879.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0202-1950-0500-1950
Design Head (m)	0.500
Design Flow (l/s)	19.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	202
Invert Level (m)	49.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	19.4	Kick-Flo®	0.428	18.0
Flush-Flo™	0.282	19.4	Mean Flow over Head Range	-	14.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.9	0.800	24.3	2.000	37.7	4.000	52.7	7.000	69.0
0.200	18.8	1.000	27.0	2.200	39.4	4.500	55.8	7.500	71.4
0.300	19.4	1.200	29.4	2.400	41.1	5.000	58.7	8.000	73.8
0.400	18.5	1.400	31.7	2.600	42.7	5.500	61.0	8.500	76.1
0.500	19.4	1.600	33.8	3.000	45.8	6.000	63.8	9.000	78.3
0.600	21.1	1.800	35.8	3.500	49.4	6.500	66.4	9.500	80.5

Orifice Overflow Control

Diameter (m) 0.210 Discharge Coefficient 0.600 Invert Level (m) 49.500

Summary of Results for 2 year Return Period

Half Drain Time : 442 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.139	0.139	0.0	2.1	0.0	2.1	49.5	O K
30 min Summer	99.175	0.175	0.0	2.1	0.0	2.1	62.4	O K
60 min Summer	99.209	0.209	0.0	2.1	0.0	2.1	74.5	O K
120 min Summer	99.240	0.240	0.0	2.1	0.0	2.1	85.4	O K
180 min Summer	99.254	0.254	0.0	2.1	0.0	2.1	90.4	O K
240 min Summer	99.261	0.261	0.0	2.1	0.0	2.1	92.9	O K
360 min Summer	99.265	0.265	0.0	2.1	0.0	2.1	94.3	O K
480 min Summer	99.264	0.264	0.0	2.1	0.0	2.1	94.0	O K
600 min Summer	99.262	0.262	0.0	2.1	0.0	2.1	93.2	O K
720 min Summer	99.258	0.258	0.0	2.1	0.0	2.1	92.1	O K
960 min Summer	99.250	0.250	0.0	2.1	0.0	2.1	89.2	O K
1440 min Summer	99.231	0.231	0.0	2.1	0.0	2.1	82.1	O K
2160 min Summer	99.199	0.199	0.0	2.1	0.0	2.1	71.1	O K
2880 min Summer	99.171	0.171	0.0	2.1	0.0	2.1	61.0	O K
4320 min Summer	99.128	0.128	0.0	2.1	0.0	2.1	45.6	O K
5760 min Summer	99.101	0.101	0.0	2.0	0.0	2.0	36.0	O K
7200 min Summer	99.087	0.087	0.0	1.9	0.0	1.9	31.0	O K
8640 min Summer	99.078	0.078	0.0	1.7	0.0	1.7	27.8	O K
10080 min Summer	99.071	0.071	0.0	1.5	0.0	1.5	25.4	O K
15 min Winter	99.156	0.156	0.0	2.1	0.0	2.1	55.6	O K
30 min Winter	99.197	0.197	0.0	2.1	0.0	2.1	70.1	O K
60 min Winter	99.236	0.236	0.0	2.1	0.0	2.1	83.9	O K
120 min Winter	99.271	0.271	0.0	2.1	0.0	2.1	96.5	O K
180 min Winter	99.288	0.288	0.0	2.1	0.0	2.1	102.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	41.734	0.0	47.5	0.0	19
30 min Summer	26.594	0.0	61.2	0.0	33
60 min Summer	16.285	0.0	77.7	0.0	62
120 min Summer	9.752	0.0	93.2	0.0	122
180 min Summer	7.183	0.0	103.1	0.0	182
240 min Summer	5.773	0.0	110.6	0.0	240
360 min Summer	4.234	0.0	121.7	0.0	342
480 min Summer	3.389	0.0	130.0	0.0	394
600 min Summer	2.851	0.0	136.7	0.0	454
720 min Summer	2.475	0.0	142.3	0.0	520
960 min Summer	1.980	0.0	151.8	0.0	654
1440 min Summer	1.445	0.0	165.8	0.0	924
2160 min Summer	1.055	0.0	184.0	0.0	1320
2880 min Summer	0.844	0.0	196.1	0.0	1700
4320 min Summer	0.616	0.0	213.8	0.0	2416
5760 min Summer	0.492	0.0	229.7	0.0	3064
7200 min Summer	0.414	0.0	241.2	0.0	3752
8640 min Summer	0.359	0.0	250.9	0.0	4496
10080 min Summer	0.319	0.0	258.9	0.0	5152
15 min Winter	41.734	0.0	53.5	0.0	18
30 min Winter	26.594	0.0	68.7	0.0	33
60 min Winter	16.285	0.0	87.1	0.0	62
120 min Winter	9.752	0.0	104.6	0.0	120
180 min Winter	7.183	0.0	115.6	0.0	178

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing School Attenuation
Date 16/12/2015 16:04 File 0031-SW-02-A-PH1 SCHOOL ATTEN...	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.298	0.298	0.0	2.1	0.0	2.1	106.1	O K
360 min Winter	99.305	0.305	0.0	2.1	0.0	2.1	108.7	O K
480 min Winter	99.304	0.304	0.0	2.1	0.0	2.1	108.1	O K
600 min Winter	99.298	0.298	0.0	2.1	0.0	2.1	106.2	O K
720 min Winter	99.293	0.293	0.0	2.1	0.0	2.1	104.5	O K
960 min Winter	99.281	0.281	0.0	2.1	0.0	2.1	100.0	O K
1440 min Winter	99.250	0.250	0.0	2.1	0.0	2.1	88.9	O K
2160 min Winter	99.201	0.201	0.0	2.1	0.0	2.1	71.5	O K
2880 min Winter	99.158	0.158	0.0	2.1	0.0	2.1	56.4	O K
4320 min Winter	99.102	0.102	0.0	2.0	0.0	2.0	36.4	O K
5760 min Winter	99.082	0.082	0.0	1.8	0.0	1.8	29.1	O K
7200 min Winter	99.071	0.071	0.0	1.5	0.0	1.5	25.1	O K
8640 min Winter	99.063	0.063	0.0	1.3	0.0	1.3	22.5	O K
10080 min Winter	99.058	0.058	0.0	1.2	0.0	1.2	20.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	5.773	0.0	124.0	0.0	236
360 min Winter	4.234	0.0	136.5	0.0	348
480 min Winter	3.389	0.0	145.7	0.0	454
600 min Winter	2.851	0.0	153.2	0.0	498
720 min Winter	2.475	0.0	159.5	0.0	564
960 min Winter	1.980	0.0	170.1	0.0	714
1440 min Winter	1.445	0.0	185.8	0.0	1010
2160 min Winter	1.055	0.0	206.2	0.0	1424
2880 min Winter	0.844	0.0	219.8	0.0	1788
4320 min Winter	0.616	0.0	239.8	0.0	2424
5760 min Winter	0.492	0.0	257.3	0.0	3104
7200 min Winter	0.414	0.0	270.3	0.0	3792
8640 min Winter	0.359	0.0	281.2	0.0	4496
10080 min Winter	0.319	0.0	290.3	0.0	5240

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.650

Time (mins) From:	To:	Area (ha)
0	4	0.650

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	375.0	0.0	1.000	375.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0076-2100-0500-2100
Design Head (m)	0.500
Design Flow (l/s)	2.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	76
Invert Level (m)	99.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	2.1	Kick-Flo®	0.345	1.8
Flush-Flo™	0.150	2.1	Mean Flow over Head Range	-	1.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	0.800	2.6	2.000	4.0	4.000	5.5	7.000	7.2
0.200	2.1	1.000	2.9	2.200	4.1	4.500	5.8	7.500	7.4
0.300	1.9	1.200	3.1	2.400	4.3	5.000	6.1	8.000	7.7
0.400	1.9	1.400	3.4	2.600	4.5	5.500	6.4	8.500	7.9
0.500	2.1	1.600	3.6	3.000	4.8	6.000	6.6	9.000	8.1
0.600	2.3	1.800	3.8	3.500	5.1	6.500	6.9	9.500	8.4

Orifice Overflow Control

Diameter (m) 0.045 Discharge Coefficient 0.600 Invert Level (m) 99.500

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

Half Drain Time : 915 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.294	0.294	0.0	2.1	0.0	2.1	104.8	O K
30 min Summer	99.374	0.374	0.0	2.1	0.0	2.1	133.3	O K
60 min Summer	99.451	0.451	0.0	2.1	0.0	2.1	160.6	O K
120 min Summer	99.521	0.521	0.0	2.1	0.1	2.3	185.4	O K
180 min Summer	99.553	0.553	0.0	2.2	0.7	2.8	197.0	O K
240 min Summer	99.568	0.568	0.0	2.2	0.9	3.1	202.5	O K
360 min Summer	99.578	0.578	0.0	2.2	1.0	3.2	206.0	O K
480 min Summer	99.576	0.576	0.0	2.2	1.0	3.2	205.3	O K
600 min Summer	99.573	0.573	0.0	2.2	1.0	3.2	204.2	O K
720 min Summer	99.570	0.570	0.0	2.2	0.9	3.1	203.0	O K
960 min Summer	99.562	0.562	0.0	2.2	0.8	3.0	200.1	O K
1440 min Summer	99.544	0.544	0.0	2.2	0.5	2.7	193.6	O K
2160 min Summer	99.512	0.512	0.0	2.1	0.0	2.2	182.3	O K
2880 min Summer	99.473	0.473	0.0	2.1	0.0	2.1	168.6	O K
4320 min Summer	99.401	0.401	0.0	2.1	0.0	2.1	143.0	O K
5760 min Summer	99.327	0.327	0.0	2.1	0.0	2.1	116.4	O K
7200 min Summer	99.260	0.260	0.0	2.1	0.0	2.1	92.5	O K
8640 min Summer	99.207	0.207	0.0	2.1	0.0	2.1	73.7	O K
10080 min Summer	99.166	0.166	0.0	2.1	0.0	2.1	59.0	O K
15 min Winter	99.330	0.330	0.0	2.1	0.0	2.1	117.5	O K
30 min Winter	99.420	0.420	0.0	2.1	0.0	2.1	149.5	O K
60 min Winter	99.506	0.506	0.0	2.1	0.0	2.1	180.2	O K
120 min Winter	99.582	0.582	0.0	2.2	1.0	3.3	207.3	O K
180 min Winter	99.617	0.617	0.0	2.3	1.3	3.6	219.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	87.227	0.0	101.2	0.0	19
30 min Summer	55.777	0.0	128.7	0.0	34
60 min Summer	34.065	0.0	163.6	0.0	64
120 min Summer	20.201	0.0	194.1	0.2	122
180 min Summer	14.736	0.0	212.3	2.9	182
240 min Summer	11.736	0.0	225.4	6.0	242
360 min Summer	8.483	0.0	244.3	10.4	360
480 min Summer	6.739	0.0	258.6	13.3	450
600 min Summer	5.634	0.0	269.9	15.0	506
720 min Summer	4.865	0.0	279.3	15.7	570
960 min Summer	3.858	0.0	294.1	14.7	700
1440 min Summer	2.780	0.0	310.6	7.9	994
2160 min Summer	2.001	0.0	349.5	0.4	1452
2880 min Summer	1.584	0.0	368.6	0.0	1872
4320 min Summer	1.138	0.0	396.5	0.0	2684
5760 min Summer	0.900	0.0	420.5	0.0	3464
7200 min Summer	0.750	0.0	437.8	0.0	4184
8640 min Summer	0.646	0.0	452.1	0.0	4848
10080 min Summer	0.569	0.0	464.0	0.0	5544
15 min Winter	87.227	0.0	113.3	0.0	19
30 min Winter	55.777	0.0	142.9	0.0	33
60 min Winter	34.065	0.0	183.3	0.0	62
120 min Winter	20.201	0.0	217.4	6.2	120
180 min Winter	14.736	0.0	237.9	12.6	178

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing School Attenuation
Date 16/12/2015 16:04 File 0031-SW-02-A-PH1 SCHOOL ATTEN...	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.635	0.635	0.0	2.3	1.4	3.7	226.1	O K
360 min Winter	99.648	0.648	0.0	2.4	1.5	3.8	230.8	O K
480 min Winter	99.648	0.648	0.0	2.4	1.5	3.8	230.8	O K
600 min Winter	99.642	0.642	0.0	2.3	1.5	3.8	228.7	O K
720 min Winter	99.638	0.638	0.0	2.3	1.4	3.8	227.4	O K
960 min Winter	99.627	0.627	0.0	2.3	1.4	3.7	223.5	O K
1440 min Winter	99.599	0.599	0.0	2.3	1.2	3.4	213.3	O K
2160 min Winter	99.558	0.558	0.0	2.2	0.7	2.9	198.7	O K
2880 min Winter	99.520	0.520	0.0	2.1	0.1	2.2	185.2	O K
4320 min Winter	99.416	0.416	0.0	2.1	0.0	2.1	148.2	O K
5760 min Winter	99.299	0.299	0.0	2.1	0.0	2.1	106.7	O K
7200 min Winter	99.205	0.205	0.0	2.1	0.0	2.1	73.0	O K
8640 min Winter	99.140	0.140	0.0	2.1	0.0	2.1	49.8	O K
10080 min Winter	99.103	0.103	0.0	2.0	0.0	2.0	36.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	11.736	0.0	252.6	17.2	236
360 min Winter	8.483	0.0	273.7	23.4	348
480 min Winter	6.739	0.0	289.6	27.5	454
600 min Winter	5.634	0.0	302.2	30.2	508
720 min Winter	4.865	0.0	312.7	31.9	566
960 min Winter	3.858	0.0	329.0	33.2	722
1440 min Winter	2.780	0.0	345.7	29.6	1028
2160 min Winter	2.001	0.0	391.5	14.5	1496
2880 min Winter	1.584	0.0	412.9	1.6	2016
4320 min Winter	1.138	0.0	443.9	0.0	2900
5760 min Winter	0.900	0.0	471.0	0.0	3688
7200 min Winter	0.750	0.0	490.4	0.0	4328
8640 min Winter	0.646	0.0	506.6	0.0	4928
10080 min Winter	0.569	0.0	520.1	0.0	5448

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.650

Time (mins) From:	To:	Area (ha)
0	4	0.650

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	375.0	0.0	1.000	375.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0076-2100-0500-2100
Design Head (m)	0.500
Design Flow (l/s)	2.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	76
Invert Level (m)	99.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	2.1	Kick-Flo®	0.345	1.8
Flush-Flo™	0.150	2.1	Mean Flow over Head Range	-	1.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	0.800	2.6	2.000	4.0	4.000	5.5	7.000	7.2
0.200	2.1	1.000	2.9	2.200	4.1	4.500	5.8	7.500	7.4
0.300	1.9	1.200	3.1	2.400	4.3	5.000	6.1	8.000	7.7
0.400	1.9	1.400	3.4	2.600	4.5	5.500	6.4	8.500	7.9
0.500	2.1	1.600	3.6	3.000	4.8	6.000	6.6	9.000	8.1
0.600	2.3	1.800	3.8	3.500	5.1	6.500	6.9	9.500	8.4

Orifice Overflow Control

Diameter (m) 0.045 Discharge Coefficient 0.600 Invert Level (m) 99.500

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

Half Drain Time : 1222 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.454	0.454	0.0	2.1	0.0	2.1	161.7	O K
30 min Summer	99.580	0.580	0.0	2.2	1.0	3.3	206.8	O K
60 min Summer	99.699	0.699	0.0	2.4	1.8	4.2	249.0	O K
120 min Summer	99.802	0.802	0.0	2.6	2.2	4.8	285.7	Flood Risk
180 min Summer	99.848	0.848	0.0	2.7	2.4	5.1	301.9	Flood Risk
240 min Summer	99.869	0.869	0.0	2.7	2.5	5.2	309.6	Flood Risk
360 min Summer	99.880	0.880	0.0	2.7	2.5	5.2	313.6	Flood Risk
480 min Summer	99.876	0.876	0.0	2.7	2.5	5.2	312.2	Flood Risk
600 min Summer	99.871	0.871	0.0	2.7	2.5	5.2	310.4	Flood Risk
720 min Summer	99.865	0.865	0.0	2.7	2.5	5.2	308.2	Flood Risk
960 min Summer	99.850	0.850	0.0	2.7	2.4	5.1	302.9	Flood Risk
1440 min Summer	99.814	0.814	0.0	2.6	2.3	4.9	290.1	Flood Risk
2160 min Summer	99.759	0.759	0.0	2.5	2.1	4.6	270.4	Flood Risk
2880 min Summer	99.710	0.710	0.0	2.5	1.8	4.3	253.0	Flood Risk
4320 min Summer	99.635	0.635	0.0	2.3	1.4	3.7	226.2	O K
5760 min Summer	99.581	0.581	0.0	2.2	1.0	3.3	206.9	O K
7200 min Summer	99.544	0.544	0.0	2.2	0.5	2.7	193.7	O K
8640 min Summer	99.500	0.500	0.0	2.1	0.0	2.1	178.0	O K
10080 min Summer	99.441	0.441	0.0	2.1	0.0	2.1	157.3	O K
15 min Winter	99.509	0.509	0.0	2.1	0.0	2.1	181.2	O K
30 min Winter	99.650	0.650	0.0	2.4	1.5	3.9	231.5	O K
60 min Winter	99.784	0.784	0.0	2.6	2.2	4.7	279.3	Flood Risk
120 min Winter	99.901	0.901	0.0	2.7	2.6	5.3	321.1	Flood Risk
180 min Winter	99.955	0.955	0.0	2.8	2.8	5.6	340.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	133.985	0.0	151.9	0.0	19
30 min Summer	86.337	0.0	177.5	5.0	34
60 min Summer	52.933	0.0	254.5	22.8	64
120 min Summer	31.380	0.0	301.8	43.2	122
180 min Summer	22.833	0.0	329.3	55.1	182
240 min Summer	18.130	0.0	348.4	63.2	242
360 min Summer	13.031	0.0	375.1	73.9	360
480 min Summer	10.316	0.0	395.3	81.3	430
600 min Summer	8.601	0.0	410.9	86.7	488
720 min Summer	7.410	0.0	423.5	90.6	550
960 min Summer	5.854	0.0	441.3	95.7	676
1440 min Summer	4.194	0.0	445.3	99.2	954
2160 min Summer	3.001	0.0	524.7	94.5	1364
2880 min Summer	2.364	0.0	550.8	80.8	1784
4320 min Summer	1.688	0.0	586.9	56.6	2592
5760 min Summer	1.328	0.0	620.7	34.4	3400
7200 min Summer	1.102	0.0	643.7	12.6	4256
8640 min Summer	0.946	0.0	662.7	0.0	5184
10080 min Summer	0.831	0.0	678.4	0.0	5952
15 min Winter	133.985	0.0	165.3	0.0	19
30 min Winter	86.337	0.0	188.5	14.3	33
60 min Winter	52.933	0.0	285.2	36.7	62
120 min Winter	31.380	0.0	338.0	61.0	120
180 min Winter	22.833	0.0	368.7	75.2	178

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.982	0.982	0.0	2.8	2.9	5.7	349.8	Flood Risk
360 min Winter	100.000	1.000	0.0	2.9	2.9	5.8	356.2	Flood Risk
480 min Winter	99.999	0.999	0.0	2.9	2.9	5.8	355.9	Flood Risk
600 min Winter	99.988	0.988	0.0	2.9	2.9	5.7	352.1	Flood Risk
720 min Winter	99.981	0.981	0.0	2.8	2.9	5.7	349.4	Flood Risk
960 min Winter	99.961	0.961	0.0	2.8	2.8	5.6	342.4	Flood Risk
1440 min Winter	99.910	0.910	0.0	2.7	2.6	5.4	324.2	Flood Risk
2160 min Winter	99.831	0.831	0.0	2.6	2.3	5.0	296.1	Flood Risk
2880 min Winter	99.762	0.762	0.0	2.5	2.1	4.6	271.6	Flood Risk
4320 min Winter	99.659	0.659	0.0	2.4	1.6	3.9	234.8	O K
5760 min Winter	99.589	0.589	0.0	2.3	1.1	3.3	209.9	O K
7200 min Winter	99.544	0.544	0.0	2.2	0.5	2.7	193.8	O K
8640 min Winter	99.480	0.480	0.0	2.1	0.0	2.1	171.1	O K
10080 min Winter	99.392	0.392	0.0	2.1	0.0	2.1	139.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	18.130	0.0	390.0	84.8	236
360 min Winter	13.031	0.0	419.7	97.5	348
480 min Winter	10.316	0.0	441.9	106.6	454
600 min Winter	8.601	0.0	458.8	113.2	542
720 min Winter	7.410	0.0	472.0	118.2	568
960 min Winter	5.854	0.0	487.8	125.0	722
1440 min Winter	4.194	0.0	487.7	130.8	1024
2160 min Winter	3.001	0.0	587.8	129.2	1468
2880 min Winter	2.364	0.0	617.1	118.0	1900
4320 min Winter	1.688	0.0	656.7	83.8	2724
5760 min Winter	1.328	0.0	695.2	50.6	3568
7200 min Winter	1.102	0.0	721.0	16.6	4472
8640 min Winter	0.946	0.0	742.5	0.0	5536
10080 min Winter	0.831	0.0	760.3	0.0	6360

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.650

Time (mins) From:	To:	Area (ha)
0	4	0.650

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	375.0	0.0	1.000	375.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0076-2100-0500-2100
Design Head (m)	0.500
Design Flow (l/s)	2.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	76
Invert Level (m)	99.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	2.1	Kick-Flo®	0.345	1.8
Flush-Flo™	0.150	2.1	Mean Flow over Head Range	-	1.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	0.800	2.6	2.000	4.0	4.000	5.5	7.000	7.2
0.200	2.1	1.000	2.9	2.200	4.1	4.500	5.8	7.500	7.4
0.300	1.9	1.200	3.1	2.400	4.3	5.000	6.1	8.000	7.7
0.400	1.9	1.400	3.4	2.600	4.5	5.500	6.4	8.500	7.9
0.500	2.1	1.600	3.6	3.000	4.8	6.000	6.6	9.000	8.1
0.600	2.3	1.800	3.8	3.500	5.1	6.500	6.9	9.500	8.4

Orifice Overflow Control

Diameter (m) 0.045 Discharge Coefficient 0.600 Invert Level (m) 99.500

Summary of Results for 2 year Return Period

Half Drain Time : 154 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.339	0.339	0.0	16.3	0.0	16.3	161.2	O K
30 min Summer	98.420	0.420	0.0	16.3	0.0	16.3	199.4	O K
60 min Summer	98.486	0.486	0.0	16.3	0.0	16.3	231.0	O K
120 min Summer	98.519	0.519	0.0	16.3	0.0	16.3	246.7	O K
180 min Summer	98.522	0.522	0.0	16.3	0.0	16.3	247.9	O K
240 min Summer	98.518	0.518	0.0	16.3	0.0	16.3	246.0	O K
360 min Summer	98.499	0.499	0.0	16.3	0.0	16.3	236.9	O K
480 min Summer	98.470	0.470	0.0	16.3	0.0	16.3	223.5	O K
600 min Summer	98.439	0.439	0.0	16.3	0.0	16.3	208.4	O K
720 min Summer	98.408	0.408	0.0	16.3	0.0	16.3	193.7	O K
960 min Summer	98.351	0.351	0.0	16.3	0.0	16.3	166.7	O K
1440 min Summer	98.263	0.263	0.0	16.3	0.0	16.3	125.0	O K
2160 min Summer	98.190	0.190	0.0	15.8	0.0	15.8	90.3	O K
2880 min Summer	98.163	0.163	0.0	13.6	0.0	13.6	77.3	O K
4320 min Summer	98.134	0.134	0.0	10.5	0.0	10.5	63.7	O K
5760 min Summer	98.118	0.118	0.0	8.6	0.0	8.6	55.9	O K
7200 min Summer	98.107	0.107	0.0	7.3	0.0	7.3	50.6	O K
8640 min Summer	98.098	0.098	0.0	6.3	0.0	6.3	46.8	O K
10080 min Summer	98.092	0.092	0.0	5.7	0.0	5.7	43.7	O K
15 min Winter	98.382	0.382	0.0	16.3	0.0	16.3	181.5	O K
30 min Winter	98.475	0.475	0.0	16.3	0.0	16.3	225.5	O K
60 min Winter	98.550	0.550	0.0	16.3	0.0	16.3	261.4	O K
120 min Winter	98.592	0.592	0.0	16.3	0.0	16.3	281.0	O K
180 min Winter	98.590	0.590	0.0	16.3	0.0	16.3	280.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	41.734	0.0	167.9	0.0	18
30 min Summer	26.594	0.0	214.8	0.0	32
60 min Summer	16.285	0.0	265.7	0.0	62
120 min Summer	9.752	0.0	318.5	0.0	116
180 min Summer	7.183	0.0	352.1	0.0	144
240 min Summer	5.773	0.0	377.4	0.0	176
360 min Summer	4.234	0.0	415.3	0.0	246
480 min Summer	3.389	0.0	443.4	0.0	314
600 min Summer	2.851	0.0	466.3	0.0	380
720 min Summer	2.475	0.0	485.8	0.0	442
960 min Summer	1.980	0.0	518.0	0.0	568
1440 min Summer	1.445	0.0	566.8	0.0	806
2160 min Summer	1.055	0.0	622.5	0.0	1128
2880 min Summer	0.844	0.0	663.7	0.0	1496
4320 min Summer	0.616	0.0	725.3	0.0	2204
5760 min Summer	0.492	0.0	775.4	0.0	2936
7200 min Summer	0.414	0.0	814.6	0.0	3672
8640 min Summer	0.359	0.0	848.0	0.0	4408
10080 min Summer	0.319	0.0	876.6	0.0	5136
15 min Winter	41.734	0.0	188.4	0.0	18
30 min Winter	26.594	0.0	240.9	0.0	32
60 min Winter	16.285	0.0	297.8	0.0	60
120 min Winter	9.752	0.0	356.9	0.0	116
180 min Winter	7.183	0.0	394.5	0.0	164

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 2
Date 16/12/2015 15:40 File 0031-SW-03-A-PH2 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	98.582	0.582	0.0	16.3	0.0	16.3	276.6	O K
360 min Winter	98.552	0.552	0.0	16.3	0.0	16.3	262.4	O K
480 min Winter	98.511	0.511	0.0	16.3	0.0	16.3	242.8	O K
600 min Winter	98.463	0.463	0.0	16.3	0.0	16.3	219.9	O K
720 min Winter	98.413	0.413	0.0	16.3	0.0	16.3	196.1	O K
960 min Winter	98.325	0.325	0.0	16.3	0.0	16.3	154.6	O K
1440 min Winter	98.210	0.210	0.0	16.0	0.0	16.0	99.7	O K
2160 min Winter	98.158	0.158	0.0	13.1	0.0	13.1	74.8	O K
2880 min Winter	98.136	0.136	0.0	10.7	0.0	10.7	64.5	O K
4320 min Winter	98.112	0.112	0.0	7.9	0.0	7.9	53.1	O K
5760 min Winter	98.098	0.098	0.0	6.3	0.0	6.3	46.6	O K
7200 min Winter	98.089	0.089	0.0	5.3	0.0	5.3	42.3	O K
8640 min Winter	98.082	0.082	0.0	4.6	0.0	4.6	39.0	O K
10080 min Winter	98.077	0.077	0.0	4.1	0.0	4.1	36.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	5.773	0.0	422.9	0.0	188
360 min Winter	4.234	0.0	465.4	0.0	264
480 min Winter	3.389	0.0	496.8	0.0	340
600 min Winter	2.851	0.0	522.4	0.0	414
720 min Winter	2.475	0.0	544.3	0.0	478
960 min Winter	1.980	0.0	580.5	0.0	598
1440 min Winter	1.445	0.0	635.1	0.0	810
2160 min Winter	1.055	0.0	697.4	0.0	1144
2880 min Winter	0.844	0.0	743.5	0.0	1500
4320 min Winter	0.616	0.0	812.8	0.0	2208
5760 min Winter	0.492	0.0	868.5	0.0	2944
7200 min Winter	0.414	0.0	912.5	0.0	3664
8640 min Winter	0.359	0.0	950.0	0.0	4408
10080 min Winter	0.319	0.0	982.3	0.0	5120

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 2.190

Time (mins) From:	To:	Area (ha)
0	4	2.190

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	500.0	0.0	2.000	500.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0186-1640-0600-1640
Design Head (m)	0.600
Design Flow (l/s)	16.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	186
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	16.3	Kick-Flo®	0.478	14.7
Flush-Flo™	0.278	16.3	Mean Flow over Head Range	-	12.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.5	0.800	18.7	2.000	29.0	4.000	40.5	7.000	52.9
0.200	15.9	1.000	20.8	2.200	30.4	4.500	42.9	7.500	54.8
0.300	16.3	1.200	22.7	2.400	31.7	5.000	45.2	8.000	56.6
0.400	15.7	1.400	24.5	2.600	32.9	5.500	47.3	8.500	58.4
0.500	15.0	1.600	26.1	3.000	35.3	6.000	49.3	9.000	60.1
0.600	16.3	1.800	27.6	3.500	38.0	6.500	51.0	9.500	61.8

Orifice Overflow Control

Diameter (m) 0.110 Discharge Coefficient 0.600 Invert Level (m) 98.600

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

Half Drain Time : 254 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.725	0.725	0.0	17.9	5.8	23.6	344.2	O K
30 min Summer	98.893	0.893	0.0	19.7	12.3	32.1	424.2	O K
60 min Summer	99.019	1.019	0.0	21.0	15.2	36.3	484.2	O K
120 min Summer	99.070	1.070	0.0	21.5	16.3	37.8	508.1	O K
180 min Summer	99.074	1.074	0.0	21.5	16.3	37.9	510.1	O K
240 min Summer	99.064	1.064	0.0	21.4	16.2	37.6	505.6	O K
360 min Summer	99.028	1.028	0.0	21.1	15.4	36.5	488.1	O K
480 min Summer	98.986	0.986	0.0	20.7	14.5	35.2	468.2	O K
600 min Summer	98.944	0.944	0.0	20.3	13.6	33.8	448.4	O K
720 min Summer	98.905	0.905	0.0	19.9	12.6	32.5	429.9	O K
960 min Summer	98.837	0.837	0.0	19.1	10.8	29.9	397.7	O K
1440 min Summer	98.741	0.741	0.0	18.0	6.9	25.0	351.8	O K
2160 min Summer	98.632	0.632	0.0	16.7	0.5	17.2	300.1	O K
2880 min Summer	98.490	0.490	0.0	16.3	0.0	16.3	232.7	O K
4320 min Summer	98.259	0.259	0.0	16.3	0.0	16.3	122.9	O K
5760 min Summer	98.182	0.182	0.0	15.4	0.0	15.4	86.5	O K
7200 min Summer	98.158	0.158	0.0	13.2	0.0	13.2	75.1	O K
8640 min Summer	98.142	0.142	0.0	11.4	0.0	11.4	67.6	O K
10080 min Summer	98.131	0.131	0.0	10.1	0.0	10.1	62.3	O K
15 min Winter	98.810	0.810	0.0	18.8	10.0	28.8	384.9	O K
30 min Winter	99.003	1.003	0.0	20.9	14.9	35.8	476.5	O K
60 min Winter	99.151	1.151	0.0	22.3	17.8	40.1	546.8	O K
120 min Winter	99.213	1.213	0.0	22.8	18.9	41.7	576.3	O K
180 min Winter	99.212	1.212	0.0	22.8	18.8	41.7	575.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	87.227	0.0	354.1	7.7	18
30 min Summer	55.777	0.0	453.8	41.9	32
60 min Summer	34.065	0.0	557.6	80.6	62
120 min Summer	20.201	0.0	661.7	118.1	104
180 min Summer	14.736	0.0	724.1	137.0	134
240 min Summer	11.736	0.0	769.1	147.6	168
360 min Summer	8.483	0.0	833.9	156.2	236
480 min Summer	6.739	0.0	883.3	154.1	306
600 min Summer	5.634	0.0	923.0	143.0	374
720 min Summer	4.865	0.0	956.5	130.4	440
960 min Summer	3.858	0.0	1011.3	106.4	576
1440 min Summer	2.780	0.0	1092.6	58.4	838
2160 min Summer	2.001	0.0	1181.7	2.6	1260
2880 min Summer	1.584	0.0	1246.9	0.0	1668
4320 min Summer	1.138	0.0	1343.0	0.0	2292
5760 min Summer	0.900	0.0	1418.2	0.0	2944
7200 min Summer	0.750	0.0	1476.9	0.0	3672
8640 min Summer	0.646	0.0	1526.2	0.0	4408
10080 min Summer	0.569	0.0	1568.1	0.0	5136
15 min Winter	87.227	0.0	397.0	21.9	18
30 min Winter	55.777	0.0	508.7	64.7	32
60 min Winter	34.065	0.0	624.7	110.6	60
120 min Winter	20.201	0.0	741.3	155.2	114
180 min Winter	14.736	0.0	811.2	178.0	140

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 2
Date 16/12/2015 15:39 File 0031-SW-03-A-PH2 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.194	1.194	0.0	22.7	18.5	41.2	567.1	O K
360 min Winter	99.135	1.135	0.0	22.1	17.5	39.6	539.0	O K
480 min Winter	99.071	1.071	0.0	21.5	16.3	37.8	508.7	O K
600 min Winter	99.010	1.010	0.0	20.9	15.1	36.0	479.8	O K
720 min Winter	98.955	0.955	0.0	20.4	13.8	34.2	453.5	O K
960 min Winter	98.862	0.862	0.0	19.4	11.5	30.9	409.3	O K
1440 min Winter	98.739	0.739	0.0	18.0	6.8	24.8	350.9	O K
2160 min Winter	98.583	0.583	0.0	16.3	0.0	16.3	277.1	O K
2880 min Winter	98.335	0.335	0.0	16.3	0.0	16.3	159.3	O K
4320 min Winter	98.172	0.172	0.0	14.5	0.0	14.5	81.5	O K
5760 min Winter	98.143	0.143	0.0	11.5	0.0	11.5	68.1	O K
7200 min Winter	98.127	0.127	0.0	9.7	0.0	9.7	60.4	O K
8640 min Winter	98.116	0.116	0.0	8.3	0.0	8.3	55.0	O K
10080 min Winter	98.107	0.107	0.0	7.3	0.0	7.3	51.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	11.736	0.0	861.6	191.4	180
360 min Winter	8.483	0.0	934.2	203.6	254
480 min Winter	6.739	0.0	989.5	205.7	326
600 min Winter	5.634	0.0	1034.0	198.9	398
720 min Winter	4.865	0.0	1071.6	183.5	468
960 min Winter	3.858	0.0	1132.9	148.5	604
1440 min Winter	2.780	0.0	1223.9	74.3	880
2160 min Winter	2.001	0.0	1323.7	0.0	1360
2880 min Winter	1.584	0.0	1396.7	0.0	1676
4320 min Winter	1.138	0.0	1504.6	0.0	2244
5760 min Winter	0.900	0.0	1588.5	0.0	2944
7200 min Winter	0.750	0.0	1654.3	0.0	3672
8640 min Winter	0.646	0.0	1709.6	0.0	4408
10080 min Winter	0.569	0.0	1756.8	0.0	5144

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 2.190

Time (mins) From:	To:	Area (ha)
0	4	2.190

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	500.0	0.0	2.000	500.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0186-1640-0600-1640
Design Head (m)	0.600
Design Flow (l/s)	16.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	186
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	16.3	Kick-Flo®	0.478	14.7
Flush-Flo™	0.278	16.3	Mean Flow over Head Range	-	12.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.5	0.800	18.7	2.000	29.0	4.000	40.5	7.000	52.9
0.200	15.9	1.000	20.8	2.200	30.4	4.500	42.9	7.500	54.8
0.300	16.3	1.200	22.7	2.400	31.7	5.000	45.2	8.000	56.6
0.400	15.7	1.400	24.5	2.600	32.9	5.500	47.3	8.500	58.4
0.500	15.0	1.600	26.1	3.000	35.3	6.000	49.3	9.000	60.1
0.600	16.3	1.800	27.6	3.500	38.0	6.500	51.0	9.500	61.8

Orifice Overflow Control

Diameter (m) 0.110 Discharge Coefficient 0.600 Invert Level (m) 98.600

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

Half Drain Time : 328 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.110	1.110	0.0	21.9	17.0	38.9	527.3	O K
30 min Summer	99.387	1.387	0.0	24.3	21.6	46.0	658.9	O K
60 min Summer	99.604	1.604	0.0	26.1	24.6	50.7	761.8	O K
120 min Summer	99.700	1.700	0.0	26.8	25.8	52.7	807.3	O K
180 min Summer	99.706	1.706	0.0	26.9	25.9	52.8	810.5	Flood Risk
240 min Summer	99.691	1.691	0.0	26.8	25.7	52.5	803.3	O K
360 min Summer	99.631	1.631	0.0	26.3	25.0	51.3	774.9	O K
480 min Summer	99.564	1.564	0.0	25.8	24.1	49.9	742.9	O K
600 min Summer	99.495	1.495	0.0	25.2	23.1	48.4	709.9	O K
720 min Summer	99.428	1.428	0.0	24.7	22.2	46.9	678.3	O K
960 min Summer	99.309	1.309	0.0	23.7	20.4	44.1	621.9	O K
1440 min Summer	99.124	1.124	0.0	22.0	17.3	39.3	534.1	O K
2160 min Summer	98.938	0.938	0.0	20.2	13.4	33.6	445.5	O K
2880 min Summer	98.816	0.816	0.0	18.9	10.1	29.0	387.5	O K
4320 min Summer	98.678	0.678	0.0	17.3	2.8	20.1	322.0	O K
5760 min Summer	98.491	0.491	0.0	16.3	0.0	16.3	233.1	O K
7200 min Summer	98.284	0.284	0.0	16.3	0.0	16.3	135.1	O K
8640 min Summer	98.201	0.201	0.0	15.9	0.0	15.9	95.6	O K
10080 min Summer	98.174	0.174	0.0	14.7	0.0	14.7	82.7	O K
15 min Winter	99.245	1.245	0.0	23.1	19.4	42.5	591.5	O K
30 min Winter	99.561	1.561	0.0	25.8	24.0	49.8	741.4	O K
60 min Winter	99.812	1.812	0.0	27.7	27.2	54.8	860.7	Flood Risk
120 min Winter	99.936	1.936	0.0	28.6	28.6	57.2	919.7	Flood Risk
180 min Winter	99.929	1.929	0.0	28.5	28.5	57.0	916.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	133.985	0.0	545.8	83.4	18
30 min Summer	86.337	0.0	704.3	154.6	33
60 min Summer	52.933	0.0	867.4	227.3	62
120 min Summer	31.380	0.0	1028.8	297.1	110
180 min Summer	22.833	0.0	1123.0	333.5	140
240 min Summer	18.130	0.0	1189.0	355.5	172
360 min Summer	13.031	0.0	1282.0	379.4	240
480 min Summer	10.316	0.0	1353.3	391.6	308
600 min Summer	8.601	0.0	1410.3	395.8	376
720 min Summer	7.410	0.0	1458.1	394.0	442
960 min Summer	5.854	0.0	1535.7	368.7	578
1440 min Summer	4.194	0.0	1649.9	313.7	836
2160 min Summer	3.001	0.0	1773.0	240.1	1208
2880 min Summer	2.364	0.0	1862.4	167.3	1584
4320 min Summer	1.688	0.0	1993.1	32.4	2380
5760 min Summer	1.328	0.0	2093.0	0.0	3224
7200 min Summer	1.102	0.0	2170.9	0.0	3816
8640 min Summer	0.946	0.0	2235.9	0.0	4416
10080 min Summer	0.831	0.0	2291.0	0.0	5136
15 min Winter	133.985	0.0	611.7	113.3	18
30 min Winter	86.337	0.0	789.3	195.6	32
60 min Winter	52.933	0.0	971.7	279.5	60
120 min Winter	31.380	0.0	1152.5	360.6	116
180 min Winter	22.833	0.0	1258.0	403.8	146

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 2
Date 16/12/2015 15:38 File 0031-SW-03-A-PH2 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.903	1.903	0.0	28.3	28.2	56.5	904.0	Flood Risk
360 min Winter	99.811	1.811	0.0	27.7	27.2	54.8	860.0	Flood Risk
480 min Winter	99.709	1.709	0.0	26.9	25.9	52.8	811.9	Flood Risk
600 min Winter	99.609	1.609	0.0	26.1	24.7	50.8	764.1	O K
720 min Winter	99.514	1.514	0.0	25.4	23.4	48.8	719.2	O K
960 min Winter	99.349	1.349	0.0	24.0	21.0	45.1	640.8	O K
1440 min Winter	99.105	1.105	0.0	21.8	16.9	38.8	525.1	O K
2160 min Winter	98.883	0.883	0.0	19.6	12.1	31.7	419.2	O K
2880 min Winter	98.759	0.759	0.0	18.3	8.1	26.4	360.4	O K
4320 min Winter	98.571	0.571	0.0	16.3	0.0	16.3	271.3	O K
5760 min Winter	98.225	0.225	0.0	16.1	0.0	16.1	107.0	O K
7200 min Winter	98.168	0.168	0.0	14.2	0.0	14.2	79.9	O K
8640 min Winter	98.149	0.149	0.0	12.2	0.0	12.2	70.8	O K
10080 min Winter	98.136	0.136	0.0	10.7	0.0	10.7	64.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	18.130	0.0	1331.9	430.7	182
360 min Winter	13.031	0.0	1436.1	461.3	258
480 min Winter	10.316	0.0	1515.9	478.4	332
600 min Winter	8.601	0.0	1579.8	486.3	404
720 min Winter	7.410	0.0	1633.3	487.7	474
960 min Winter	5.854	0.0	1720.3	472.8	608
1440 min Winter	4.194	0.0	1848.1	396.8	866
2160 min Winter	3.001	0.0	1985.9	283.2	1252
2880 min Winter	2.364	0.0	2086.1	162.5	1616
4320 min Winter	1.688	0.0	2232.7	0.0	2592
5760 min Winter	1.328	0.0	2344.3	0.0	3112
7200 min Winter	1.102	0.0	2431.6	0.0	3672
8640 min Winter	0.946	0.0	2504.4	0.0	4400
10080 min Winter	0.831	0.0	2566.4	0.0	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 2.190

Time (mins) From:	To:	Area (ha)
0	4	2.190

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	500.0	0.0	2.000	500.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0186-1640-0600-1640
Design Head (m)	0.600
Design Flow (l/s)	16.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	186
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	16.3	Kick-Flo®	0.478	14.7
Flush-Flo™	0.278	16.3	Mean Flow over Head Range	-	12.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.5	0.800	18.7	2.000	29.0	4.000	40.5	7.000	52.9
0.200	15.9	1.000	20.8	2.200	30.4	4.500	42.9	7.500	54.8
0.300	16.3	1.200	22.7	2.400	31.7	5.000	45.2	8.000	56.6
0.400	15.7	1.400	24.5	2.600	32.9	5.500	47.3	8.500	58.4
0.500	15.0	1.600	26.1	3.000	35.3	6.000	49.3	9.000	60.1
0.600	16.3	1.800	27.6	3.500	38.0	6.500	51.0	9.500	61.8

Orifice Overflow Control

Diameter (m) 0.110 Discharge Coefficient 0.600 Invert Level (m) 98.600

Summary of Results for 2 year Return Period

Half Drain Time : 92 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.373	0.373	0.0	4.6	0.0	4.6	30.1	O K
30 min Summer	98.453	0.453	0.0	4.6	0.0	4.6	36.6	O K
60 min Summer	98.505	0.505	0.0	4.6	0.0	4.6	40.8	O K
120 min Summer	98.507	0.507	0.0	4.6	0.0	4.6	41.0	O K
180 min Summer	98.490	0.490	0.0	4.6	0.0	4.6	39.6	O K
240 min Summer	98.464	0.464	0.0	4.6	0.0	4.6	37.5	O K
360 min Summer	98.408	0.408	0.0	4.6	0.0	4.6	33.0	O K
480 min Summer	98.355	0.355	0.0	4.6	0.0	4.6	28.6	O K
600 min Summer	98.306	0.306	0.0	4.6	0.0	4.6	24.7	O K
720 min Summer	98.264	0.264	0.0	4.6	0.0	4.6	21.3	O K
960 min Summer	98.198	0.198	0.0	4.6	0.0	4.6	16.0	O K
1440 min Summer	98.127	0.127	0.0	4.4	0.0	4.4	10.3	O K
2160 min Summer	98.098	0.098	0.0	3.5	0.0	3.5	7.9	O K
2880 min Summer	98.083	0.083	0.0	2.9	0.0	2.9	6.7	O K
4320 min Summer	98.068	0.068	0.0	2.1	0.0	2.1	5.5	O K
5760 min Summer	98.060	0.060	0.0	1.7	0.0	1.7	4.8	O K
7200 min Summer	98.054	0.054	0.0	1.4	0.0	1.4	4.4	O K
8640 min Summer	98.050	0.050	0.0	1.2	0.0	1.2	4.0	O K
10080 min Summer	98.047	0.047	0.0	1.1	0.0	1.1	3.8	O K
15 min Winter	98.421	0.421	0.0	4.6	0.0	4.6	34.0	O K
30 min Winter	98.516	0.516	0.0	4.6	0.0	4.6	41.7	O K
60 min Winter	98.577	0.577	0.0	4.6	0.0	4.6	46.6	O K
120 min Winter	98.579	0.579	0.0	4.6	0.0	4.6	46.8	O K
180 min Winter	98.556	0.556	0.0	4.6	0.0	4.6	44.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	41.734	0.0	33.1	0.0	18
30 min Summer	26.594	0.0	42.2	0.0	32
60 min Summer	16.285	0.0	51.8	0.0	60
120 min Summer	9.752	0.0	62.1	0.0	98
180 min Summer	7.183	0.0	68.6	0.0	130
240 min Summer	5.773	0.0	73.5	0.0	164
360 min Summer	4.234	0.0	80.9	0.0	230
480 min Summer	3.389	0.0	86.4	0.0	294
600 min Summer	2.851	0.0	90.8	0.0	356
720 min Summer	2.475	0.0	94.6	0.0	416
960 min Summer	1.980	0.0	100.9	0.0	530
1440 min Summer	1.445	0.0	110.4	0.0	750
2160 min Summer	1.055	0.0	121.0	0.0	1104
2880 min Summer	0.844	0.0	129.0	0.0	1468
4320 min Summer	0.616	0.0	141.2	0.0	2200
5760 min Summer	0.492	0.0	150.6	0.0	2928
7200 min Summer	0.414	0.0	158.2	0.0	3672
8640 min Summer	0.359	0.0	164.8	0.0	4368
10080 min Summer	0.319	0.0	170.5	0.0	5120
15 min Winter	41.734	0.0	37.1	0.0	18
30 min Winter	26.594	0.0	47.3	0.0	32
60 min Winter	16.285	0.0	58.1	0.0	60
120 min Winter	9.752	0.0	69.6	0.0	110
180 min Winter	7.183	0.0	76.9	0.0	138

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 3
Date 16/12/2015 15:44 File 0031-SW-04-A-PH3 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	98.522	0.522	0.0	4.6	0.0	4.6	42.2	O K
360 min Winter	98.435	0.435	0.0	4.6	0.0	4.6	35.1	O K
480 min Winter	98.349	0.349	0.0	4.6	0.0	4.6	28.2	O K
600 min Winter	98.275	0.275	0.0	4.6	0.0	4.6	22.2	O K
720 min Winter	98.215	0.215	0.0	4.6	0.0	4.6	17.4	O K
960 min Winter	98.139	0.139	0.0	4.5	0.0	4.5	11.2	O K
1440 min Winter	98.099	0.099	0.0	3.6	0.0	3.6	8.0	O K
2160 min Winter	98.078	0.078	0.0	2.6	0.0	2.6	6.3	O K
2880 min Winter	98.068	0.068	0.0	2.1	0.0	2.1	5.5	O K
4320 min Winter	98.056	0.056	0.0	1.5	0.0	1.5	4.5	O K
5760 min Winter	98.050	0.050	0.0	1.2	0.0	1.2	4.0	O K
7200 min Winter	98.045	0.045	0.0	1.0	0.0	1.0	3.6	O K
8640 min Winter	98.042	0.042	0.0	0.9	0.0	0.9	3.4	O K
10080 min Winter	98.039	0.039	0.0	0.8	0.0	0.8	3.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	5.773	0.0	82.4	0.0	178
360 min Winter	4.234	0.0	90.6	0.0	250
480 min Winter	3.389	0.0	96.7	0.0	314
600 min Winter	2.851	0.0	101.7	0.0	374
720 min Winter	2.475	0.0	106.0	0.0	430
960 min Winter	1.980	0.0	113.0	0.0	530
1440 min Winter	1.445	0.0	123.7	0.0	750
2160 min Winter	1.055	0.0	135.5	0.0	1104
2880 min Winter	0.844	0.0	144.5	0.0	1468
4320 min Winter	0.616	0.0	158.1	0.0	2176
5760 min Winter	0.492	0.0	168.7	0.0	2920
7200 min Winter	0.414	0.0	177.2	0.0	3672
8640 min Winter	0.359	0.0	184.6	0.0	4416
10080 min Winter	0.319	0.0	191.0	0.0	5120

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.425

Time (mins) From:	To:	Area (ha)
0	4	0.425

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	85.0	0.0	2.000	85.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0106-4700-0700-4700
Design Head (m)	0.700
Design Flow (l/s)	4.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	106
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.700	4.6	Kick-Flo®	0.477	3.9
Flush-Flo™	0.211	4.6	Mean Flow over Head Range	-	4.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	0.800	4.9	2.000	7.6	4.000	10.5	7.000	13.7
0.200	4.6	1.000	5.5	2.200	7.9	4.500	11.1	7.500	14.1
0.300	4.5	1.200	6.0	2.400	8.2	5.000	11.7	8.000	14.6
0.400	4.3	1.400	6.4	2.600	8.6	5.500	12.2	8.500	15.1
0.500	4.0	1.600	6.8	3.000	9.2	6.000	12.7	9.000	15.5
0.600	4.3	1.800	7.2	3.500	9.8	6.500	13.2	9.500	15.9

Orifice Overflow Control

Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 98.700

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

Half Drain Time : 161 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.808	0.808	0.0	5.0	2.1	7.0	65.2	O K
30 min Summer	98.975	0.975	0.0	5.4	3.7	9.1	78.8	O K
60 min Summer	99.072	1.072	0.0	5.6	4.4	10.0	86.6	O K
120 min Summer	99.092	1.092	0.0	5.7	4.5	10.2	88.2	O K
180 min Summer	99.073	1.073	0.0	5.6	4.4	10.0	86.6	O K
240 min Summer	99.040	1.040	0.0	5.6	4.2	9.8	84.0	O K
360 min Summer	98.972	0.972	0.0	5.4	3.7	9.1	78.5	O K
480 min Summer	98.913	0.913	0.0	5.2	3.2	8.5	73.7	O K
600 min Summer	98.863	0.863	0.0	5.1	2.7	7.8	69.7	O K
720 min Summer	98.822	0.822	0.0	5.0	2.3	7.3	66.4	O K
960 min Summer	98.760	0.760	0.0	4.8	1.0	5.8	61.4	O K
1440 min Summer	98.601	0.601	0.0	4.6	0.0	4.6	48.5	O K
2160 min Summer	98.327	0.327	0.0	4.6	0.0	4.6	26.4	O K
2880 min Summer	98.183	0.183	0.0	4.6	0.0	4.6	14.8	O K
4320 min Summer	98.108	0.108	0.0	3.9	0.0	3.9	8.7	O K
5760 min Summer	98.088	0.088	0.0	3.1	0.0	3.1	7.1	O K
7200 min Summer	98.078	0.078	0.0	2.6	0.0	2.6	6.3	O K
8640 min Summer	98.070	0.070	0.0	2.2	0.0	2.2	5.7	O K
10080 min Summer	98.065	0.065	0.0	2.0	0.0	2.0	5.3	O K
15 min Winter	98.903	0.903	0.0	5.2	3.1	8.3	72.9	O K
30 min Winter	99.098	1.098	0.0	5.7	4.6	10.3	88.7	O K
60 min Winter	99.218	1.218	0.0	6.0	5.2	11.2	98.4	O K
120 min Winter	99.237	1.237	0.0	6.0	5.3	11.4	99.9	O K
180 min Winter	99.206	1.206	0.0	6.0	5.2	11.1	97.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	87.227	0.0	69.4	1.9	18
30 min Summer	55.777	0.0	88.7	8.8	32
60 min Summer	34.065	0.0	108.5	16.2	60
120 min Summer	20.201	0.0	128.7	22.4	90
180 min Summer	14.736	0.0	140.8	24.7	124
240 min Summer	11.736	0.0	149.6	25.1	158
360 min Summer	8.483	0.0	162.2	22.0	228
480 min Summer	6.739	0.0	171.8	18.1	296
600 min Summer	5.634	0.0	179.5	14.5	362
720 min Summer	4.865	0.0	186.0	10.9	432
960 min Summer	3.858	0.0	196.7	3.7	570
1440 min Summer	2.780	0.0	212.5	0.0	852
2160 min Summer	2.001	0.0	229.5	0.0	1192
2880 min Summer	1.584	0.0	242.2	0.0	1524
4320 min Summer	1.138	0.0	261.1	0.0	2204
5760 min Summer	0.900	0.0	275.3	0.0	2936
7200 min Summer	0.750	0.0	286.8	0.0	3672
8640 min Summer	0.646	0.0	296.4	0.0	4400
10080 min Summer	0.569	0.0	304.7	0.0	5072
15 min Winter	87.227	0.0	77.7	5.0	18
30 min Winter	55.777	0.0	99.4	13.7	31
60 min Winter	34.065	0.0	121.5	22.5	58
120 min Winter	20.201	0.0	144.2	30.2	94
180 min Winter	14.736	0.0	157.7	33.3	132

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 3
Date 16/12/2015 15:43 File 0031-SW-04-A-PH3 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.157	1.157	0.0	5.8	4.9	10.8	93.4	O K
360 min Winter	99.055	1.055	0.0	5.6	4.3	9.9	85.2	O K
480 min Winter	98.970	0.970	0.0	5.4	3.7	9.1	78.3	O K
600 min Winter	98.900	0.900	0.0	5.2	3.1	8.3	72.7	O K
720 min Winter	98.844	0.844	0.0	5.1	2.5	7.6	68.2	O K
960 min Winter	98.765	0.765	0.0	4.8	1.2	6.0	61.8	O K
1440 min Winter	98.529	0.529	0.0	4.6	0.0	4.6	42.7	O K
2160 min Winter	98.171	0.171	0.0	4.6	0.0	4.6	13.8	O K
2880 min Winter	98.109	0.109	0.0	3.9	0.0	3.9	8.8	O K
4320 min Winter	98.083	0.083	0.0	2.9	0.0	2.9	6.7	O K
5760 min Winter	98.071	0.071	0.0	2.3	0.0	2.3	5.7	O K
7200 min Winter	98.063	0.063	0.0	1.9	0.0	1.9	5.1	O K
8640 min Winter	98.058	0.058	0.0	1.6	0.0	1.6	4.7	O K
10080 min Winter	98.054	0.054	0.0	1.4	0.0	1.4	4.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	11.736	0.0	167.5	34.3	170
360 min Winter	8.483	0.0	181.6	32.8	242
480 min Winter	6.739	0.0	192.4	27.6	314
600 min Winter	5.634	0.0	201.0	22.4	382
720 min Winter	4.865	0.0	208.3	17.0	454
960 min Winter	3.858	0.0	220.3	5.7	604
1440 min Winter	2.780	0.0	238.0	0.0	922
2160 min Winter	2.001	0.0	257.1	0.0	1188
2880 min Winter	1.584	0.0	271.3	0.0	1472
4320 min Winter	1.138	0.0	292.4	0.0	2188
5760 min Winter	0.900	0.0	308.4	0.0	2904
7200 min Winter	0.750	0.0	321.2	0.0	3584
8640 min Winter	0.646	0.0	332.0	0.0	4400
10080 min Winter	0.569	0.0	341.3	0.0	5128

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.425

Time (mins) From:	To:	Area (ha)
0	4	0.425

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	85.0	0.0	2.000	85.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0106-4700-0700-4700
Design Head (m)	0.700
Design Flow (l/s)	4.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	106
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.700	4.6	Kick-Flo®	0.477	3.9
Flush-Flo™	0.211	4.6	Mean Flow over Head Range	-	4.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	0.800	4.9	2.000	7.6	4.000	10.5	7.000	13.7
0.200	4.6	1.000	5.5	2.200	7.9	4.500	11.1	7.500	14.1
0.300	4.5	1.200	6.0	2.400	8.2	5.000	11.7	8.000	14.6
0.400	4.3	1.400	6.4	2.600	8.6	5.500	12.2	8.500	15.1
0.500	4.0	1.600	6.8	3.000	9.2	6.000	12.7	9.000	15.5
0.600	4.3	1.800	7.2	3.500	9.8	6.500	13.2	9.500	15.9

Orifice Overflow Control

Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 98.700

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 3
Date 16/12/2015 15:42 File 0031-SW-04-A-PH3 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Half Drain Time : 228 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.238	1.238	0.0	6.0	5.4	11.4	99.9	O K
30 min Summer	99.520	1.520	0.0	6.6	6.7	13.3	122.8	O K
60 min Summer	99.702	1.702	0.0	7.0	7.4	14.4	137.4	Flood Risk
120 min Summer	99.749	1.749	0.0	7.1	7.6	14.7	141.2	Flood Risk
180 min Summer	99.727	1.727	0.0	7.1	7.5	14.6	139.5	Flood Risk
240 min Summer	99.678	1.678	0.0	7.0	7.3	14.3	135.5	O K
360 min Summer	99.558	1.558	0.0	6.7	6.8	13.6	125.8	O K
480 min Summer	99.451	1.451	0.0	6.5	6.4	12.9	117.2	O K
600 min Summer	99.358	1.358	0.0	6.3	6.0	12.3	109.7	O K
720 min Summer	99.278	1.278	0.0	6.1	5.6	11.7	103.2	O K
960 min Summer	99.146	1.146	0.0	5.8	4.8	10.7	92.5	O K
1440 min Summer	98.962	0.962	0.0	5.4	3.6	9.0	77.7	O K
2160 min Summer	98.802	0.802	0.0	4.9	2.0	6.9	64.8	O K
2880 min Summer	98.693	0.693	0.0	4.6	0.0	4.6	56.0	O K
4320 min Summer	98.277	0.277	0.0	4.6	0.0	4.6	22.4	O K
5760 min Summer	98.133	0.133	0.0	4.5	0.0	4.5	10.7	O K
7200 min Summer	98.106	0.106	0.0	3.8	0.0	3.8	8.5	O K
8640 min Summer	98.092	0.092	0.0	3.3	0.0	3.3	7.4	O K
10080 min Summer	98.083	0.083	0.0	2.9	0.0	2.9	6.7	O K
15 min Winter	99.390	1.390	0.0	6.4	6.1	12.5	112.2	O K
30 min Winter	99.715	1.715	0.0	7.0	7.5	14.5	138.5	Flood Risk
60 min Winter	99.934	1.934	0.0	7.4	8.2	15.7	156.2	Flood Risk
120 min Winter	99.982	1.982	0.0	7.5	8.4	15.9	160.0	Flood Risk
180 min Winter	99.942	1.942	0.0	7.5	8.3	15.7	156.9	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	133.985	0.0	106.6	18.0	18
30 min Summer	86.337	0.0	137.4	32.5	32
60 min Summer	52.933	0.0	168.7	46.8	60
120 min Summer	31.380	0.0	200.0	59.8	92
180 min Summer	22.833	0.0	218.3	65.7	126
240 min Summer	18.130	0.0	231.1	68.6	160
360 min Summer	13.031	0.0	249.1	70.2	228
480 min Summer	10.316	0.0	263.0	69.0	296
600 min Summer	8.601	0.0	274.1	64.4	362
720 min Summer	7.410	0.0	283.4	60.1	426
960 min Summer	5.854	0.0	298.5	52.4	556
1440 min Summer	4.194	0.0	320.7	37.8	808
2160 min Summer	3.001	0.0	344.3	16.0	1192
2880 min Summer	2.364	0.0	361.7	0.0	1644
4320 min Summer	1.688	0.0	387.2	0.0	2296
5760 min Summer	1.328	0.0	406.3	0.0	2936
7200 min Summer	1.102	0.0	421.5	0.0	3672
8640 min Summer	0.946	0.0	434.1	0.0	4360
10080 min Summer	0.831	0.0	445.0	0.0	5136
15 min Winter	133.985	0.0	119.4	24.2	18
30 min Winter	86.337	0.0	153.9	41.1	32
60 min Winter	52.933	0.0	188.9	57.8	60
120 min Winter	31.380	0.0	224.0	73.2	96
180 min Winter	22.833	0.0	244.5	80.6	134

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 3
Date 16/12/2015 15:42 File 0031-SW-04-A-PH3 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.868	1.868	0.0	7.3	8.0	15.3	150.8	Flood Risk
360 min Winter	99.697	1.697	0.0	7.0	7.4	14.4	137.0	O K
480 min Winter	99.544	1.544	0.0	6.7	6.8	13.5	124.7	O K
600 min Winter	99.414	1.414	0.0	6.4	6.2	12.6	114.2	O K
720 min Winter	99.305	1.305	0.0	6.2	5.7	11.9	105.4	O K
960 min Winter	99.134	1.134	0.0	5.8	4.8	10.6	91.6	O K
1440 min Winter	98.918	0.918	0.0	5.3	3.3	8.5	74.1	O K
2160 min Winter	98.765	0.765	0.0	4.8	1.2	6.0	61.7	O K
2880 min Winter	98.505	0.505	0.0	4.6	0.0	4.6	40.8	O K
4320 min Winter	98.117	0.117	0.0	4.2	0.0	4.2	9.5	O K
5760 min Winter	98.093	0.093	0.0	3.3	0.0	3.3	7.5	O K
7200 min Winter	98.081	0.081	0.0	2.8	0.0	2.8	6.5	O K
8640 min Winter	98.073	0.073	0.0	2.4	0.0	2.4	5.9	O K
10080 min Winter	98.067	0.067	0.0	2.1	0.0	2.1	5.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	18.130	0.0	258.8	84.5	172
360 min Winter	13.031	0.0	279.1	87.4	246
480 min Winter	10.316	0.0	294.6	87.2	314
600 min Winter	8.601	0.0	307.0	84.3	384
720 min Winter	7.410	0.0	317.4	78.4	448
960 min Winter	5.854	0.0	334.3	67.3	578
1440 min Winter	4.194	0.0	359.2	44.5	836
2160 min Winter	3.001	0.0	385.6	9.8	1256
2880 min Winter	2.364	0.0	405.1	0.0	1760
4320 min Winter	1.688	0.0	433.7	0.0	2204
5760 min Winter	1.328	0.0	455.0	0.0	2928
7200 min Winter	1.102	0.0	472.0	0.0	3672
8640 min Winter	0.946	0.0	486.2	0.0	4400
10080 min Winter	0.831	0.0	498.4	0.0	4976

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.425

Time (mins) From:	To:	Area (ha)
0	4	0.425

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	85.0	0.0	2.000	85.0	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0106-4700-0700-4700
Design Head (m)	0.700
Design Flow (l/s)	4.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	106
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.700	4.6	Kick-Flo®	0.477	3.9
Flush-Flo™	0.211	4.6	Mean Flow over Head Range	-	4.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	0.800	4.9	2.000	7.6	4.000	10.5	7.000	13.7
0.200	4.6	1.000	5.5	2.200	7.9	4.500	11.1	7.500	14.1
0.300	4.5	1.200	6.0	2.400	8.2	5.000	11.7	8.000	14.6
0.400	4.3	1.400	6.4	2.600	8.6	5.500	12.2	8.500	15.1
0.500	4.0	1.600	6.8	3.000	9.2	6.000	12.7	9.000	15.5
0.600	4.3	1.800	7.2	3.500	9.8	6.500	13.2	9.500	15.9

Orifice Overflow Control

Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 98.700

Summary of Results for 2 year Return Period

Half Drain Time : 189 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.331	0.331	0.0	10.0	0.0	10.0	121.8	O K
30 min Summer	98.411	0.411	0.0	10.0	0.0	10.0	151.4	O K
60 min Summer	98.481	0.481	0.0	10.0	0.0	10.0	177.1	O K
120 min Summer	98.526	0.526	0.0	10.0	0.0	10.0	193.5	O K
180 min Summer	98.531	0.531	0.0	10.0	0.0	10.0	195.3	O K
240 min Summer	98.528	0.528	0.0	10.0	0.0	10.0	194.5	O K
360 min Summer	98.515	0.515	0.0	10.0	0.0	10.0	189.4	O K
480 min Summer	98.493	0.493	0.0	10.0	0.0	10.0	181.5	O K
600 min Summer	98.467	0.467	0.0	10.0	0.0	10.0	171.8	O K
720 min Summer	98.440	0.440	0.0	10.0	0.0	10.0	161.9	O K
960 min Summer	98.389	0.389	0.0	10.0	0.0	10.0	143.0	O K
1440 min Summer	98.300	0.300	0.0	10.0	0.0	10.0	110.6	O K
2160 min Summer	98.210	0.210	0.0	10.0	0.0	10.0	77.3	O K
2880 min Summer	98.162	0.162	0.0	9.8	0.0	9.8	59.6	O K
4320 min Summer	98.128	0.128	0.0	7.7	0.0	7.7	47.3	O K
5760 min Summer	98.111	0.111	0.0	6.4	0.0	6.4	41.0	O K
7200 min Summer	98.100	0.100	0.0	5.4	0.0	5.4	36.9	O K
8640 min Summer	98.092	0.092	0.0	4.8	0.0	4.8	33.9	O K
10080 min Summer	98.086	0.086	0.0	4.2	0.0	4.2	31.6	O K
15 min Winter	98.372	0.372	0.0	10.0	0.0	10.0	137.0	O K
30 min Winter	98.464	0.464	0.0	10.0	0.0	10.0	170.9	O K
60 min Winter	98.544	0.544	0.0	10.0	0.0	10.0	200.3	O K
120 min Winter	98.597	0.597	0.0	10.0	0.0	10.0	219.9	O K
180 min Winter	98.606	0.606	0.0	10.0	0.0	10.0	223.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	41.734	0.0	125.9	0.0	18
30 min Summer	26.594	0.0	161.0	0.0	33
60 min Summer	16.285	0.0	199.1	0.0	62
120 min Summer	9.752	0.0	238.6	0.0	120
180 min Summer	7.183	0.0	263.8	0.0	164
240 min Summer	5.773	0.0	282.7	0.0	192
360 min Summer	4.234	0.0	311.1	0.0	258
480 min Summer	3.389	0.0	332.1	0.0	328
600 min Summer	2.851	0.0	349.3	0.0	394
720 min Summer	2.475	0.0	363.9	0.0	460
960 min Summer	1.980	0.0	388.1	0.0	588
1440 min Summer	1.445	0.0	424.6	0.0	836
2160 min Summer	1.055	0.0	466.3	0.0	1172
2880 min Summer	0.844	0.0	497.1	0.0	1500
4320 min Summer	0.616	0.0	543.4	0.0	2208
5760 min Summer	0.492	0.0	580.7	0.0	2936
7200 min Summer	0.414	0.0	610.1	0.0	3672
8640 min Summer	0.359	0.0	635.1	0.0	4408
10080 min Summer	0.319	0.0	656.6	0.0	5136
15 min Winter	41.734	0.0	141.3	0.0	18
30 min Winter	26.594	0.0	180.6	0.0	32
60 min Winter	16.285	0.0	223.1	0.0	62
120 min Winter	9.752	0.0	267.4	0.0	118
180 min Winter	7.183	0.0	295.5	0.0	172

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	98.599	0.599	0.0	10.0	0.0	10.0	220.6	O K
360 min Winter	98.579	0.579	0.0	10.0	0.0	10.0	213.3	O K
480 min Winter	98.549	0.549	0.0	10.0	0.0	10.0	202.0	O K
600 min Winter	98.513	0.513	0.0	10.0	0.0	10.0	188.9	O K
720 min Winter	98.472	0.472	0.0	10.0	0.0	10.0	173.6	O K
960 min Winter	98.389	0.389	0.0	10.0	0.0	10.0	143.0	O K
1440 min Winter	98.257	0.257	0.0	10.0	0.0	10.0	94.6	O K
2160 min Winter	98.157	0.157	0.0	9.6	0.0	9.6	57.8	O K
2880 min Winter	98.131	0.131	0.0	7.9	0.0	7.9	48.1	O K
4320 min Winter	98.105	0.105	0.0	5.9	0.0	5.9	38.8	O K
5760 min Winter	98.092	0.092	0.0	4.7	0.0	4.7	33.8	O K
7200 min Winter	98.083	0.083	0.0	4.0	0.0	4.0	30.5	O K
8640 min Winter	98.076	0.076	0.0	3.5	0.0	3.5	28.2	O K
10080 min Winter	98.071	0.071	0.0	3.1	0.0	3.1	26.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	5.773	0.0	316.8	0.0	220
360 min Winter	4.234	0.0	348.6	0.0	276
480 min Winter	3.389	0.0	372.1	0.0	354
600 min Winter	2.851	0.0	391.3	0.0	430
720 min Winter	2.475	0.0	407.7	0.0	504
960 min Winter	1.980	0.0	434.8	0.0	634
1440 min Winter	1.445	0.0	475.8	0.0	866
2160 min Winter	1.055	0.0	522.3	0.0	1164
2880 min Winter	0.844	0.0	556.9	0.0	1504
4320 min Winter	0.616	0.0	608.9	0.0	2244
5760 min Winter	0.492	0.0	650.4	0.0	2944
7200 min Winter	0.414	0.0	683.4	0.0	3680
8640 min Winter	0.359	0.0	711.5	0.0	4408
10080 min Winter	0.319	0.0	735.8	0.0	5144

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.640

Time (mins) From:	To:	Area (ha)
0	4	1.640

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	387.5	0.0	2.000	387.5	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0151-1010-0650-1010
Design Head (m)	0.650
Design Flow (l/s)	10.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	151
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.650	10.1	Kick-Flo®	0.483	8.7
Flush-Flo™	0.239	10.0	Mean Flow over Head Range	-	8.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.4	0.800	11.1	2.000	17.1	4.000	23.8	7.000	31.1
0.200	10.0	1.000	12.3	2.200	17.9	4.500	25.2	7.500	32.2
0.300	10.0	1.200	13.4	2.400	18.7	5.000	26.6	8.000	33.3
0.400	9.6	1.400	14.4	2.600	19.4	5.500	27.8	8.500	34.3
0.500	8.9	1.600	15.4	3.000	20.8	6.000	29.0	9.000	35.3
0.600	9.7	1.800	16.3	3.500	22.4	6.500	30.1	9.500	36.3

Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.650

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

Half Drain Time : 330 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.707	0.707	0.0	10.5	1.4	11.9	260.1	O K
30 min Summer	98.877	0.877	0.0	11.6	7.2	18.8	323.0	O K
60 min Summer	99.014	1.014	0.0	12.4	9.5	21.9	373.2	O K
120 min Summer	99.082	1.082	0.0	12.8	10.5	23.3	398.1	O K
180 min Summer	99.089	1.089	0.0	12.8	10.6	23.4	400.8	O K
240 min Summer	99.085	1.085	0.0	12.8	10.6	23.4	399.3	O K
360 min Summer	99.060	1.060	0.0	12.7	10.2	22.9	390.1	O K
480 min Summer	99.027	1.027	0.0	12.5	9.7	22.2	378.2	O K
600 min Summer	98.994	0.994	0.0	12.3	9.2	21.5	365.7	O K
720 min Summer	98.960	0.960	0.0	12.1	8.7	20.8	353.5	O K
960 min Summer	98.900	0.900	0.0	11.7	7.7	19.4	331.4	O K
1440 min Summer	98.807	0.807	0.0	11.1	5.7	16.8	297.2	O K
2160 min Summer	98.717	0.717	0.0	10.5	1.8	12.3	263.9	O K
2880 min Summer	98.608	0.608	0.0	10.0	0.0	10.0	223.8	O K
4320 min Summer	98.355	0.355	0.0	10.0	0.0	10.0	130.5	O K
5760 min Summer	98.213	0.213	0.0	10.0	0.0	10.0	78.5	O K
7200 min Summer	98.158	0.158	0.0	9.7	0.0	9.7	58.1	O K
8640 min Summer	98.139	0.139	0.0	8.5	0.0	8.5	51.1	O K
10080 min Summer	98.126	0.126	0.0	7.6	0.0	7.6	46.2	O K
15 min Winter	98.790	0.790	0.0	11.0	5.2	16.2	291.0	O K
30 min Winter	98.984	0.984	0.0	12.2	9.1	21.3	362.2	O K
60 min Winter	99.142	1.142	0.0	13.1	11.3	24.4	420.3	O K
120 min Winter	99.229	1.229	0.0	13.6	12.4	25.9	452.6	O K
180 min Winter	99.232	1.232	0.0	13.6	12.4	26.0	453.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	87.227	0.0	265.3	1.2	19
30 min Summer	55.777	0.0	339.8	24.1	33
60 min Summer	34.065	0.0	417.7	54.0	62
120 min Summer	20.201	0.0	495.6	84.0	118
180 min Summer	14.736	0.0	542.3	99.7	144
240 min Summer	11.736	0.0	576.0	109.0	176
360 min Summer	8.483	0.0	624.6	118.1	244
480 min Summer	6.739	0.0	661.5	120.7	314
600 min Summer	5.634	0.0	691.3	117.3	382
720 min Summer	4.865	0.0	716.4	109.1	450
960 min Summer	3.858	0.0	757.3	92.0	586
1440 min Summer	2.780	0.0	818.2	60.2	852
2160 min Summer	2.001	0.0	885.0	14.7	1276
2880 min Summer	1.584	0.0	933.9	0.0	1700
4320 min Summer	1.138	0.0	1006.0	0.0	2380
5760 min Summer	0.900	0.0	1062.1	0.0	3048
7200 min Summer	0.750	0.0	1106.1	0.0	3672
8640 min Summer	0.646	0.0	1143.0	0.0	4408
10080 min Summer	0.569	0.0	1174.5	0.0	5136
15 min Winter	87.227	0.0	297.4	9.4	18
30 min Winter	55.777	0.0	380.9	41.5	32
60 min Winter	34.065	0.0	467.9	77.4	60
120 min Winter	20.201	0.0	555.2	113.1	116
180 min Winter	14.736	0.0	607.6	132.2	148

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 4
Date 16/12/2015 15:46 File 0031-SW-05-A-PH4 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.225	1.225	0.0	13.6	12.3	25.9	450.9	O K
360 min Winter	99.185	1.185	0.0	13.3	11.8	25.2	436.2	O K
480 min Winter	99.136	1.136	0.0	13.1	11.2	24.3	418.1	O K
600 min Winter	99.085	1.085	0.0	12.8	10.6	23.4	399.4	O K
720 min Winter	99.036	1.036	0.0	12.5	9.9	22.4	381.5	O K
960 min Winter	98.951	0.951	0.0	12.0	8.6	20.6	349.9	O K
1440 min Winter	98.824	0.824	0.0	11.2	6.1	17.3	303.5	O K
2160 min Winter	98.711	0.711	0.0	10.5	1.6	12.1	261.8	O K
2880 min Winter	98.543	0.543	0.0	10.0	0.0	10.0	200.0	O K
4320 min Winter	98.203	0.203	0.0	10.0	0.0	10.0	74.8	O K
5760 min Winter	98.141	0.141	0.0	8.6	0.0	8.6	51.8	O K
7200 min Winter	98.121	0.121	0.0	7.2	0.0	7.2	44.7	O K
8640 min Winter	98.110	0.110	0.0	6.3	0.0	6.3	40.3	O K
10080 min Winter	98.101	0.101	0.0	5.5	0.0	5.5	37.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	11.736	0.0	645.3	143.8	184
360 min Winter	8.483	0.0	699.7	156.1	262
480 min Winter	6.739	0.0	741.1	161.0	336
600 min Winter	5.634	0.0	774.4	160.9	410
720 min Winter	4.865	0.0	802.5	156.2	480
960 min Winter	3.858	0.0	848.4	134.3	618
1440 min Winter	2.780	0.0	916.5	87.7	894
2160 min Winter	2.001	0.0	991.3	15.8	1360
2880 min Winter	1.584	0.0	1046.1	0.0	1816
4320 min Winter	1.138	0.0	1127.0	0.0	2376
5760 min Winter	0.900	0.0	1189.6	0.0	2944
7200 min Winter	0.750	0.0	1238.9	0.0	3672
8640 min Winter	0.646	0.0	1280.3	0.0	4400
10080 min Winter	0.569	0.0	1315.8	0.0	5144

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.640

Time (mins) From:	To:	Area (ha)
0	4	1.640

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	387.5	0.0	2.000	387.5	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0151-1010-0650-1010
Design Head (m)	0.650
Design Flow (l/s)	10.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	151
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.650	10.1	Kick-Flo®	0.483	8.7
Flush-Flo™	0.239	10.0	Mean Flow over Head Range	-	8.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.4	0.800	11.1	2.000	17.1	4.000	23.8	7.000	31.1
0.200	10.0	1.000	12.3	2.200	17.9	4.500	25.2	7.500	32.2
0.300	10.0	1.200	13.4	2.400	18.7	5.000	26.6	8.000	33.3
0.400	9.6	1.400	14.4	2.600	19.4	5.500	27.8	8.500	34.3
0.500	8.9	1.600	15.4	3.000	20.8	6.000	29.0	9.000	35.3
0.600	9.7	1.800	16.3	3.500	22.4	6.500	30.1	9.500	36.3

Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.650

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 4
Date 16/12/2015 15:45 File 0031-SW-05-A-PH4 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Half Drain Time : 423 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.081	1.081	0.0	12.8	10.5	23.3	398.1	O K
30 min Summer	99.359	1.359	0.0	14.2	13.8	28.0	500.3	O K
60 min Summer	99.588	1.588	0.0	15.3	16.0	31.3	584.6	O K
120 min Summer	99.715	1.715	0.0	15.9	17.1	33.0	631.5	Flood Risk
180 min Summer	99.727	1.727	0.0	16.0	17.2	33.1	635.6	Flood Risk
240 min Summer	99.719	1.719	0.0	15.9	17.1	33.0	632.8	Flood Risk
360 min Summer	99.678	1.678	0.0	15.7	16.8	32.5	617.7	O K
480 min Summer	99.627	1.627	0.0	15.5	16.3	31.8	599.0	O K
600 min Summer	99.571	1.571	0.0	15.3	15.8	31.1	578.4	O K
720 min Summer	99.514	1.514	0.0	15.0	15.3	30.3	557.5	O K
960 min Summer	99.408	1.408	0.0	14.5	14.3	28.8	518.4	O K
1440 min Summer	99.235	1.235	0.0	13.6	12.4	26.0	454.8	O K
2160 min Summer	99.052	1.052	0.0	12.6	10.1	22.7	387.2	O K
2880 min Summer	98.925	0.925	0.0	11.9	8.1	20.0	340.5	O K
4320 min Summer	98.773	0.773	0.0	10.9	4.6	15.5	284.5	O K
5760 min Summer	98.671	0.671	0.0	10.2	0.2	10.4	247.1	O K
7200 min Summer	98.479	0.479	0.0	10.0	0.0	10.0	176.5	O K
8640 min Summer	98.292	0.292	0.0	10.0	0.0	10.0	107.7	O K
10080 min Summer	98.202	0.202	0.0	10.0	0.0	10.0	74.3	O K
15 min Winter	99.213	1.213	0.0	13.5	12.2	25.7	446.5	O K
30 min Winter	99.527	1.527	0.0	15.0	15.4	30.5	562.2	O K
60 min Winter	99.790	1.790	0.0	16.2	17.7	33.9	659.0	Flood Risk
120 min Winter	99.950	1.950	0.0	16.9	18.9	35.8	717.7	Flood Risk
180 min Winter	99.961	1.961	0.0	17.0	19.0	36.0	722.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	133.985	0.0	408.7	55.7	18
30 min Summer	86.337	0.0	527.3	111.3	33
60 min Summer	52.933	0.0	649.7	168.8	62
120 min Summer	31.380	0.0	770.5	224.8	120
180 min Summer	22.833	0.0	841.0	254.8	152
240 min Summer	18.130	0.0	890.4	273.4	182
360 min Summer	13.031	0.0	960.1	294.9	248
480 min Summer	10.316	0.0	1013.4	307.3	316
600 min Summer	8.601	0.0	1056.1	313.6	386
720 min Summer	7.410	0.0	1091.9	315.8	454
960 min Summer	5.854	0.0	1150.1	310.2	588
1440 min Summer	4.194	0.0	1235.4	270.9	852
2160 min Summer	3.001	0.0	1327.8	219.8	1232
2880 min Summer	2.364	0.0	1394.8	171.6	1612
4320 min Summer	1.688	0.0	1492.7	75.5	2376
5760 min Summer	1.328	0.0	1567.4	1.7	3240
7200 min Summer	1.102	0.0	1625.8	0.0	4040
8640 min Summer	0.946	0.0	1674.5	0.0	4584
10080 min Summer	0.831	0.0	1715.8	0.0	5240
15 min Winter	133.985	0.0	458.0	78.9	18
30 min Winter	86.337	0.0	590.9	143.4	32
60 min Winter	52.933	0.0	727.8	209.9	60
120 min Winter	31.380	0.0	863.1	274.9	116
180 min Winter	22.833	0.0	942.1	310.2	168

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 4
Date 16/12/2015 15:45 File 0031-SW-05-A-PH4 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.943	1.943	0.0	16.9	18.9	35.8	715.4	Flood Risk
360 min Winter	99.881	1.881	0.0	16.6	18.4	35.0	692.5	Flood Risk
480 min Winter	99.804	1.804	0.0	16.3	17.8	34.1	664.0	Flood Risk
600 min Winter	99.721	1.721	0.0	15.9	17.1	33.1	633.5	Flood Risk
720 min Winter	99.639	1.639	0.0	15.6	16.4	32.0	603.5	O K
960 min Winter	99.490	1.490	0.0	14.9	15.1	29.9	548.4	O K
1440 min Winter	99.254	1.254	0.0	13.7	12.6	26.3	461.5	O K
2160 min Winter	99.021	1.021	0.0	12.4	9.7	22.1	375.9	O K
2880 min Winter	98.877	0.877	0.0	11.6	7.2	18.8	322.8	O K
4320 min Winter	98.733	0.733	0.0	10.6	2.5	13.1	269.8	O K
5760 min Winter	98.491	0.491	0.0	10.0	0.0	10.0	180.8	O K
7200 min Winter	98.202	0.202	0.0	10.0	0.0	10.0	74.5	O K
8640 min Winter	98.148	0.148	0.0	9.1	0.0	9.1	54.6	O K
10080 min Winter	98.132	0.132	0.0	8.0	0.0	8.0	48.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	18.130	0.0	997.5	332.7	190
360 min Winter	13.031	0.0	1075.5	359.7	266
480 min Winter	10.316	0.0	1135.2	376.2	342
600 min Winter	8.601	0.0	1183.0	385.7	416
720 min Winter	7.410	0.0	1223.1	390.4	486
960 min Winter	5.854	0.0	1288.2	389.9	626
1440 min Winter	4.194	0.0	1383.9	350.6	894
2160 min Winter	3.001	0.0	1487.2	276.6	1276
2880 min Winter	2.364	0.0	1562.3	199.8	1648
4320 min Winter	1.688	0.0	1672.2	48.2	2508
5760 min Winter	1.328	0.0	1755.6	0.0	3520
7200 min Winter	1.102	0.0	1821.0	0.0	3888
8640 min Winter	0.946	0.0	1875.5	0.0	4408
10080 min Winter	0.831	0.0	1922.1	0.0	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.640

Time (mins) From:	To:	Area (ha)
0	4	1.640

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	387.5	0.0	2.000	387.5	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0151-1010-0650-1010
Design Head (m)	0.650
Design Flow (l/s)	10.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	151
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.650	10.1	Kick-Flo®	0.483	8.7
Flush-Flo™	0.239	10.0	Mean Flow over Head Range	-	8.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.4	0.800	11.1	2.000	17.1	4.000	23.8	7.000	31.1
0.200	10.0	1.000	12.3	2.200	17.9	4.500	25.2	7.500	32.2
0.300	10.0	1.200	13.4	2.400	18.7	5.000	26.6	8.000	33.3
0.400	9.6	1.400	14.4	2.600	19.4	5.500	27.8	8.500	34.3
0.500	8.9	1.600	15.4	3.000	20.8	6.000	29.0	9.000	35.3
0.600	9.7	1.800	16.3	3.500	22.4	6.500	30.1	9.500	36.3

Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.650

Summary of Results for 2 year Return Period

Half Drain Time : 192 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.330	0.330	0.0	10.9	0.0	10.9	133.8	O K
30 min Summer	98.410	0.410	0.0	10.9	0.0	10.9	166.5	O K
60 min Summer	98.480	0.480	0.0	10.9	0.0	10.9	195.0	O K
120 min Summer	98.524	0.524	0.0	10.9	0.0	10.9	213.0	O K
180 min Summer	98.530	0.530	0.0	10.9	0.0	10.9	215.2	O K
240 min Summer	98.528	0.528	0.0	10.9	0.0	10.9	214.6	O K
360 min Summer	98.516	0.516	0.0	10.9	0.0	10.9	209.6	O K
480 min Summer	98.496	0.496	0.0	10.9	0.0	10.9	201.5	O K
600 min Summer	98.473	0.473	0.0	10.9	0.0	10.9	191.9	O K
720 min Summer	98.446	0.446	0.0	10.9	0.0	10.9	181.1	O K
960 min Summer	98.395	0.395	0.0	10.9	0.0	10.9	160.4	O K
1440 min Summer	98.308	0.308	0.0	10.9	0.0	10.9	124.9	O K
2160 min Summer	98.217	0.217	0.0	10.8	0.0	10.8	88.1	O K
2880 min Summer	98.168	0.168	0.0	10.6	0.0	10.6	68.1	O K
4320 min Summer	98.133	0.133	0.0	8.5	0.0	8.5	54.0	O K
5760 min Summer	98.115	0.115	0.0	7.0	0.0	7.0	46.8	O K
7200 min Summer	98.104	0.104	0.0	5.9	0.0	5.9	42.2	O K
8640 min Summer	98.096	0.096	0.0	5.2	0.0	5.2	38.8	O K
10080 min Summer	98.089	0.089	0.0	4.7	0.0	4.7	36.2	O K
15 min Winter	98.371	0.371	0.0	10.9	0.0	10.9	150.6	O K
30 min Winter	98.463	0.463	0.0	10.9	0.0	10.9	187.9	O K
60 min Winter	98.542	0.542	0.0	10.9	0.0	10.9	220.1	O K
120 min Winter	98.596	0.596	0.0	10.9	0.0	10.9	241.9	O K
180 min Winter	98.605	0.605	0.0	10.9	0.0	10.9	245.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	41.734	0.0	138.0	0.0	18
30 min Summer	26.594	0.0	176.5	0.0	33
60 min Summer	16.285	0.0	218.4	0.0	62
120 min Summer	9.752	0.0	261.8	0.0	120
180 min Summer	7.183	0.0	289.4	0.0	162
240 min Summer	5.773	0.0	310.2	0.0	192
360 min Summer	4.234	0.0	341.3	0.0	258
480 min Summer	3.389	0.0	364.4	0.0	326
600 min Summer	2.851	0.0	383.2	0.0	396
720 min Summer	2.475	0.0	399.2	0.0	462
960 min Summer	1.980	0.0	425.8	0.0	588
1440 min Summer	1.445	0.0	465.9	0.0	838
2160 min Summer	1.055	0.0	511.7	0.0	1188
2880 min Summer	0.844	0.0	545.5	0.0	1500
4320 min Summer	0.616	0.0	596.2	0.0	2208
5760 min Summer	0.492	0.0	637.3	0.0	2944
7200 min Summer	0.414	0.0	669.6	0.0	3672
8640 min Summer	0.359	0.0	697.0	0.0	4408
10080 min Summer	0.319	0.0	720.5	0.0	5136
15 min Winter	41.734	0.0	154.8	0.0	18
30 min Winter	26.594	0.0	197.9	0.0	32
60 min Winter	16.285	0.0	244.8	0.0	62
120 min Winter	9.752	0.0	293.4	0.0	118
180 min Winter	7.183	0.0	324.3	0.0	172

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 5
Date 16/12/2015 15:50 File 0031-SW-06-A-PH5 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	98.599	0.599	0.0	10.9	0.0	10.9	243.1	O K
360 min Winter	98.580	0.580	0.0	10.9	0.0	10.9	235.7	O K
480 min Winter	98.551	0.551	0.0	10.9	0.0	10.9	223.8	O K
600 min Winter	98.517	0.517	0.0	10.9	0.0	10.9	210.1	O K
720 min Winter	98.480	0.480	0.0	10.9	0.0	10.9	195.0	O K
960 min Winter	98.397	0.397	0.0	10.9	0.0	10.9	161.4	O K
1440 min Winter	98.266	0.266	0.0	10.9	0.0	10.9	108.0	O K
2160 min Winter	98.163	0.163	0.0	10.6	0.0	10.6	66.0	O K
2880 min Winter	98.136	0.136	0.0	8.7	0.0	8.7	55.1	O K
4320 min Winter	98.109	0.109	0.0	6.4	0.0	6.4	44.4	O K
5760 min Winter	98.095	0.095	0.0	5.2	0.0	5.2	38.7	O K
7200 min Winter	98.086	0.086	0.0	4.4	0.0	4.4	34.9	O K
8640 min Winter	98.079	0.079	0.0	3.8	0.0	3.8	32.2	O K
10080 min Winter	98.074	0.074	0.0	3.4	0.0	3.4	30.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	5.773	0.0	347.6	0.0	218
360 min Winter	4.234	0.0	382.5	0.0	274
480 min Winter	3.389	0.0	408.3	0.0	352
600 min Winter	2.851	0.0	429.3	0.0	428
720 min Winter	2.475	0.0	447.3	0.0	506
960 min Winter	1.980	0.0	477.1	0.0	636
1440 min Winter	1.445	0.0	522.1	0.0	868
2160 min Winter	1.055	0.0	573.2	0.0	1164
2880 min Winter	0.844	0.0	611.1	0.0	1504
4320 min Winter	0.616	0.0	668.1	0.0	2244
5760 min Winter	0.492	0.0	713.9	0.0	2944
7200 min Winter	0.414	0.0	750.0	0.0	3672
8640 min Winter	0.359	0.0	780.8	0.0	4408
10080 min Winter	0.319	0.0	807.4	0.0	5064

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.800

Time (mins) From:	To:	Area (ha)
0	4	1.800

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	427.5	0.0	2.000	427.5	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0156-1090-0620-1090
Design Head (m)	0.620
Design Flow (l/s)	10.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	156
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.620	10.9	Kick-Flo®	0.470	9.5
Flush-Flo™	0.243	10.9	Mean Flow over Head Range	-	8.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.6	0.800	12.3	2.000	19.0	4.000	26.4	7.000	34.5
0.200	10.8	1.000	13.6	2.200	19.8	4.500	28.0	7.500	35.7
0.300	10.8	1.200	14.9	2.400	20.7	5.000	29.4	8.000	36.9
0.400	10.3	1.400	16.0	2.600	21.5	5.500	30.8	8.500	38.1
0.500	9.8	1.600	17.0	3.000	23.0	6.000	32.1	9.000	39.2
0.600	10.7	1.800	18.0	3.500	24.8	6.500	33.2	9.500	40.3

Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.620

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

Half Drain Time : 329 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.703	0.703	0.0	11.5	2.5	14.1	285.3	O K
30 min Summer	98.873	0.873	0.0	12.8	7.7	20.5	354.5	O K
60 min Summer	99.010	1.010	0.0	13.7	9.9	23.6	410.2	O K
120 min Summer	99.080	1.080	0.0	14.1	10.9	25.0	438.8	O K
180 min Summer	99.088	1.088	0.0	14.2	11.0	25.2	441.8	O K
240 min Summer	99.084	1.084	0.0	14.2	10.9	25.1	440.2	O K
360 min Summer	99.060	1.060	0.0	14.0	10.6	24.6	430.3	O K
480 min Summer	99.028	1.028	0.0	13.8	10.2	24.0	417.4	O K
600 min Summer	98.994	0.994	0.0	13.6	9.7	23.3	403.6	O K
720 min Summer	98.960	0.960	0.0	13.4	9.2	22.6	389.9	O K
960 min Summer	98.899	0.899	0.0	13.0	8.2	21.1	365.0	O K
1440 min Summer	98.801	0.801	0.0	12.3	6.2	18.5	325.5	O K
2160 min Summer	98.707	0.707	0.0	11.6	2.7	14.3	287.1	O K
2880 min Summer	98.613	0.613	0.0	10.9	0.0	10.9	249.0	O K
4320 min Summer	98.369	0.369	0.0	10.9	0.0	10.9	149.9	O K
5760 min Summer	98.224	0.224	0.0	10.8	0.0	10.8	90.8	O K
7200 min Summer	98.164	0.164	0.0	10.6	0.0	10.6	66.5	O K
8640 min Summer	98.144	0.144	0.0	9.3	0.0	9.3	58.5	O K
10080 min Summer	98.130	0.130	0.0	8.3	0.0	8.3	53.0	O K
15 min Winter	98.786	0.786	0.0	12.2	5.9	18.0	319.2	O K
30 min Winter	98.979	0.979	0.0	13.5	9.5	23.0	397.7	O K
60 min Winter	99.138	1.138	0.0	14.5	11.6	26.1	462.1	O K
120 min Winter	99.228	1.228	0.0	15.0	12.7	27.7	498.9	O K
180 min Winter	99.231	1.231	0.0	15.0	12.7	27.8	500.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	87.227	0.0	290.9	3.0	18
30 min Summer	55.777	0.0	372.7	29.3	33
60 min Summer	34.065	0.0	458.3	61.1	62
120 min Summer	20.201	0.0	543.8	93.0	120
180 min Summer	14.736	0.0	595.1	109.8	146
240 min Summer	11.736	0.0	632.0	120.0	178
360 min Summer	8.483	0.0	685.4	130.2	246
480 min Summer	6.739	0.0	725.9	133.8	314
600 min Summer	5.634	0.0	758.6	132.0	382
720 min Summer	4.865	0.0	786.1	124.7	452
960 min Summer	3.858	0.0	831.1	107.0	588
1440 min Summer	2.780	0.0	897.8	74.3	852
2160 min Summer	2.001	0.0	971.3	25.8	1256
2880 min Summer	1.584	0.0	1024.9	0.0	1700
4320 min Summer	1.138	0.0	1103.9	0.0	2420
5760 min Summer	0.900	0.0	1165.7	0.0	3056
7200 min Summer	0.750	0.0	1213.9	0.0	3672
8640 min Summer	0.646	0.0	1254.4	0.0	4408
10080 min Summer	0.569	0.0	1288.9	0.0	5136
15 min Winter	87.227	0.0	326.1	13.3	18
30 min Winter	55.777	0.0	417.8	47.7	32
60 min Winter	34.065	0.0	513.4	85.7	60
120 min Winter	20.201	0.0	609.2	123.6	116
180 min Winter	14.736	0.0	666.7	143.9	152

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 5
Date 16/12/2015 15:49 File 0031-SW-06-A-PH5 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.225	1.225	0.0	15.0	12.6	27.7	497.4	O K
360 min Winter	99.186	1.186	0.0	14.8	12.2	27.0	481.7	O K
480 min Winter	99.137	1.137	0.0	14.5	11.6	26.1	461.9	O K
600 min Winter	99.086	1.086	0.0	14.2	11.0	25.1	441.2	O K
720 min Winter	99.037	1.037	0.0	13.9	10.3	24.2	421.3	O K
960 min Winter	98.950	0.950	0.0	13.3	9.0	22.3	385.7	O K
1440 min Winter	98.818	0.818	0.0	12.4	6.6	19.0	332.1	O K
2160 min Winter	98.701	0.701	0.0	11.5	2.4	13.9	284.5	O K
2880 min Winter	98.555	0.555	0.0	10.9	0.0	10.9	225.3	O K
4320 min Winter	98.216	0.216	0.0	10.8	0.0	10.8	87.7	O K
5760 min Winter	98.146	0.146	0.0	9.5	0.0	9.5	59.3	O K
7200 min Winter	98.126	0.126	0.0	7.9	0.0	7.9	51.2	O K
8640 min Winter	98.114	0.114	0.0	6.8	0.0	6.8	46.2	O K
10080 min Winter	98.105	0.105	0.0	6.0	0.0	6.0	42.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	11.736	0.0	708.1	156.5	186
360 min Winter	8.483	0.0	767.8	170.1	262
480 min Winter	6.739	0.0	813.2	176.0	338
600 min Winter	5.634	0.0	849.8	176.8	410
720 min Winter	4.865	0.0	880.6	173.4	482
960 min Winter	3.858	0.0	931.0	152.9	624
1440 min Winter	2.780	0.0	1005.7	104.9	894
2160 min Winter	2.001	0.0	1088.0	28.4	1340
2880 min Winter	1.584	0.0	1148.0	0.0	1816
4320 min Winter	1.138	0.0	1236.7	0.0	2380
5760 min Winter	0.900	0.0	1305.6	0.0	2944
7200 min Winter	0.750	0.0	1359.7	0.0	3672
8640 min Winter	0.646	0.0	1405.2	0.0	4408
10080 min Winter	0.569	0.0	1444.0	0.0	5136

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.800

Time (mins) From:	To:	Area (ha)
0	4	1.800

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	427.5	0.0	2.000	427.5	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0156-1090-0620-1090
Design Head (m)	0.620
Design Flow (l/s)	10.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	156
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.620	10.9	Kick-Flo®	0.470	9.5
Flush-Flo™	0.243	10.9	Mean Flow over Head Range	-	8.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.6	0.800	12.3	2.000	19.0	4.000	26.4	7.000	34.5
0.200	10.8	1.000	13.6	2.200	19.8	4.500	28.0	7.500	35.7
0.300	10.8	1.200	14.9	2.400	20.7	5.000	29.4	8.000	36.9
0.400	10.3	1.400	16.0	2.600	21.5	5.500	30.8	8.500	38.1
0.500	9.8	1.600	17.0	3.000	23.0	6.000	32.1	9.000	39.2
0.600	10.7	1.800	18.0	3.500	24.8	6.500	33.2	9.500	40.3

Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.620

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 5
Date 16/12/2015 15:49 File 0031-SW-06-A-PH5 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Half Drain Time : 426 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.076	1.076	0.0	14.1	10.8	25.0	437.2	O K
30 min Summer	99.354	1.354	0.0	15.7	14.0	29.8	549.9	O K
60 min Summer	99.585	1.585	0.0	17.0	16.2	33.2	643.7	O K
120 min Summer	99.717	1.717	0.0	17.6	17.3	35.0	697.5	Flood Risk
180 min Summer	99.730	1.730	0.0	17.7	17.4	35.1	702.5	Flood Risk
240 min Summer	99.722	1.722	0.0	17.6	17.4	35.0	699.5	Flood Risk
360 min Summer	99.683	1.683	0.0	17.5	17.1	34.5	683.5	O K
480 min Summer	99.634	1.634	0.0	17.2	16.6	33.9	663.4	O K
600 min Summer	99.579	1.579	0.0	16.9	16.2	33.1	641.2	O K
720 min Summer	99.523	1.523	0.0	16.6	15.7	32.3	618.6	O K
960 min Summer	99.417	1.417	0.0	16.1	14.7	30.7	575.6	O K
1440 min Summer	99.243	1.243	0.0	15.1	12.9	28.0	504.9	O K
2160 min Summer	99.056	1.056	0.0	14.0	10.6	24.6	428.7	O K
2880 min Summer	98.924	0.924	0.0	13.1	8.6	21.7	375.4	O K
4320 min Summer	98.760	0.760	0.0	12.0	5.2	17.2	308.7	O K
5760 min Summer	98.666	0.666	0.0	11.2	0.9	12.2	270.5	O K
7200 min Summer	98.504	0.504	0.0	10.9	0.0	10.9	204.5	O K
8640 min Summer	98.309	0.309	0.0	10.9	0.0	10.9	125.4	O K
10080 min Summer	98.214	0.214	0.0	10.8	0.0	10.8	86.8	O K
15 min Winter	99.207	1.207	0.0	14.9	12.5	27.4	490.3	O K
30 min Winter	99.522	1.522	0.0	16.6	15.6	32.3	618.0	O K
60 min Winter	99.786	1.786	0.0	18.0	17.9	35.9	725.4	Flood Risk
120 min Winter	99.951	1.951	0.0	18.7	19.2	37.9	792.4	Flood Risk
180 min Winter	99.968	1.968	0.0	18.8	19.3	38.1	799.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	133.985	0.0	448.2	62.7	18
30 min Summer	86.337	0.0	578.4	121.2	33
60 min Summer	52.933	0.0	712.9	181.8	62
120 min Summer	31.380	0.0	845.5	240.9	120
180 min Summer	22.833	0.0	922.9	272.5	154
240 min Summer	18.130	0.0	977.2	292.4	184
360 min Summer	13.031	0.0	1053.6	315.5	250
480 min Summer	10.316	0.0	1112.1	329.1	318
600 min Summer	8.601	0.0	1159.0	336.4	386
720 min Summer	7.410	0.0	1198.3	339.4	456
960 min Summer	5.854	0.0	1262.1	336.3	588
1440 min Summer	4.194	0.0	1355.7	297.5	852
2160 min Summer	3.001	0.0	1457.2	244.4	1232
2880 min Summer	2.364	0.0	1530.8	194.9	1612
4320 min Summer	1.688	0.0	1638.2	96.0	2376
5760 min Summer	1.328	0.0	1720.3	10.8	3224
7200 min Summer	1.102	0.0	1784.3	0.0	4040
8640 min Summer	0.946	0.0	1837.7	0.0	4592
10080 min Summer	0.831	0.0	1883.0	0.0	5240
15 min Winter	133.985	0.0	502.4	87.1	18
30 min Winter	86.337	0.0	648.2	155.0	32
60 min Winter	52.933	0.0	798.6	224.9	60
120 min Winter	31.380	0.0	947.1	293.4	118
180 min Winter	22.833	0.0	1033.8	330.7	170

Kensington Court Woodwater Park Pynes Hill Exeter EX2 5TY	0031 - Royal Brunswick Park Preliminary Attenuation Sizing Phase 5
Date 16/12/2015 15:49 File 0031-SW-06-A-PH5 ATTENUATION....	Designed by gareth.jane Checked by
XP Solutions	Source Control 2015.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	99.948	1.948	0.0	18.7	19.2	37.9	791.3	Flood Risk
360 min Winter	99.889	1.889	0.0	18.4	18.7	37.2	767.3	Flood Risk
480 min Winter	99.815	1.815	0.0	18.1	18.1	36.2	737.0	Flood Risk
600 min Winter	99.734	1.734	0.0	17.7	17.5	35.2	704.1	Flood Risk
720 min Winter	99.653	1.653	0.0	17.3	16.8	34.1	671.4	O K
960 min Winter	99.504	1.504	0.0	16.5	15.5	32.0	610.7	O K
1440 min Winter	99.265	1.265	0.0	15.2	13.1	28.3	513.7	O K
2160 min Winter	99.024	1.024	0.0	13.8	10.1	23.9	416.0	O K
2880 min Winter	98.873	0.873	0.0	12.8	7.7	20.5	354.3	O K
4320 min Winter	98.716	0.716	0.0	11.6	3.2	14.8	290.9	O K
5760 min Winter	98.519	0.519	0.0	10.9	0.0	10.9	211.0	O K
7200 min Winter	98.218	0.218	0.0	10.8	0.0	10.8	88.5	O K
8640 min Winter	98.154	0.154	0.0	10.0	0.0	10.0	62.6	O K
10080 min Winter	98.137	0.137	0.0	8.8	0.0	8.8	55.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
240 min Winter	18.130	0.0	1094.6	354.7	192
360 min Winter	13.031	0.0	1180.2	383.5	268
480 min Winter	10.316	0.0	1245.8	401.5	344
600 min Winter	8.601	0.0	1298.3	412.1	416
720 min Winter	7.410	0.0	1342.3	417.7	490
960 min Winter	5.854	0.0	1413.7	418.9	628
1440 min Winter	4.194	0.0	1518.7	383.9	896
2160 min Winter	3.001	0.0	1632.2	307.0	1280
2880 min Winter	2.364	0.0	1714.6	228.4	1668
4320 min Winter	1.688	0.0	1835.1	68.2	2468
5760 min Winter	1.328	0.0	1926.8	0.0	3464
7200 min Winter	1.102	0.0	1998.6	0.0	3896
8640 min Winter	0.946	0.0	2058.4	0.0	4408
10080 min Winter	0.831	0.0	2109.4	0.0	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.100	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.800

Time (mins) From:	To:	Area (ha)
0	4	1.800

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	427.5	0.0	2.000	427.5	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0156-1090-0620-1090
Design Head (m)	0.620
Design Flow (l/s)	10.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	156
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.620	10.9	Kick-Flo®	0.470	9.5
Flush-Flo™	0.243	10.9	Mean Flow over Head Range	-	8.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.6	0.800	12.3	2.000	19.0	4.000	26.4	7.000	34.5
0.200	10.8	1.000	13.6	2.200	19.8	4.500	28.0	7.500	35.7
0.300	10.8	1.200	14.9	2.400	20.7	5.000	29.4	8.000	36.9
0.400	10.3	1.400	16.0	2.600	21.5	5.500	30.8	8.500	38.1
0.500	9.8	1.600	17.0	3.000	23.0	6.000	32.1	9.000	39.2
0.600	10.7	1.800	18.0	3.500	24.8	6.500	33.2	9.500	40.3

Orifice Overflow Control

Diameter (m) 0.090 Discharge Coefficient 0.600 Invert Level (m) 98.620

Appendix E – Drainage Layout Drawings

Notes

1. The development is entirely located within Flood Zone 1 - Low Risk. It is therefore not at risk of flooding from fluvial sources in up to a 1 in 1000 year return period.
3. The proposed drainage strategy has been prepared in accordance with the National Planning Policy Framework (NPPF) and the supplementary Planning Practice Guidance (NPPG).
4. The Barnet Surface Water Management Plan identifies the site as being wholly located within Brunswick Park - Group2_030 Critical Drainage Area.
5. The site has been previously developed and is currently occupied by a business park and school, therefore the site can be classed as 'brownfield'.
6. In accordance with London Plan 'Policy 5.13 - Sustainable Drainage' and the North London Strategic Flood Risk Assessment, the discharge from the proposed development will be restricted back to undeveloped Greenfield run-off rates.
6. A desk top study has indicated that the site suffers from 'impeded drainage', therefore the drainage strategy utilises attenuation features with a restricted discharge, sized to cater for up to the 1 in 100 year storm.
7. Roof water from buildings and private areas of hard-standing (including the on-site road network) will be collected from downpipes, gutters and trapped gullies before being transferred via a private storm network towards on site attenuation features.
8. Rainwater harvesting will be provided throughout the development to reduce the volume of runoff being discharged and to capture the first 5mm of rainfall.
9. This Preliminary Drainage Layout drawing does not attempt to present a final design of the proposed drainage systems. Detailed design of the systems and any inherent features will commence on approval of the strategy and will include assessments due to further site investigations, health and safety, CDM etc.
10. We are currently liaising with Thames water to agree on a point of connection for both surface water and foul and confirm whether the existing sewerage networks have capacity to accommodate the development or to otherwise outline any offsite reinforcement requirements.
11. Any private drainage networks or features will be designed in accordance with Building Regulations Part H. The operation and maintenance of any communal private drainage will be undertaken via a third party management company.
12. Any adoptable drainage networks will be designed in accordance with Sewers for Adoption and will be handed to Thames Water for adoption.
13. The alignment of existing public drainage infrastructure is based on Thames Water asset record plans, as built survey information and topographic survey information.

Pre Development Runoff

In accordance with Policy 5.13 of The London Plan and the North London Strategic Flood Risk Assessment, the rate of runoff from the proposed brownfield development site will be restricted to replicate the pre-development greenfield scenario.

Given the proposed Phase 1 development area of only 5.5ha, the pre-development greenfield run-off rates have been assessed in accordance with the ICP SuDS Method, which is based on IH124, but for catchments of less than 50 ha.

Greenfield Runoff Rates

Return Period	Greenfield Runoff Rate (l/s)
2yr	21.5
30yr	55.0
100yr	77.0

Proposed Phase 1 Drainage Features

School Site to independent Cellular Storage feature

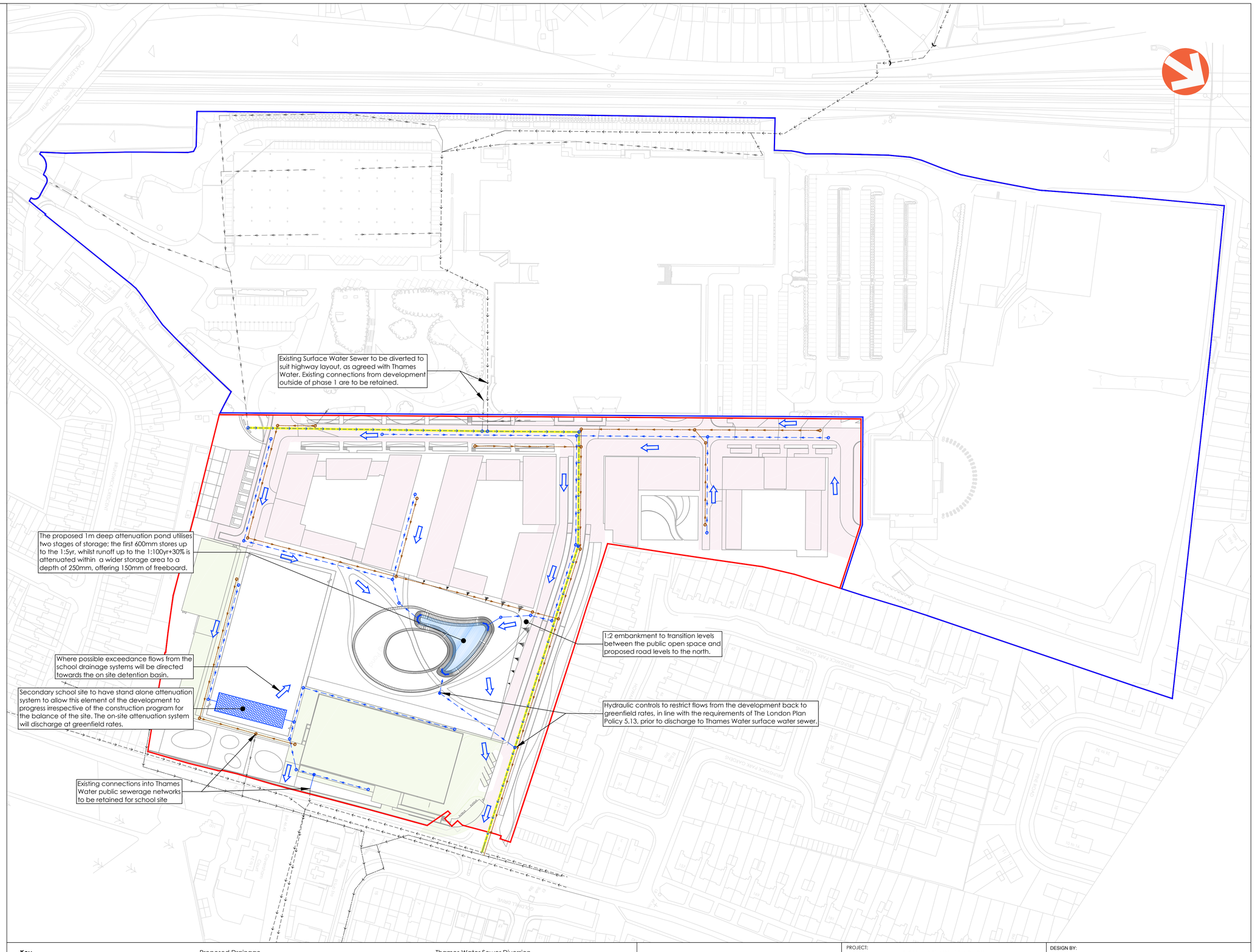
Ownership	Private (Management Company)
Impermeable Catchment	0.65 ha
Dimensions	37.5 m x 10.0 m x 1.0 m deep
100yr + 30% Volume	356 m³

Balance of Phase 1 to proposed Detention Basin

Ownership	Private (Management Company)
Impermeable Catchment	1.97 ha
100yr+30% Volume	768 m³ (above permanent water)
100yr+30% water level	0.838 m (above permanent water)

Future runoff rates

Return Period	School Runoff (l/s)	Basin Discharge (l/s)	Total
2yr	2.1	19.4	21.5
30yr+10%	3.8	42.2	46.0
100yr+30%	5.8	69.7	75.5



Key

- Detailed Application (Phase 1)
- Outline Application Boundary

Existing Retained Drainage

- Thames Water Foul Sewer
- Thames Water Surface Water Sewer

Proposed Drainage

- Impermeable Catchment (Phase 1)
- Imp. Catchment (School)
- Attenuation Pond
- Cellular Storage Attenuation
- Overland Flood Flow Route
- Thames Water Sewer Diversion (indicative)
- Private Surface Water Drain
- Private Foul Water Drain

REV	DATE	DESCRIPTION	BY	CHK	APD
A	16.12.2015	INITIAL ISSUE	AJH	CPY	RW

CLIENT: COMER HOMES GROUP

DRAWING STATUS: PLANNING APPLICATION

PROJECT: ROYAL BRUNSWICK PARK

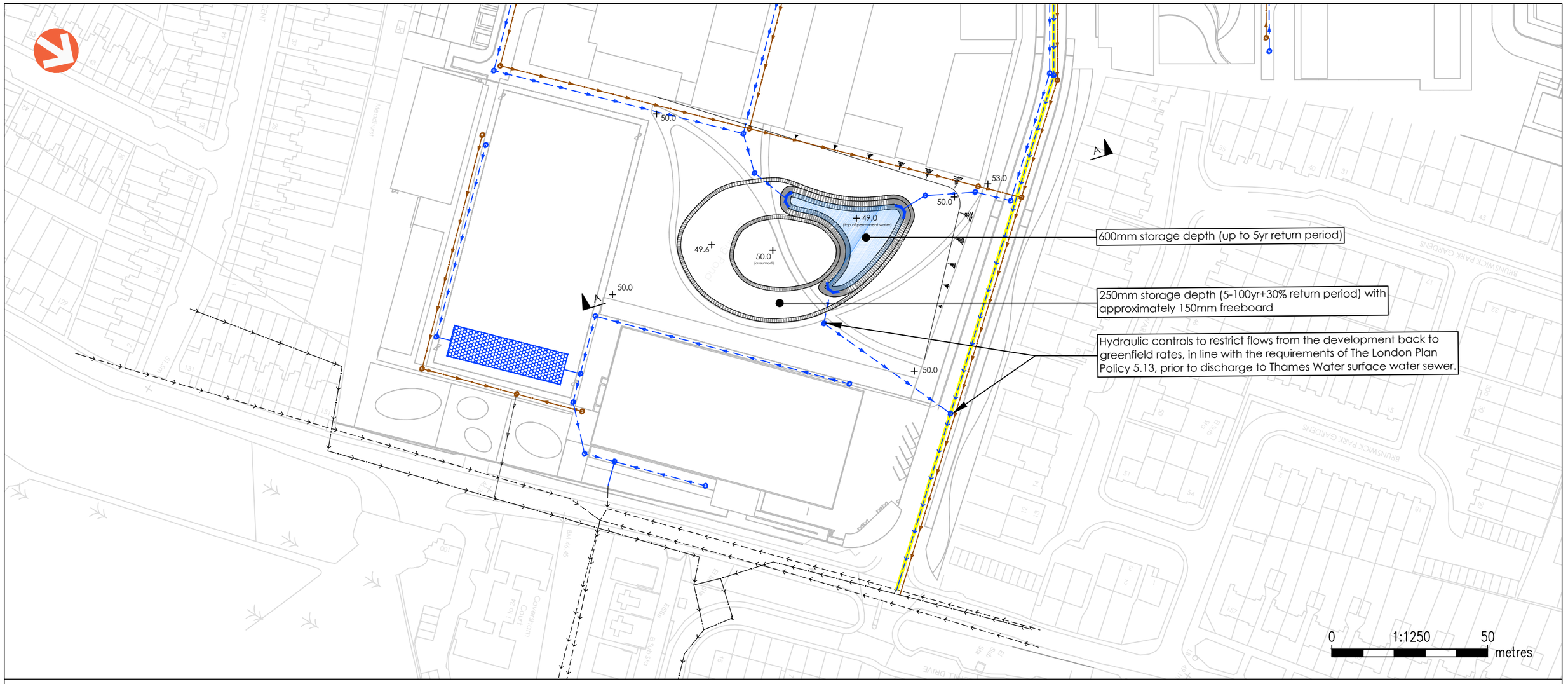
TITLE: PHASE 1 PRELIMINARY DRAINAGE LAYOUT

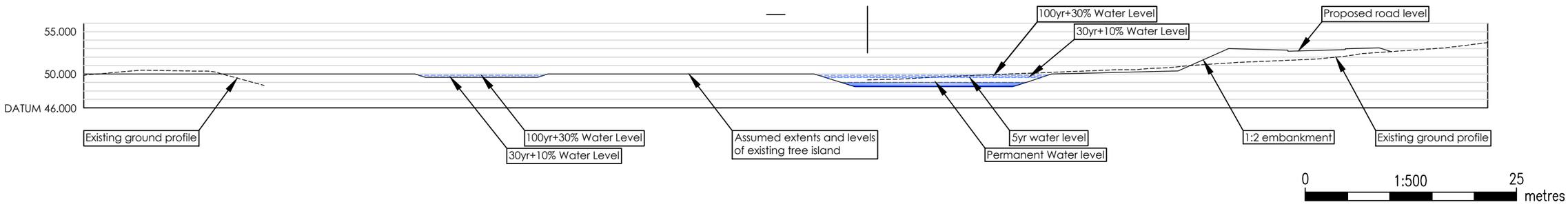
PROJECT No:	DRAWING No:	REV:
0031	PDL-100	A

SCALE @ A1: 0 1:1000 50 metres

DESIGN BY:

awcockward partnership
Awcock Ward Partnership, Kensington Court, Woodwater Park, Pynes Hill, Exeter, EX2 5TY
Tel: 01392 409007 Web: www.awpexeter.com





Key

Existing Retained Drainage

- Thames Water Foul Sewer
- Thames Water Surface Water Sewer

Proposed Drainage

- Attenuation Pond
- Cellular Storage Attenuation
- Thames Water Sewer Diversion (Indicative)
- Private Surface Water Drain
- Private Foul Water Drain

REV	DATE	DESCRIPTION	BY	CHK	APD
A	16.12.2015	INITIAL ISSUE	GJ	CY	IDA

CLIENT: COMER HOMES GROUP

DRAWING STATUS: PLANNING APPLICATION

PROJECT: ROYAL BRUNSWICK PARK

TITLE: PROPOSED DETENTION BASIN

PROJECT No:	DRAWING No:	REV:
0031	PDL-101	A

SCALE @ A3: AS SHOWN

awcockward partnership

Awcock Ward Partnership, Kensington Court, Woodwater Park, Pynes Hill, Exeter, EX2 5TY
Tel: 01392 409007 Web: www.awpexeter.com

Notes

1. The development is entirely located within Flood Zone 1 - Low Risk. It is therefore not at risk of flooding from fluvial sources in up to a 1 in 1000 year return period.
3. The proposed drainage strategy has been prepared in accordance with the National Planning Policy Framework (NPPF) and the supplementary Planning Practice Guidance (NPPG).
4. The Barnet Surface Water Management Plan identifies the site as being wholly located within Brunswick Park - Group2_030 Critical Drainage Area.
5. The site has been previously developed and is currently occupied by a business park and school, therefore the site can be classed as 'brownfield'.
6. In accordance with London Plan 'Policy 5.13 - Sustainable Drainage' and the North London Strategic Flood Risk Assessment, the discharge from the proposed development will be restricted back to undeveloped Greenfield run-off rates.
6. A desk top study has indicated that the site suffers from 'impeded drainage', therefore the drainage strategy utilises attenuation features with a restricted discharge, sized to cater for up to the 1 in 100 year storm.
7. Roof water from buildings and private areas of hard-standing (including the on-site road network) will be collected from downpipes, gutters and trapped gullies before being transferred via a private storm network towards on site attenuation features.
8. Rainwater harvesting will be provided throughout the development to reduce the volume of runoff being discharged and to capture the first 5mm of rainfall.
9. This Preliminary Drainage Layout drawing does not attempt to present a final design of the proposed drainage systems. Detailed design of the systems and any inherent features will commence on approval of the strategy and will include assessments due to further site investigations, health and safety, CDM etc.
10. We are currently liaising with Thames water to agree on a point of connection for both surface water and foul and confirm whether the existing sewerage networks have capacity to accommodate the development or to otherwise outline any offsite reinforcement requirements.
11. Any private drainage networks or features will be designed in accordance with Building Regulations Part H. The operation and maintenance of any communal private drainage will be undertaken via a third party management company.
12. Any adoptable drainage networks will be designed in accordance with Sewers for Adoption and will be handed to Thames Water for adoption.
13. The alignment of existing public drainage infrastructure is based on Thames Water asset record plans, as built survey information and topographic survey information.

Pre Development Runoff

In accordance with Policy 5.13 of The London Plan and the North London Strategic Flood Risk Assessment, the rate of runoff from the proposed brownfield development site will be restricted to replicate the pre-development greenfield scenario.

The pre-development greenfield run-off rates have been assessed in accordance with the ICP SuDS Method, which is based on IH124, but for catchments of less than 50 ha.

	Greenfield Runoff Rates (l/s)				
Return Period	Ph2	PH3	PH4	PH5	Total
2yr	16.4	4.7	10.1	10.9	42.1
30yr	42.0	12.0	26.0	28.0	108.0
100yr	58.8	16.8	36.4	39.2	151.2

Proposed Attenuation Features

Phase 2

Ownership	Private (Management Company)
Impermeable Catchment	2.19 ha
Dimensions	25.0 m x 20.0 m x 2.0 m deep
100yr + 30% Volume	920 m³

Phase 3

Ownership	Private (Management Company)
Impermeable Catchment	0.425 ha
Dimensions	12.0 m x 7.0 m x 2.0 m deep
100yr + 30% Volume	160.0 m³

Phase 4a

Ownership	Private (Management Company)
Impermeable Catchment	0.32 ha
Dimensions	15.5 m x 5.0 m x 2.0 m deep
100yr + 30% Volume	144 m³

Phase 4b&c

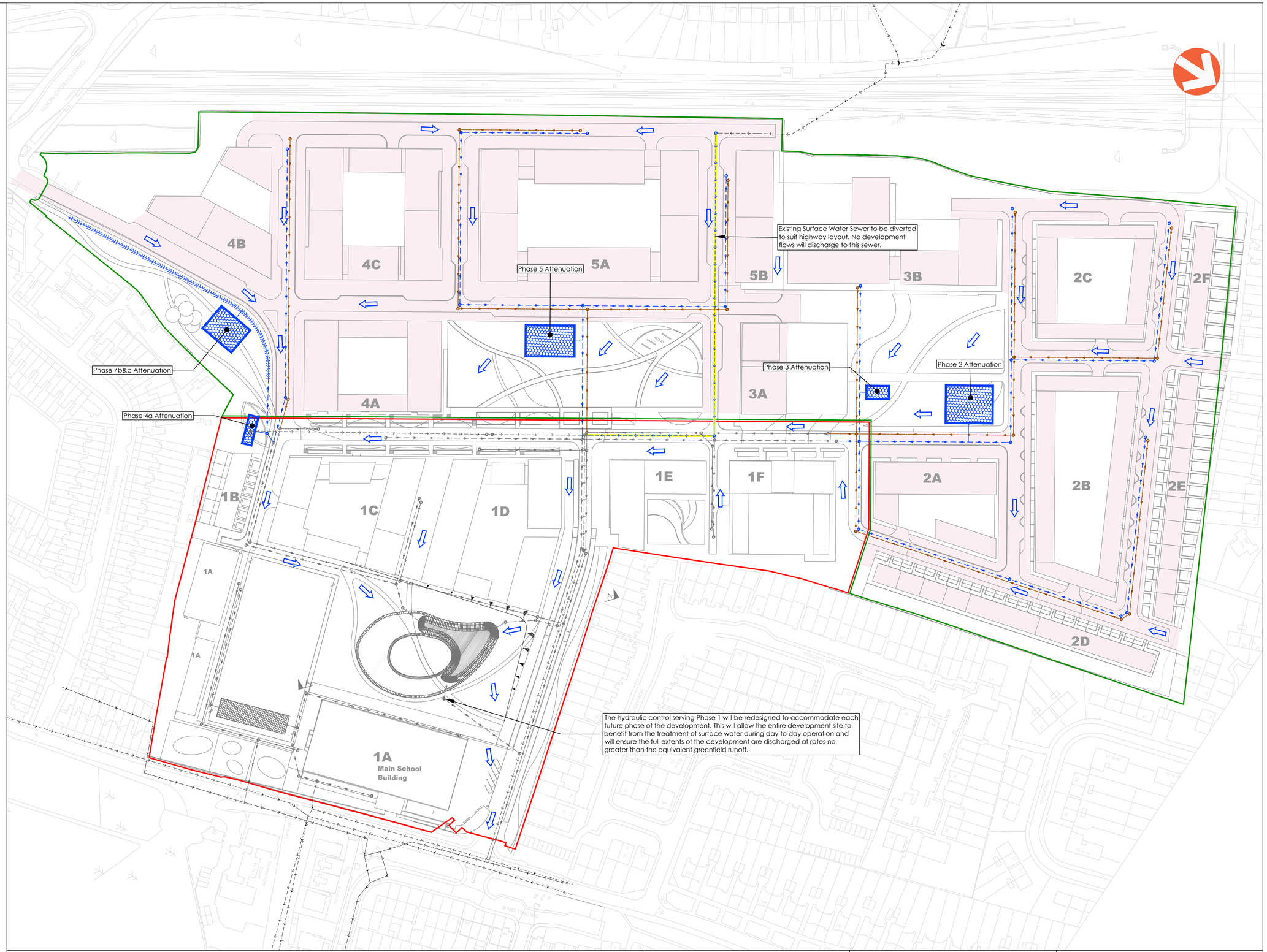
Ownership	Private (Management Company)
Impermeable Catchment	1.31 ha
Dimensions	15.5 m x 20.0 m x 2.0 m deep
100yr + 30% Volume	578 m³

Phase 5

Ownership	Private (Management Company)
Impermeable Catchment	1.8 ha
Dimensions	26.0 m x 16.5 m x 2.0 m deep
100yr + 30% Volume	799 m³

Future Runoff Rates

Return Period	PH2 (l/s)	PH3 (l/s)	PH4 (l/s)	PH5 (l/s)	Total
2yr	16.3	4.6	10.0	10.9	41.8
30yr+10%	41.7	11.4	26.0	27.8	106.9
100yr+30%	57.2	15.9	36.0	38.1	147.2



Key

- Detailed Application (Phase 1)
- Outline Application Boundary

Existing Retained Drainage

- Thames Water Foul Sewer
- Thames Water Surface Water Sewer

Proposed Drainage

- Impermeable Catchment
- Cellular Storage Attenuation
- Overland Flood Flow Route
- Thames Water Sewer Diversion (indicative)
- Private Surface Water Drain
- Private Foul Water Drain

REV	DATE	DESCRIPTION	BY	CHK	APD
A	16.12.2015	INITIAL ISSUE	GJ	CPY	RW

CLIENT: COMER HOMES GROUP

DRAWING STATUS: PLANNING APPLICATION

PROJECT: ROYAL BRUNSWICK PARK

TITLE: PRELIMINARY DRAINAGE LAYOUT - FULL SITE

PROJECT No: 0031 | DRAWING No: PDL-200 | REV: A

SCALE @ A1: 0 1:1000 50 metres

DESIGN BY:

awcockward partnership
Awcock Ward Partnership, Kensington Court, Woodwater Park, Pynes Hill, Exeter, EX2 5TY
Tel: 01392 409007 Web: www.awpexeter.com

Appendix F – Thames Water Correspondence

Chris Yalden

From: DEVELOPER.SERVICES@THAMESWATER.CO.UK
Sent: 15 December 2015 08:32
To: Chris Yalden
Subject: IRef:1013480825 RE: Royal Brunswick Park re-development scheme, Barnet - Outline SW Strategy

Dear Chris,

Thank you for your email.

From the information you have provided, we have no issues with your reduction/attenuation measures.

Best regards

Shaun Picart

Thames Water - Development Engineer

0800 009 3921

Original Text

From: chris.yalden@awpexeter.com
To: DEVELOPER.SERVICES@THAMESWATER.CO.UK
CC:
Sent: 08.12.15 15:12:50
Subject: Royal Brunswick Park re-development scheme, Barnet - Outline SW Strategy

FAO Shaun Picart, Development Engineer
Chris Freeman, Technical Coordinator

Shaun, Chris,

We spoke with you both earlier this year with regard to the proposed school which forms Phase 1 of the 'Royal Brunswick Park re-development scheme', at Brunswick Park Road, Barnet (site formerly known as North London Business Park).

I would now like to seek your thoughts on our work-in-progress drainage strategy for the full redevelopment site. I am not seeking approval or final agreement as clearly you will need to review full details of the scheme, however I'm hoping your response will give us confidence that we're currently progressing in the right direction.

To remain compliant with local and regional policies the scheme will need to reduce the peak runoff from the brownfield site to the equivalent greenfield rates; offering a significant reduction and downstream betterment.

As-built records indicate connections between your existing surface water sewer and an existing on-site attenuation pond. In accordance with the London Plan Policy 5.13 Sustainable Drainage Hierarchy, we are

keen to retain the function of this pond to provide on-site attenuation, with a controlled discharge to your network, at greenfield rates. The proposals would demonstrate a significant reduction in peak rate of runoff whilst also providing water quality enhancement and improved site management.

Can you please confirm that this outline drainage strategy is acceptable in principle?

With regards to foul flows, the proposals will generate an increased foul flow. We've completed a pre-development enquiry to establish whether this flow can be accommodated or whether any off-site reinforcement will be required – this will be submitted shortly.

I look forward to hearing from you in due course and welcome any discussions.

Best Regards,

Chris Yalden
Associate
MICE, IEng

awcockward partnership

Michelmores Property Awards SHORTLISTED 2015

Kensington Court, Woodwater Park, Pynes Hill, Exeter EX2 5TY

office: 01392 409007
direct dial: 01392 441066
Mobile: 07843 107790
email: chris.yalden@awpexeter.com
web: www.awpexeter.com

From: DEVELOPER.SERVICES@THAMESWATER.CO.UK [mailto:DEVELOPER.SERVICES@THAMESWATER.CO.UK]
Sent: 26 March 2015 11:14
To: Chris Yalden
Subject: RE: RE: IRef:1012416174 RE: Query relating to Buildover Agreement (Ref. 50039476-BN)

Dear Chris,

Thank you for your email.

I've reviewed your drawing, what you're proposing seems fine in principal.

We look forward to receiving your application including longitudinal drawings.

Best regards

Shaun Picart

Thames Water - Development Engineer

0800 009 3921

Original Text

From: chris.yalden@awpexeter.com
To: DEVELOPER.SERVICES@THAMESWATER.CO.UK
CC:
Sent: 19.03.15 10:05:57
Subject: RE: IRef:1012416174 RE: Query relating to Buildover Agreement (Ref. 50039476-BN)

FAO Chris Freeman, Technical Coordinator

RE: Application to build over a Class 3 and a Class 2 Public Sewer (Ref: 50039476-BN)
Site Address: Royal Brunswick Park, London, N14 5DU

Many thanks for your below email, received at the tail end of last year.

Given that Thames Water will not accept a build-over agreement and are making recommendations to divert the existing 375mm and 600mm diameter sewers, we have undertaken an assessment to define a possible diversion route. The output of this assessment can be seen on the attached Sketch Plan (ref. 0031-SK-101).

The deliverability of this potential diversion will be subject to existing sewer levels and capacity at the point of connection. There is a risk that the existing sewer beneath Brunswick Park Road will be too shallow / small to enable a connection and the diversion may need to include relaying of this system, downstream towards Caversham Court, where the public sewers turn and head east.

Pleas can you confirm whether the broad principles of this diversion are preferable to Thames Water, as opposed to the previously discussed build-over.

Best Regards,

Chris Yalden
Associate
MICE, IEng

awcockward partnership

Michelmores Property Awards SHORTLISTED 2015

Kensington Court, Woodwater Park, Pynes Hill, Exeter EX2 5TY

office: 01392 409007
direct dial: 01392 441066
email: chris.yalden@awpexeter.com
web: www.awpexeter.com

From: DEVELOPER.SERVICES@THAMESWATER.CO.UK [mailto:DEVELOPER.SERVICES@THAMESWATER.CO.UK]
Sent: 30 December 2014 10:01
To: Chris Yalden
Cc: Gavin Swift; Ian Awcock
Subject: IRef:1012416174 RE: Query relating to Buildover Agreement (Ref. 50039476-BN)

Dear Mr Yalden,

Many thanks for your below email.

I have discussed your comments with our senior connections manager who is of the opinion that the Sewers For Adoption 6th Edition and specifically Table 2.1 which you mention is in it's principals referring to sewers in residential development land or in public roads and built-up domestic areas which due to the difficulty and complexities of cordoning off areas for open-cut trench works would make this type of access unlikely to be sought and given.

In areas such as parks and greenfield spaces however it is very likely that open-cut trenches would be used to repair sewers due to cost-effectiveness and simplicity of access even at 8 metres as tunnelling repairs would be significantly more costly.

It is for the above reasons and those previously mentioned that we are not able in this instance to allow these 2 sewers to be built over by this proposed development and we must request that an application be made under Section 185 of the Water Industry Act 1991 to divert the sewers around the proposed development.

Kind Regards

Chris Freeman

Technical Coordinator

Original Text

From: chris.yalden@awpexeter.com
To: developer.services@thameswater.co.uk
CC: Ian.Awcock@awpexeter.com ;gavin.swift@awpexeter.com
Sent: 18.12.14 15:05:39
Subject: Query relating to Buildover Agreement (Ref. 50039476-BN)

FAO Chris Freeman, Technical Coordinator

RE: Application to build over a Class 3 and a Class 2 Public Sewer (Ref: 50039476-BN)
Site Address: Royal Brunswick Park, London, N14 5DU

Many thanks for your response to our build-over application for the above scheme; I wanted to touch base with you to discuss the application in a little more detail but understand that you're out of office today.

We respect that it's likely a standard position for Thames Water to refuse Build Over Consent for developments located above large public sewers however in this case we wanted to ensure that consideration had been given to the fact the existing sewer is 8m deep. In accordance with Sewers for Adoption guidance (SfA 6th Edition, Table 2.1) any repair, maintenance or renewal of this network by open-cut methods is not anticipated. On this basis we had considered that a build over agreement would be permitted for this scheme as it would not impact on any future works associated to the underlying sewers.

We welcome your comments on the above.

Regards,

Chris Yalden

Principal Engineer
MICE, IEng

awcockward partnership

Kensington Court, Woodwater Park, Pynes Hill, Exeter EX2 5TY

office: 01392 409007
direct dial: 01392 441066
email: chris.yalden@awpexeter.com
web: www.awpexeter.com

AWP is a regional engineering consultancy providing development planning and infrastructure services to developers and house builders across the south west.