65-67 Holmes Road, London, NW5 3AN

Basement Impact Assessment Audit

For

London Borough of Camden

Project Number: 12727-51
Revision: D1

Date April 2018

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1.0 NON-TECHNICAL SUMMARY

1.1. CampbellReith was instructed by London Borough of Camden, (LBC) to carry out an audit on the Basement Impact Assessment submitted as part of the Planning Submission documentation for 65-67 Holmes Road (planning reference 2017/6786/P). The basement is considered to fall within Category C as defined by the Terms of Reference.

1.2. The Audit reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development in accordance with LBC's policies and technical procedures.

1.3. CampbellReith was able to access LBC's Planning Portal and gain access to the latest revision of submitted documentation and reviewed it against an agreed audit check list.

1.4. The BIA has been prepared by engineering consultants holding suitable qualifications, with the exception of the ground water aspect of the assessment.

1.5. The LBC Instruction to proceed with the audit identified that the basement proposal neither involved a listed building or was adjacent to listed buildings.

1.6. The proposal consists of the demolition of the existing retail unit, with the construction of a double level basement with residential accommodation above ground level.

1.7. A similar planning proposal has already been granted, with much of the critical aspects of the basement construction has been undertaken, therefore impacts relating to wall construction have not been considered within the scope of this audit.

1.8. A borehole site investigation has been undertaken, during which ground water was not encountered.

1.9. The geology has been identified as a moderate to deep depth of made ground overlaying the London Clay, with the site geology potentially sloping or uneven. The proposed basement is to be founded within the London Clay.

1.10. The proposed basement structure is proposed of common basement construction methods.

1.11. A drainage strategy report indicates that surface water drainage from the site will be in accordance with the London Plan.

1.12. It is accepted that the basement proposal is unlikely to impact on the ground water flows. However it is suggest that care be taken during excavation should unanticipated geology or ground water be encountered.

1.13. It is accepted that there are no slope stability concerns regarding the proposed development and it is not in an area prone to flooding.

1.14. It can be confirmed that the proposal adheres to the requirements of CPG4.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 7th February 2018 to carry out a Category C Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 65-67 Holmes Road, London, NW5 3AN and Reference 2017/6786/P.

2.2. The Audit was carried out in accordance with the Terms of Reference set by LBC. It reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development.

2.3. A BIA is required for all planning applications with basements in Camden in general accordance with policies and technical procedures contained within

- Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners.
- Camden Planning Guidance (CPG) 4: Basements and Lightwells.
- Camden Development Policy (DP) 27: Basements and Lightwells.
- Camden Development Policy (DP) 23: Water.
- Local Plan 2017, Policy A5 Basements.

2.4. The BIA should demonstrate that schemes:

a) maintain the structural stability of the building and neighbouring properties;

b) avoid adversely affecting drainage and run off or causing other damage to the water environment;

c) avoid cumulative impacts upon structural stability or the water environment in the local area, and;

evaluate the impacts of the proposed basement considering the issues of hydrology, hydrogeology and land stability via the process described by the GSD and to make recommendations for the detailed design.

2.5. LBC's Audit Instruction described the planning proposal as *"Variation of condition 20 (approved plans) of 2013/7130/P as varied by 2015/5435/P and 2016/4664/P for a of a 3-7 storey building (with 2 basement levels) to provide 273 units of student accommodation with ancillary facilities and warehouse space; CHANGES ARE to lower the basement level by 950mm, internal changes and the reduction of warehouse and ancillary student space."*

The Audit Instruction also confirmed 65-67 Holmes Road did not involve, or was neighbour to, listed buildings.

2.6. CampbellReith accessed LBC's Planning Portal on 20/03/2018 and gained access to the following relevant documents for audit purposes:

- Basement Impact Assessment Report (BIA), Pringuer-James Consulting Engineers, February 2018, Revision A.
- Structural Engineer's Assessment, Pringuer-James Consulting Engineers, October 2017, Revision -.
- Planning Application Drawings consisting of

  Proposed Elevations,

  Proposed Floor Plans,

  Proposed Sections A-G

  Appendix D PJCE Planning Drawings

  Temporary Propping to Sheet Piled Walls Step 1-7
- Design & Access Statement – s73 update February 2018

2.7. The following was received via email on 24/04/18.

- Drainage Strategy Report , 6th April 2018

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	No	CGeol is not held
Is data required by Cl.233 of the GSD presented?	Yes	While a programme is not provided generally the requirement has been met
Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology?	Yes	
Are suitable plan/maps included?	Yes	
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	Yes	
Land Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	A justification statement is provided for all answers
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	A justification statement is provided for all answers
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	A justification statement is provided for all answers
Is a conceptual model presented?	No	Refer to section 4.5.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	A scoping statement is provided for all items identified as by screening

Item	Yes/No/NA	Comment
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	N/A	No hydrogeological items have been carried forward from screening
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	N/A	No hydrological items have been carried forward from screening
Is factual ground investigation data provided?	Yes	Borehole logs are provided
Is monitoring data presented?	No	
Is the ground investigation informed by a desk study?	Yes	Some study of geological maps has been undertaken.
Has a site walkover been undertaken?	-	Assumed undertaken as part of the Ground Investigation.
Is the presence/absence of adjacent or nearby basements confirmed?	No	
Is a geotechnical interpretation presented?	No	
Does the geotechnical interpretation include information on retaining wall design?	No	
Are reports on other investigations required by screening and scoping presented?	N/A	
Are the baseline conditions described, based on the GSD?	Yes	
Do the base line conditions consider adjacent or nearby basements?	No	
Is an Impact Assessment provided?	Yes	
Are estimates of ground movement and structural impact presented?	No	A GMA has not been undertaken

Item	Yes/No/NA	Comment
Is the Impact Assessment appropriate to the matters identified by screen and scoping?	No	
Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme?	No	
Has the need for monitoring during construction been considered?	No	
Have the residual (after mitigation) impacts been clearly identified?	No	
Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained?	No	However due to the advanced stage of construction this has not been considered within this audit
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	Flow to be attenuated in accordance with The London Plan
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	No	However due to the advanced stage of construction this has not been considered within this audit
Does report state that damage to surrounding buildings will be no worse than Burland Category 1?	No	However due to the advanced stage of construction this has not been considered within this audit
Are non-technical summaries provided?	Yes	

4.0 DISCUSSION

4.1. The BIA has been prepared by engineering consultants Pringuer-James Consulting Engineers using individuals with a CEng and MICE qualification, although the authors did not provide evidence of their expertise. The BIA has not been authored by a Hydrogeologist with a CGeol qualification and this is a requirement of CPG4 July 2015 Section 3.6.

4.2. 65-67 Holmes Road was previously occupied by a Magnet warehouse building with hard standing on the western part of site. The site is located amongst residential and commercial properties with Holmes Road located directly adjacent to the site to the north. To the east 61-63 Holmes Road comprises a recently finished six storey residential building, and 55 to 57 Holmes road comprises a six storey residential building with a single storey basement. To the south is a three storey newly converted industrial building adjacent to a number of three storey flat on Azania Mews. To the west of the site is adjacent to Cathcart Street.

4.3. The LBC Instruction to proceed with the audit identified that the basement proposal neither involved a listed building or was adjacent to listed buildings.

4.4. The proposed basement consists of a two storey construction to 9.20mbgl formed by lowering an existing site level across the whole site. The basement will be mixed use comprising plant, warehouse, laundry and cycle storage alongside study areas at the lower level and a warehouse and accommodation at the upper level.

4.5. The borehole logs have identified that 5.00m of Made Ground in BH2 with up to 1m of soft brown slightly gravelly, sandy clay, likely attributed to tertiary deposits of Alluvium, potentially associated with the distributary of the River Fleet. Firm to Stiff London Clay is proven to a depth of 30.00mbgl. The conceptual site model has not identified these stratigraphic boundaries.

4.6. A previous planning application, 2016/4664/P, was approved in May 2017, which was for a similar proposal with a basement to the same extent on plan but to a depth approximately 1m shallower than is proposed for the planning application under consideration 2017/6786/P.

4.7. The Desk Study and Ground Investigation Report has not been provided with the application, however factual borehole data is provided. The BIA describes that groundwater was encountered during the ground investigation although this is not identified in any of the two exploratory boreholes included in the Appendix. No exploratory hole location plan is provided and no ground water monitoring is included with the BIA.

4.8. The BIA discusses a scheme comprising steel sheet piling across the full extent of the site with the clutches of the sheet piles welded up along the length of any upper permeable layers. The anticipated depth of the basement is approximately 9.20m bgl. Floor plates at ground floor, upper basement and lower basement levels will be designed as rigid diaphragms providing adequate restraint to the sheet piling in the permanent condition. Additional propping at the mid span level of the lower basement will also be installed. The vertical loads will be transferred from the superstructure and basement floor plates onto a raft foundation extending below the entire footprint of the development via steel columns, thus the sheet piles be holding back the horizontal pressures and are hung from the basement floor plates. The BIA proposes to limit the impact to adjacent properties to the north and east, RC underpinned walls along the full length of the adjacent property to the north and raising the new basement slab over the existing property to the east is proposed. The walls will also provide support to the excavation in both the temporary and permanent condition. The lower basement floor will be designed as a reinforced concrete raft supporting steel columns.

4.9. At the time of writing it is understood that construction has commenced with the basement walls having been constructed, with the majority of the excavation undertaken. It has been confirmed that the party wall process has been followed. Given that the worst case circumstance in terms of ground movements has already occurred, which would be during the construction case prior to the permanent structure being installed, the scope of this audit does not consider ground movement considerations, retaining wall stability or design, or temporary works proposals.

4.10. The BIA proposes that the raft planned will consider the upwards effects of base heave and groundwater. While details have not been provided of how this will be achieved, given the advanced status of the basement construction it is accepted that this is likely to have been considered in the detailed design.

4.11. The Drainage strategy report indicates that storm water attenuation is to be provided which is to attenuate flow to less than 50% of the existing site discharge rate, as is in accordance with the London Plan. This strategy is accepted.

4.12. Subterranean flow screening identifies a (dis)tributary of the River Fleet potentially located under or close to the site. A 'preliminary site investigation' undertaken on site has not identified evidence of a dried water channel on site and the BIA assumes this will not be encountered. It is accepted that any historic river tributary is likely to no longer be significantly active, however it is suggested that care be taken during excavation work should unanticipated geology or hydrogeology be encountered that may indicate a historic river channel, with consideration given to any design changes that may be necessary in order to facilitate any ongoing ground water flow.

4.13. It is accepted that there are no slope stability concerns regarding the proposed development and it is not in an area prone to flooding.

5.0 CONCLUSIONS

5.1. The BIA has been prepared by engineering consultants holding suitable qualifications, with the exception of the hydrogeological aspect of the assessment.

5.2. The LBC Instruction to proceed with the audit identified that the basement proposal neither involved a listed building or was adjacent to listed buildings.

5.3. The proposal consists of the demolition of the existing retail unit, with the construction of a double level basement to a depth of up to 9.2mbgl over the site with residential accommodation above ground level.

5.4. A similar planning proposal has already been granted, with much of the basement wall and slab construction has been undertaken, therefore ground movements and wall construction has not been considered within this audit.

5.5. A site specific SI has been undertaken with two boreholes carried out. Specific details of the SI have not been provided. Ground water was not encountered during the SI.

5.6. The geology has been identified as made ground overlaying the London Clay formation, with the top of the clay strata varying between 5mbgl and 2.2mbgl.

5.7. The proposed basement wall structure is proposed as sheet piling with a RC liner wall. RC floors are to permanent prop the walls at each level. A raft foundation is proposed to bear onto the London Clay.

5.8. Due to the advanced construction stage of the basement the scope of this audit does not consider ground movement considerations, retaining wall stability or design, or temporary works proposals.

5.9. SUDs are proposed which will reduce run off in accordance with The London Plan.

5.10. Due to the lack of ground water during the SI it is accepted that the proposal is unlikely to impact on ground water. However care should be taken during construction in order to identify any historic water courses with mitigation measures enacted as maintain drainage routes of any ground water that may exist.

5.11. It is accepted that there are no slope stability concerns regarding the proposed development and it is not in an area prone to flooding.

5.12. It can be confirmed that the proposal adheres to the requirements of CPG4.

Appendix 1: Residents' Consultation Comments

None

Appendix 2: Audit Query Tracker

None

Appendix 3: Supplementary Supporting Documents

65-69 Holmes Road

Residential Development in Kentish Town
65-69 Holmes Road, London, NW5 3AN

Drainage Strategy Report

For Hallmark Property Group

06th April 2018

1980_RP_D_FRA_01

Rev	Date	Purpose/Status	Document Ref.	QA
0	15/12/17	For comment		RC/JD
A	06/04/18	For Information	1980 –RP_D_FRA_01	RC/JD

Disclaimer

This report is for the use of the client only and is not for the use of any other parties without the express permission of the client. All calculations and related quantified assumptions are indicative for planning purpose only, and are based solely on the available design proposals and must be reassessed during detailed design with the appropriate compliance methodology.

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Executive Summary

Vortex Ltd has been appointed by Hallmark Property Group to design the surface water drainage aspects of the proposed development at 65-69, Holmes Road, London, NW5 3AN.

The report outlines the strategy for the surface water drainage for the redeveloped site.

It is advised that a combination of Sustainable Drainage Systems (SUDS) is used to increase the time of concentration of the water before it enters the Thames Water combined sewer in Cathcart Street and reduce the impact upon the receiving sewer.

This can be achieved by using Green roofs, Stormwater storage tanks and orifice plates to restrict discharge rates.

This combination of SUDS and retention currently designed will reduce surface runoff for the 1 in 100 year storm return period + 30% climate change allowance to a rate of 34.2 l/s, runoff for the 1 in 30 year storm return period to a rate of 23.8 l/s and runoff for the 1 in 1 year storm return period to a rate of 4.7l/s. This is in line with, and a slight betterment, to the Pringuer-James sustainable drainage systems strategy report, reference L1405, dated July 2016.

Attenuation has been designed to assume the Green roofs to be saturated during the worst case 1 in 100 year storm event with a climate change allowance of 30%. The volume of attenuation has been calculated to be approx. 45.0 m^3.

1.0 Existing Drainage

The total existing site area is 0.245Ha of which approximately 0.245Ha (100%) is existing impermeable surfacing which includes car parking, buildings and hard landscaping.

A topographical survey has identified that surface water sewers exist within the site boundaries and that they discharge to the Thames Water combined public sewer in Cathcart Street.

A copy of the topographical survey is shown in Appendix A.

The surface water sewer currently discharges from the site at an unrestricted rate, without attenuation.

The Microdrainage calculations of the existing flow rates are shown in Appendix B.

2.0 Proposed Drainage Strategy

Within the site it is proposed to collect surface water at high level and direct it to a Stormwater attenuation tank on the mezzanine floor via rainwater pipes.

The surface water network will include a complex flow control device, consisting of two 50mm and 100 mm diameter orifice plates. One at invert level to cater for the 1 in 1 year storm event and the other 0.9m above invert level to cater for the 1 in 30 and 1in 100 year storm events.

The Drainage Layout drawings are shown in Appendix C.

2.1 Surface Water Drainage

In accordance with Ciria 753, SUDS Manual, flooding is permitted above ground during the 1 in 100 year storm event and all water must be stored below ground during the 1 in 30 year storm event. However, in this instance due to the topography of the site all attenuation will be below external ground level for the 1 in 100 year storm to ensure that no surface water leaves the site without going through the proposed control manhole.

In accordance with the current Local Water Authority technical guidance a climate change allowance of 30% has been allowed within the surface water calculations for the development

Proposed surface water calculations are shown in Appendix D.

SUDS techniques will be included where local ground conditions permit. In conjunction with the surface water management requirements, consideration of green roofs, infiltration devices, and rainwater harvesting techniques will be made. These methods are further detailed in Section 5.

The flows at the outfall will require attenuation to comply with discharge consent limits. This is still to be agreed with Thames Water Utilities ltd under a Section 106 Sewer connection agreement.

2.1.1 Proposed Infrastructure

It is proposed that the surface water drainage system will take the form of a network of pipes transferring surface water within the building.

Surface water discharge will be restricted, and water will be attenuated within the Development Site boundaries.

2.1.2 Standards

The performance of the surface water drainage system will be designed to Sewers for Adoption 6th Edition. This requires the pipes to be sized so they can run full during a simulated 1 in 1 year storm of all durations, but there will be no surcharging within manholes. Additionally, the drainage system has to be tested to ensure there is no flooding as a result of a simulated 1 in 30% year storm of any duration. For storms in excess of this, the standard requires consideration of the route flood water will take to avoid ingress into properties. The latter has been achieved by the use stormwater tanks to attenuate the worst case 1 in 100 year storm event to prevent flooding.

In accordance with the Local Water Authority guidance a climate change allowance of 30% is to be used within the proposed surface water calculations.

The materials specification for the scheme will be in accordance with the Highways Agency Specification for Highway Works. For the purposes of the indicative design, the following material types have been assumed:

- Drainage pipes up to 300mm diameter – Vitrified clayware, plastic pipes will be permitted subject to ground conditions.
- Pipes within the building footprint are to be cast iron.
- Drainage pipes over 300mm diameter - Concrete
- Manholes and chambers - Precast concrete with concrete surround or PPIC
- Gullies - precast concrete
- Chamber covers – Class D400 infill type in higher quality paved areas.
- Class D400 standard type in all other road / park areas
- Class C250 standard type in all footpath areas
- Pipe bedding - Imported granular
- Pipe Trench backfill - Selected as dug or imported material
- Manholes should be located at every change of alignment or gradient; at the head of all sewers; at the every junction of a public sewer

The drainage shall be designed utilizing the following criteria:

- Minimum flow velocity 1.0m/s for self-cleansing
- Standard pipe roughness “Ks” of 0.6.

3.0 Surface Water Flows

3.1 Existing and proposed site run-off flows

An extract from the Pringuer-James report is shown in Appendix B and a summary of flow rates are shown in table 1 below.

The existing and proposed flow calculations do not include a reduction in time of concentration or of impermeable areas and are treated as worst case scenario when the Green roofs are in a saturated condition.

A summary of the existing and proposed peak flows are detailed in Table 1 below and include the 40% climate change allowance for the worst case 1 in 100 year storm event.

Return Period	Qbar l/s	50%Qbar l/s	Proposed l/s
1 in 1 year	24.71	12.36	4.7
1 in 30 years	61.7	30.85	23.8
1 in 100 years	48.65	39.33	34.2

Table 1: Summary of Existing and Proposed Surface Water Flows

The existing surface water calculations are shown in Appendix B and the proposed surface water calculations are shown in Appendix D.

4.0 Stormwater Attenuation

It is proposed that Sustainable Urban Drainage Systems (SUDS) will be the primary consideration for surface water management. There are a number of different methods that may be used to provide sufficient attenuation of the surface water described in Section 5 below.

Attenuation should be positioned as close to the outfall as possible and would control the surface water discharge from the site. Implementation of one or all of the SUDS methods outlined in Section 5 of this report is highly recommended to reduce the requirement for below ground storage.

Existing Surface Water volume calculations shown in Appendix E indicate that 126.5m^3 of surface water will be generated by the 6 hour 1 in 100 year storm event.

Surface Water calculations shown in Appendix F indicate that 164.4m3 of surface water will be generated by the 6 hour 1 in 100 year storm event including a 30% climate change allowance.

A summary of the existing volumes is detailed in Table 2 below.

Return Period	Existing Volume Generated m^3
1 in 1 year	44.1
1 in 30 years	97.5
1 in 100 years	126.5
1 in 100 years +30%	164.4

Table 2: Summary of Existing and Proposed Surface Water Volumes

The Microdrainage calculations in Appendix D shows that no flooding occurs during the worst case 1 in 100 year storm event with a 30% climate change allowance.

Therefore the proposed attenuation system is suitable for supporting the proposed development.

5.0 Sustainable Urban Drainage Systems (SUDS)

The objective of SUDS is to minimise the impacts of the development on the quantity and quality of site runoff and maximise amenity and biodiversity opportunities. Surface water SUDS will be designed and installed in accordance with NPPF and associated technical guidance March 2012 and associated CIRIA documents.

The mix of SUDS to be used is determined by the conditions on site, in this case a development with areas of external space which can be utilised for SUDS. The methodology of surface water control is to slow the entry of the surface water into the system, by using roof level brown roofs and porous paving that increases the time of concentration (time for water to flow through the system). Then retain the runoff, by using above ground storage and porous paving, which will release it into the Watercourse at an agreed rate to limit the impact of the development on drainage infrastructure and therefore reduce the potential for flooding.

5.1 Infiltration Devices

Infiltration devices drain water directly into the ground. Infiltration trenches and soakaways are more practicable for urban sites with limited space available. Infiltration devices can be integrated into and form part of the landscaped areas.

Infiltration trenches are completely below ground, and water should not occur on the surface.

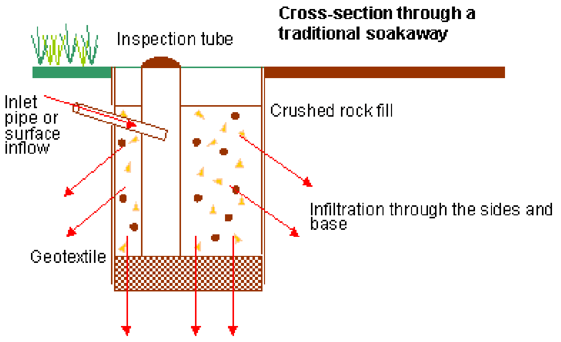


Figure 1 – Typical cross section through infiltration trench

Advantages – Reduces the volume of runoff, effective at pollutant removal, contributes to ground water recharge, simple and cost effective.

Disadvantages – Potentially high failure rates, comprehensive ground investigations required, offset from foundations (min. 5m away), risk of ground water pollution, reduced performance during prolonged wet periods.

Suitable for use – **No**, No Space for such devices and site subsoils are of clay content with poor infiltration properties.

5.2 Brown/Green Roofs

Green roofs comprise a multi-layered system that covers the roof of a building or podium structure with vegetation cover/landscaping over a drainage layer. They are designed to intercept and retain precipitation, increasing the time of concentration and reducing the volume of runoff and attenuation peak flows. Green roofs can be anything from a thin growing layer of sedums and mosses to plants, shrubs and large trees.

These roofs vary in specification and can be designed to attract bird and invertebrate species. Referring to CIRIA document C644, green and brown roofs also participate in attenuating rain water. This would reduce the requirement for below ground storage attenuation on the site.

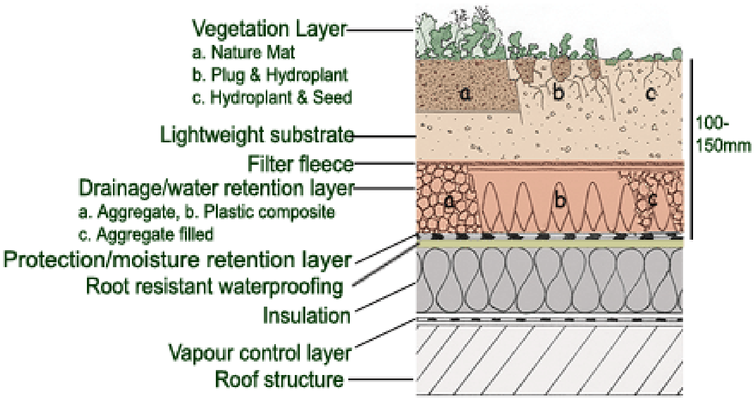


Figure 2 – Typical section through green roof build up

Advantages – Mimic greenfield state of building footprint, good removal of pollutants, ecological and amenity benefits, improve air quality, insulates building.

Disadvantages – Costs, increased structural loading, roof height, design, maintenance and exposure may preclude use.

Suitable for use – **Yes**, Green roofs are proposed.

5.3 Rainwater Harvesting

These tanks act as mini-storage chambers for surface water, reducing the extent of underground storage required. They provide a source of water for plant irrigation, washing machines and for flushing wc's

Harvested rainwater is stored below ground and pumped to provide a substitute for potable mains water reducing both the site discharge and water consumption.

Figure 4 – Rainwater Harvesting

Advantages – Provided source control of storm water runoff, reduces demand on mains water.

Disadvantages – Costs, Risk to public health, use dependant on demand requirements and seasonal rainfall characteristics, maintenance of pumps & control systems.

Suitable for use – **No –** not part of current proposal.

5.4 Porous Paving

Porous pavement is an alternative to conventional paving in which water permeates through the paved structure rather than draining off it. The surface water will be held in a reservoir structure (high void content sub-base) under the pavement for subsequent delayed discharge or infiltration into the sub-strata below.

The porous paving can be materials such as gravel, grasscrete, porous (no fines) concrete, concrete blocks or porous asphalt. Pollutant removal rates have been shown to be high, as the majority of the removal occurs as a result of the filtration of the water through the aggregate sub-base.

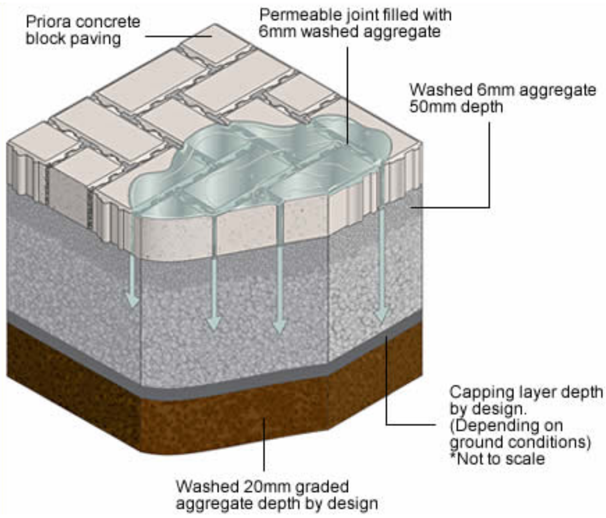


Figure 3 – Typical section through porous paving

Advantages – Effective in removing pollutants, lined systems can be used to avoid infiltration, reduces volume and rate of surface water runoff, suitable for high density developments. Mimics existing Greenfield conditions by filtering into the surrounding soft landscaped areas.

Disadvantages – Costs, used for low traffic volumes, low axel loads and speeds, risk of long term clogging due to poor maintenance.

Suitable for use – **No**. There is no space available for such construction due to the proposed basements.

5.5 Below Ground Attenuation

Attenuation involves the storing of surface water within pipework or underground tanks prior to controlled discharge into the public system. Attenuation tanks can also provide off line storage.

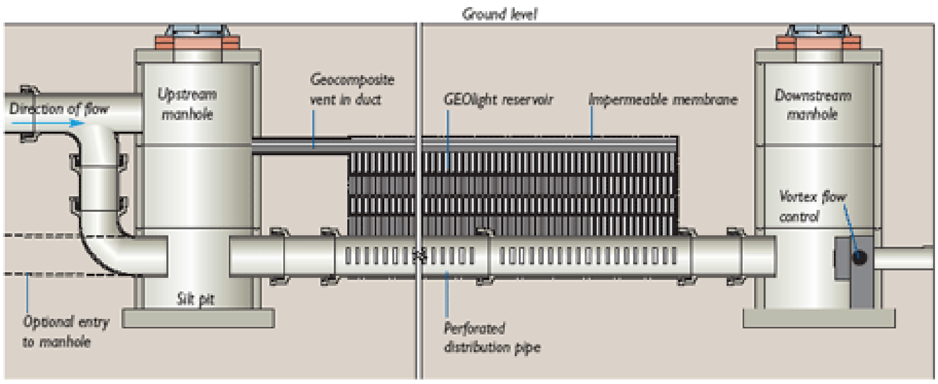


Figure 5 – Typical section through below ground attenuation chamber (cellular storage)

Advantages – Effective storage of surface water, can be used below trafficked areas, can be used below public open areas, minimum maintenance.

Disadvantages – No water quality treatment.

Suitable for use –. **No,** there is no space available

5.6 Wetlands

Wetlands provide both stormwater attenuation and treatment. They comprise shallowponds and marshy areas, covered in aquatic vegetation. Wetlands provide settlement of sediment and remove contaminants.

Advantages – Effective storage of surface water, good pollutant removal, ecological and amenity benefits.

Disadvantages – Requires large surface area. Health & Safety issues associated with large bodies of water.

Suitable for use – **No,** there is no space available.

5.7 Swales

Swales are vegetated drainage structures up to 500mm deep and used to provide flow control through attenuation. They can be used for infiltration, where possible.

Advantages – Can be incorporated into landscaping, good removal of contaminants, reduces discharge rates. Low costs.

Disadvantages – Requires large surface area. Limits extent of trees used in landscaping. Health & Safety issues associated with large bodies of water following heavy rainfall.

Suitable for use – **No,** there is no space available.

5.8 Ponds/Rain gardens

Ponds or rain gardens are irregular shaped vegetated drainage structures used to provide flow control through attenuation. They can be used for infiltration, where possible.

Advantages – Can be incorporated into landscaping, good removal of contaminants, reduces discharge rates. Low costs.

Disadvantages – Requires large surface area. Limits extent of trees used in landscaping. Health & Safety issues associated with large bodies of water following heavy rainfall.

Suitable for use – **No,** there is no space available.

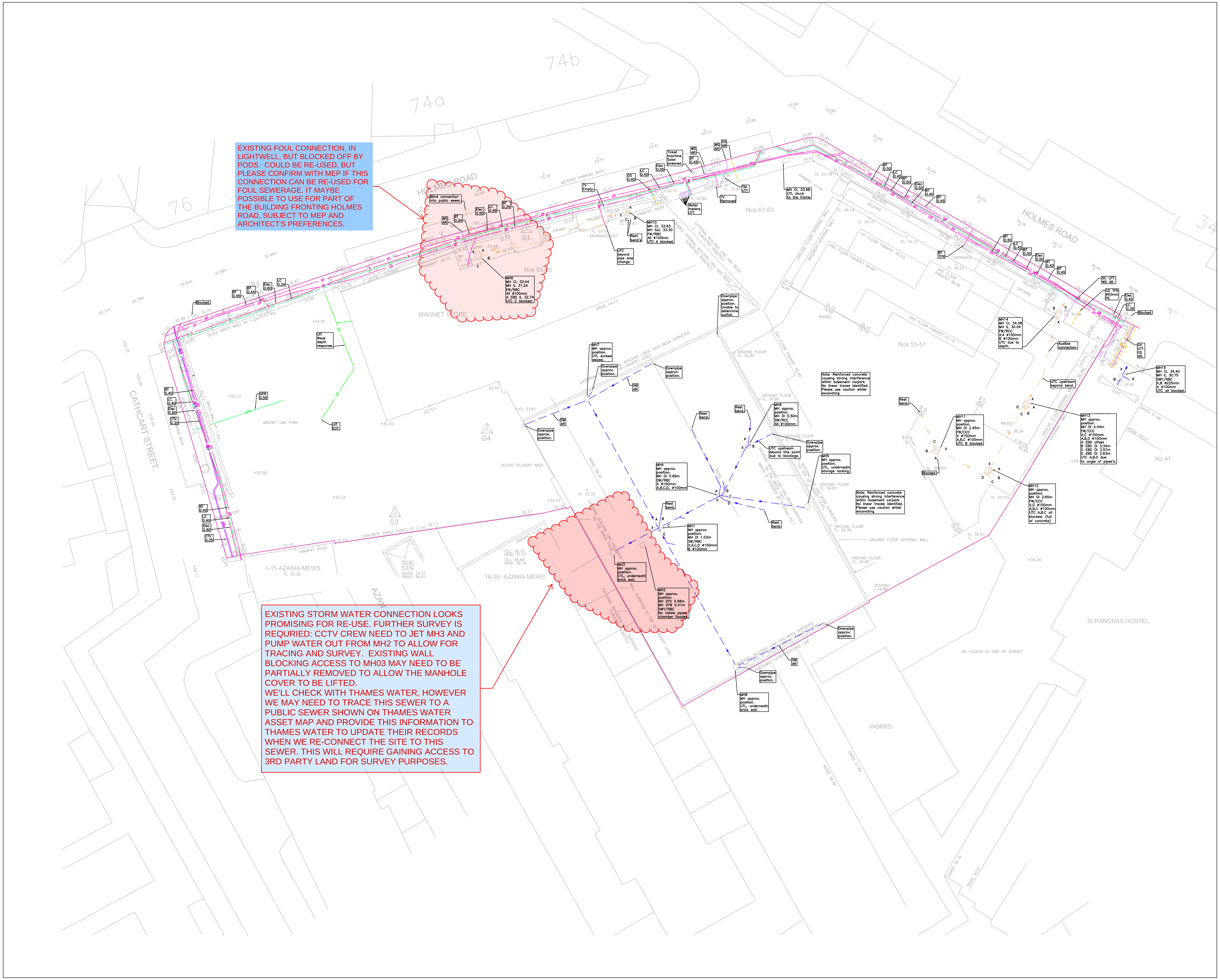
6.0 Proposed SUDS Strategy

The proposed surface water drainage system for the development will incorporate 45m^3 Stormwater storage tanks for attenuation and flows will be restricted to a maximum of 34.2l/s for the worst case 1 in 100 year storm event +30% climate change allowance.

Green roofs are proposed and will be designed by a specialist company. They will be designed to capture the first 5mm of rainfall so that it can be retained for plant use as well as evaporation. Green roofs, by nature, provide primary treatment and improve biodiversity. Benefit to the community will be dependent upon the type of roof and planting proposed.

Appendix A

Topographical Survey



UTILITIES & UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

1D 5C	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CrL	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCr	Depth To Crown	IL	Invert Level
BL	Base Level	DI	Depth To Invert	RBC	Rectangular Brick Chamber
CB	Concrete Benching	DS	Depth To Silt	RCC	Rectangular Conc Chamber
CBC	Circular Brick Chamber	DTB	Depth To Base	SL	Silt Level
CCC	Circular Conc Chamber	DTW	Depth To Water	TFR	Taken From Records
CL	Cover Level	EBD	External Backdrop	UTC	Unable To CCTV
				UTL	Unable To Lift
				UTT	Unable To Trace

- BT — BT CABLE(S)
- O/BT — OVERHEAD BT CABLE(S)
- COM — COMMUNICATIONS CABLE(S)
- CTV — CABLE TV CABLE(S)
- E — ELECTRIC CABLE(S)
- O/E — OVERHEAD ELECTRIC CABLE(S)
- FO — FIBREOPTIC CABLE(S)
- GM — GAS MAIN
- GS — GAS SERVICE
- GPR — GROUND PENETRATING RADAR (GPR) TRACE
- HW — HOT WATER PIPE
- LC — LIGHTING CIRCUIT
- SEC — SECURITY CABLING
- UIT — UNIDENTIFIED TRACE
- WM — WATER MAIN
- WS — WATER SERVICE
- COMBINED SEWER
- FOUL SEWER
- RISING MAIN
- SURFACE WATER SEWER
- UTILITIES INVESTIGATION EXTENTS

MH CL 48.93 — UTILITIES COMMENT BOX

WM 0.61 — DEPTH TO SERVICE

DRAWING NOTES

All below ground details shown have been identified from above ground without excavation. Survey Solution use electro-magnetic and/or ground penetrating radar (GPR) methods to investigate for underground utilities, services and features. Results using these methods are not infallible and we recommend trial excavations are carried out to confirm any identifications, positions and depths.

Any areas on the drawing where services or features have not been shown are not necessarily clear of services or features but are an indication that no items have been identified during our investigations. All reasonable care and normal good practice should still be employed during design and construction processes.

Certain types of services such as plastic or concrete pipes, some conduit and ducting where direct access can not be achieved for tracing may not be shown and alternative locating methods should be used.

Survey Solutions has used all reasonable care to research available service records but the completeness or use of the service records supplied to or by Survey Solutions cannot be guaranteed. Therefore Survey Solutions cannot be held responsible for any features annotated as 'taken from records' (TFR).

Depths obtained using electro-magnetic or GPR are effected by ground conditions and should be treated as indicative only. Electro-magnetic depths to utilities and services are generally taken to the centre of a feature, GPR depths to the top of a feature and drainage depth shown to inverts, unless otherwise indicated.

Drainage pipe sizes will be obtained without entering the camber and therefore should be treated as approximate. Pipe dimensions which have not been obtained visually will be taken from records when available.

All services, drainage and utilities routes are assumed straight between access points, unless otherwise stated. The numbers of cables in runs will not be shown unless specifically requested. All services are below ground unless indicated.

Services, utilities and features may not have been surveyed if obstructed or not reasonably visible or accessible at the time of survey.

Survey Solutions accept no responsibility for the completeness or accuracy of either the topographical survey or base mapping on this project.

All critical dimensions and measurements should be checked and verified with any errors or discrepancies notified to Survey Solutions immediately. The accuracy of the digital data is the same as the plotting scale implies. All dimensions are in metres unless otherwise stated.

The contractor must check and verify all site and building dimensions, levels, utilities and drainage details and connections prior to commencing work.

Do not scale from this drawing.

AVAILABILITY OF UTILITY RECORD DRAWINGS

UTILITY	AVAILABILITY	UTILITY	AVAILABILITY	UTILITY	AVAILABILITY
SEWER	NO	BT	PUBLIC	OIL PIPES	NO
WATER MAIN	NO	CABLE TV	NO	OTHERS	NO
GAS MAIN	PUBLIC	ELECTRICITY	NO		

REV	DESCRIPTION	DRAWN	APPR	DATE

SURVEY SOLUTIONS

Ipswich Coventry Yeovil Norwich Perth Nottingham Brentwood

Tel No: 0845 0405 969 Fax No: 0845 0405 970
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LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE
65-69 HOLMES ROAD
LONDON, NW5 3AN

DRAWING DETAIL
UTILITIES AND CCTV DRAINAGE INVESTIGATION
SHEET 1 OF 1

CLIENT				SCALE
CONTEMPORARY DESIGN SOLUTIONS LLP				1:200
SURVEYOR	SURVEY DATE	CHECKED BY	APPROVED BY	DWG STATUS
SRF/PI	13/07/2016	LMP	RAG	FINAL
DRAWING NUMBER			REVISION	ISSUE DATE
18004UG-01				JULY 2016

Original Sheet Size A1H

Appendix B

Pre-development surface water calculations

Greenfield runoff estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Ray Clark
Site name:	65-69 Holmes Road
Site location:	65-69 Holmes Road

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site coordinates

Latitude:	51.54942° N
Longitude:	0.14485° W
Reference:	6200902
Date:	2017-12-15T11:10:48

Methodology	IH124

Site characteristics

Total site area (ha)	0.245

Methodology

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type

	Default	Edited
SOIL type	4	4
HOST class	---	---
SPR/SPRHOST	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm)	641	641
Hydrological region	6	6
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 30 year	2.3	2.3
Growth curve factor: 100 year	3.19	3.19

Notes:

(1) Is Q_{BAR} < 2.0 l/s/ha?

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consents are usually set at 5.0l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set in which case blockage work must be addressed by using appropriate drainage elements

(3) Is SPR/SPRHOST ≤ 0.3?

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	1.07	1.07
1 in 1 year (l/s)	0.91	0.91
1 in 30 years (l/s)	2.45	2.45
1 in 100 years (l/s)	3.4	3.4

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.600	Add Flow / Climate Change (%)	0
Ratio R	0.436	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.189	4-8	0.056

Total Area Contributing (ha) = 0.245

Total Pipe Volume (m³) = 5.655

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	20.000	0.100	200.0	0.065	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	20.000	0.100	200.0	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	20.000	0.100	200.0	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	20.000	0.100	200.0	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.30	22.000	0.065	0.0	0.0	0.0	1.11	78.3	8.8
1.001	50.00	5.60	21.900	0.125	0.0	0.0	0.0	1.11	78.3	16.9
1.002	50.00	5.90	21.800	0.185	0.0	0.0	0.0	1.11	78.3	25.1
1.003	50.00	6.20	21.700	0.245	0.0	0.0	0.0	1.11	78.3	33.2

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003	EX	23.000	21.600	21.600	1200	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Storm Duration (mins)	30
Ratio R	0.436		

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.436
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 450.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1
Climate Change (%) 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	1	+0%					22.075
1.001	2	15 Winter	1	+0%					22.002
1.002	3	15 Winter	1	+0%					21.924
1.003	4	15 Winter	1	+0%					21.843

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.225	0.000	0.14		9.5	OK	
1.001	2	-0.198	0.000	0.25		17.0	OK	
1.002	3	-0.176	0.000	0.35		24.1	OK	
1.003	4	-0.157	0.000	0.46		31.2	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.600	Add Flow / Climate Change (%)	0
Ratio R	0.436	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.189	4-8	0.056

Total Area Contributing (ha) = 0.245

Total Pipe Volume (m³) = 5.655

Network Design Table for Storm

PN	**Length (m)**	**Fall (m)**	**Slope (1:X)**	**I.Area (ha)**	**T.E. (mins)**	**Base Flow (l/s)**	**k (mm)**	**HYD SECT**	**DIA (mm)**	**Section Type**	**Auto Design**
1.000	20.000	0.100	200.0	0.065	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	20.000	0.100	200.0	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	20.000	0.100	200.0	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	20.000	0.100	200.0	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	**Rain (mm/hr)**	**T.C. (mins)**	**US/IL (m)**	**Σ I.Area (ha)**	**Σ Base Flow (l/s)**	**Foul (l/s)**	**Add Flow (l/s)**	**Vel (m/s)**	**Cap (l/s)**	**Flow (l/s)**
1.000	50.00	5.30	22.000	0.065	0.0	0.0	0.0	1.11	78.3	8.8
1.001	50.00	5.60	21.900	0.125	0.0	0.0	0.0	1.11	78.3	16.9
1.002	50.00	5.90	21.800	0.185	0.0	0.0	0.0	1.11	78.3	25.1
1.003	50.00	6.20	21.700	0.245	0.0	0.0	0.0	1.11	78.3	33.2

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003	EX	23.000	21.600	21.600	1200	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Storm Duration (mins)	30
Ratio R	0.436		

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.436
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 450.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 30
Climate Change (%) 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	30	+0%					22.171
1.001	2	15 Winter	30	+0%					22.148
1.002	3	15 Winter	30	+0%	30/15 Winter				22.105
1.003	4	15 Winter	30	+0%	30/15 Summer				22.025

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.129	0.000	0.33		22.4	OK	
1.001	2	-0.052	0.000	0.61		41.4	OK	
1.002	3	0.005	0.000	0.88		60.4	SURCHARGED	
1.003	4	0.025	0.000	1.16		79.3	SURCHARGED	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.600	Add Flow / Climate Change (%)	0
Ratio R	0.436	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.189	4-8	0.056

Total Area Contributing (ha) = 0.245

Total Pipe Volume (m³) = 5.655

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	20.000	0.100	200.0	0.065	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	20.000	0.100	200.0	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	20.000	0.100	200.0	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	20.000	0.100	200.0	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.30	22.000	0.065	0.0	0.0	0.0	1.11	78.3	8.8
1.001	50.00	5.60	21.900	0.125	0.0	0.0	0.0	1.11	78.3	16.9
1.002	50.00	5.90	21.800	0.185	0.0	0.0	0.0	1.11	78.3	25.1
1.003	50.00	6.20	21.700	0.245	0.0	0.0	0.0	1.11	78.3	33.2

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003	EX	23.000	21.600	21.600	1200	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Storm Duration (mins)	30
Ratio R	0.436		

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.436
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 450.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 100
Climate Change (%) 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	100	+0%	100/15 Summer				22.348
1.001	2	15 Winter	100	+0%	100/15 Summer				22.318
1.002	3	15 Winter	100	+0%	100/15 Summer				22.256
1.003	4	15 Winter	100	+0%	100/15 Summer				22.120

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.048	0.000	0.42		28.5	SURCHARGED	
1.001	2	0.118	0.000	0.78		53.4	SURCHARGED	
1.002	3	0.156	0.000	1.14		77.8	SURCHARGED	
1.003	4	0.120	0.000	1.50		102.7	SURCHARGED	

Appendix C

Drainage Strategy Layout

Appendix D

Post Development surface water calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	20.600	Add Flow / Climate Change (%)	0
Ratio R	0.438	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	1	Maximum Backdrop Height (m)	10.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Inverts

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.162	4-8	0.083

Total Area Contributing (ha) = 0.245

Total Pipe Volume (m³) = 6.715

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	30.000	0.200	150.0	0.080	5.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	30.000	0.200	150.0	0.080	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	30.000	0.200	150.0	0.085	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	20.000	0.200	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	1.00	5.39	31.700	0.080	0.0	0.0	0.0	1.28	90.6	0.2
2.000	1.00	5.39	31.700	0.080	0.0	0.0	0.0	1.28	90.6	0.2
1.001	1.00	5.78	31.500	0.245	0.0	0.0	0.0	1.28	90.6	0.7
1.002	1.00	6.11	29.400	0.245	0.0	0.0	0.0	1.00	17.8	0.7

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
1	32.300	0.600	Open Manhole	300	1.000	31.700	300				
2	32.300	0.600	Open Manhole	300	2.000	31.700	300				
3	32.300	0.800	Open Manhole	300	1.001	31.500	300	1.000	31.500	300	
								2.000	31.500	300	
4	32.300	2.900	Open Manhole	1500	1.002	29.400	150	1.001	31.300	300	2050
EXISTING	32.300	3.100	Open Manhole	300		OUTFALL		1.002	29.200	150	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	300	1	32.300	31.700	0.300	Open Manhole	300
2.000	o	300	2	32.300	31.700	0.300	Open Manhole	300
1.001	o	300	3	32.300	31.500	0.500	Open Manhole	300
1.002	o	150	4	32.300	29.400	2.750	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	30.000	150.0	3	32.300	31.500	0.500	Open Manhole	300
2.000	30.000	150.0	3	32.300	31.500	0.500	Open Manhole	300
1.001	30.000	150.0	4	32.300	31.300	0.700	Open Manhole	1500
1.002	20.000	100.0	EXISTING	32.300	29.200	2.950	Open Manhole	300

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.002	EXISTING	32.300	29.200	29.300	300	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.438
Return Period (years)	1	Profile Type	Summer
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.600	Cv (Winter)	0.840

Synthetic Rainfall Details

Storm Duration (mins) 30

Online Controls for Storm

Complex Manhole: 4, DS/PN: 1.002, Volume (m³): 7.2

Orifice

Diameter (m) 0.050 Discharge Coefficient 0.600 Invert Level (m) 29.400

Orifice

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 30.400

Storage Structures for Storm

Cellular Storage Manhole: 4, DS/PN: 1.002

Invert Level (m) 29.400 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	20.0	20.0	2.501	0.0	64.7
2.500	20.0	64.7			

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

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.438
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.600 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 450.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 100
Climate Change (%) 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	100	+30%	100/15 Summer				32.251
2.000	2	15 Winter	100	+30%	100/15 Summer				32.251
1.001	3	15 Winter	100	+30%	100/15 Summer				32.141
1.002	4	30 Winter	100	+30%	100/15 Summer				32.002

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.251	0.000	0.54		44.4	FLOOD RISK	
2.000	2	0.251	0.000	0.54		44.4	FLOOD RISK	
1.001	3	0.341	0.000	1.62		133.6	FLOOD RISK	
1.002	4	2.452	0.000	2.05		34.2	FLOOD RISK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	20.600	Add Flow / Climate Change (%)	0
Ratio R	0.438	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	1	Maximum Backdrop Height (m)	10.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Inverts

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.162	4-8	0.083

Total Area Contributing (ha) = 0.245

Total Pipe Volume (m³) = 6.715

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	30.000	0.200	150.0	0.080	5.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	30.000	0.200	150.0	0.080	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	30.000	0.200	150.0	0.085	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	20.000	0.200	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	1.00	5.39	31.700	0.080	0.0	0.0	0.0	1.28	90.6	0.2
2.000	1.00	5.39	31.700	0.080	0.0	0.0	0.0	1.28	90.6	0.2
1.001	1.00	5.78	31.500	0.245	0.0	0.0	0.0	1.28	90.6	0.7
1.002	1.00	6.11	29.400	0.245	0.0	0.0	0.0	1.00	17.8	0.7

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
1	32.300	0.600	Open Manhole	300	1.000	31.700	300				
2	32.300	0.600	Open Manhole	300	2.000	31.700	300				
3	32.300	0.800	Open Manhole	300	1.001	31.500	300	1.000	31.500	300	
								2.000	31.500	300	
4	32.300	2.900	Open Manhole	1500	1.002	29.400	150	1.001	31.300	300	2050
EXISTING	32.300	3.100	Open Manhole	300		OUTFALL		1.002	29.200	150	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	300	1	32.300	31.700	0.300	Open Manhole	300
2.000	o	300	2	32.300	31.700	0.300	Open Manhole	300
1.001	o	300	3	32.300	31.500	0.500	Open Manhole	300
1.002	o	150	4	32.300	29.400	2.750	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	30.000	150.0	3	32.300	31.500	0.500	Open Manhole	300
2.000	30.000	150.0	3	32.300	31.500	0.500	Open Manhole	300
1.001	30.000	150.0	4	32.300	31.300	0.700	Open Manhole	1500
1.002	20.000	100.0	EXISTING	32.300	29.200	2.950	Open Manhole	300

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.002	EXISTING	32.300	29.200	29.300	300	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.438
Return Period (years)	1	Profile Type	Summer
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.600	Cv (Winter)	0.840

Synthetic Rainfall Details

Storm Duration (mins) 30

Online Controls for Storm

Complex Manhole: 4, DS/PN: 1.002, Volume (m^3): 7.2

Orifice

Diameter (m) 0.050 Discharge Coefficient 0.600 Invert Level (m) 29.400

Orifice

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 30.400

Storage Structures for Storm

Cellular Storage Manhole: 4, DS/PN: 1.002

Invert Level (m) 29.400 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	20.0	20.0	2.501	0.0	64.7
2.500	20.0	64.7			

Appendix E

Pre-development surface water volume calculations

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Volume (m³)	Status
360 min Summer	23.203	0.303	39.3	O K
360 min Winter	23.239	0.339	44.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
360 min Summer	3.569	0.0	368
360 min Winter	3.569	0.0	368

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.400	Shortest Storm (mins)	360
Ratio R	0.436	Longest Storm (mins)	360
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.245

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.125	4	8	0.120

Model Details

Storage is Online Cover Level (m) 25.400

Tank or Pond Structure

Invert Level (m) 22.900

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	130.0	2.500	130.0

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Volume (m³)	Status
360 min Summer	23.569	0.669	87.0	O K
360 min Winter	23.650	0.750	97.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
360 min Summer	7.892	0.0	368
360 min Winter	7.892	0.0	368

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)	20.400	Shortest Storm (mins)	360
Ratio R	0.436	Longest Storm (mins)	360
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.245

Time (mins) From:	**To:**	**Area (ha)**	**Time (mins) From:**	**To:**	**Area (ha)**
0	4	0.125	4	8	0.120

Model Details

Storage is Online Cover Level (m) 25.400

Tank or Pond Structure

Invert Level (m) 22.900

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	130.0	2.500	130.0

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Volume (m³)	Status
360 min Summer	23.769	0.869	112.9	O K
360 min Winter	23.873	0.973	126.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
360 min Summer	10.244	0.0	368
360 min Winter	10.244	0.0	368

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)	20.400	Shortest Storm (mins)	360
Ratio R	0.436	Longest Storm (mins)	360
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.245

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.125	4	8	0.120

Model Details

Storage is Online Cover Level (m) 25.400

Tank or Pond Structure

Invert Level (m) 22.900

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	130.0	2.500	130.0

Appendix F

Post-development surface water volume calculations

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

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.438
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.600 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 450.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 30
Climate Change (%) 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	30	+0%					31.825
2.000	2	15 Winter	30	+0%					31.825
1.001	3	15 Winter	30	+0%					31.769
1.002	4	30 Winter	30	+0%	30/15 Summer				31.115

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.175	0.000	0.35		28.4	OK	
2.000	2	-0.175	0.000	0.35		28.4	OK	
1.001	3	-0.031	0.000	1.00		82.3	OK	
1.002	4	1.565	0.000	1.42		23.8	SURCHARGED	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	20.600	Add Flow / Climate Change (%)	0
Ratio R	0.438	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	1	Maximum Backdrop Height (m)	10.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Inverts

Time Area Diagram for Storm

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.162	4-8	0.083

Total Area Contributing (ha) = 0.245

Total Pipe Volume (m³) = 6.715

Network Design Table for Storm

PN	**Length (m)**	**Fall (m)**	**Slope (1:X)**	**I.Area (ha)**	**T.E. (mins)**	**Base Flow (l/s)**	**k (mm)**	**HYD SECT**	**DIA (mm)**	**Section Type**	**Auto Design**
1.000	30.000	0.200	150.0	0.080	5.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	30.000	0.200	150.0	0.080	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	30.000	0.200	150.0	0.085	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	20.000	0.200	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	**Rain (mm/hr)**	**T.C. (mins)**	**US/IL (m)**	**Σ I.Area (ha)**	**Σ Base Flow (l/s)**	**Foul (l/s)**	**Add Flow (l/s)**	**Vel (m/s)**	**Cap (l/s)**	**Flow (l/s)**
1.000	1.00	5.39	31.700	0.080	0.0	0.0	0.0	1.28	90.6	0.2
2.000	1.00	5.39	31.700	0.080	0.0	0.0	0.0	1.28	90.6	0.2
1.001	1.00	5.78	31.500	0.245	0.0	0.0	0.0	1.28	90.6	0.7
1.002	1.00	6.11	29.400	0.245	0.0	0.0	0.0	1.00	17.8	0.7

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
1	32.300	0.600	Open Manhole	300	1.000	31.700	300				
2	32.300	0.600	Open Manhole	300	2.000	31.700	300				
3	32.300	0.800	Open Manhole	300	1.001	31.500	300	1.000	31.500	300	
								2.000	31.500	300	
4	32.300	2.900	Open Manhole	1500	1.002	29.400	150	1.001	31.300	300	2050
EXISTING	32.300	3.100	Open Manhole	300		OUTFALL		1.002	29.200	150	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	300	1	32.300	31.700	0.300	Open Manhole	300
2.000	o	300	2	32.300	31.700	0.300	Open Manhole	300
1.001	o	300	3	32.300	31.500	0.500	Open Manhole	300
1.002	o	150	4	32.300	29.400	2.750	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	30.000	150.0	3	32.300	31.500	0.500	Open Manhole	300
2.000	30.000	150.0	3	32.300	31.500	0.500	Open Manhole	300
1.001	30.000	150.0	4	32.300	31.300	0.700	Open Manhole	1500
1.002	20.000	100.0	EXISTING	32.300	29.200	2.950	Open Manhole	300

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.002	EXISTING	32.300	29.200	29.300	300	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.438
Return Period (years)	1	Profile Type	Summer
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.600	Cv (Winter)	0.840

Synthetic Rainfall Details

Storm Duration (mins) 30

Online Controls for Storm

Complex Manhole: 4, DS/PN: 1.002, Volume (m³): 7.2

Orifice

Diameter (m) 0.050 Discharge Coefficient 0.600 Invert Level (m) 29.400

Orifice

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 30.400

Storage Structures for Storm

Cellular Storage Manhole: 4, DS/PN: 1.002

Invert Level (m) 29.400 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	20.0	20.0	2.501	0.0	64.7
2.500	20.0	64.7			

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

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.438
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.600 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 450.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1
Climate Change (%) 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	1	+0%					31.776
2.000	2	15 Winter	1	+0%					31.776
1.001	3	15 Winter	1	+0%					31.633
1.002	4	60 Winter	1	+0%	1/15 Summer				30.243

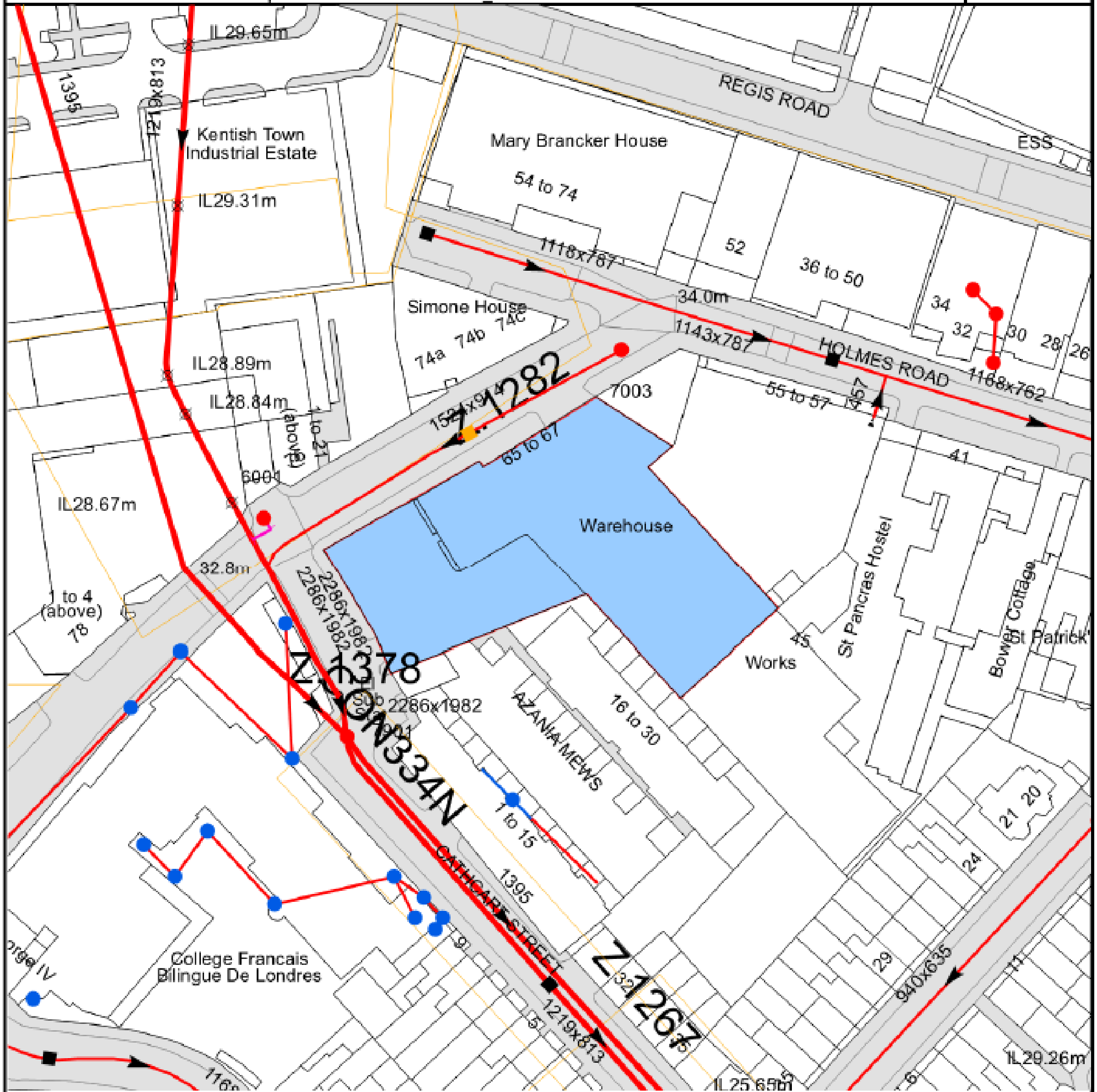
PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.224	0.000	0.14		11.6	OK	
2.000	2	-0.224	0.000	0.14		11.6	OK	
1.001	3	-0.167	0.000	0.41		33.5	OK	
1.002	4	0.693	0.000	0.28		4.7	SURCHARGED	

Appendix G

Thames Water Sewer Record

Sewer Asset Map showing extents of proposed development

Asset Location Search Sewer Map - ALS/ALS Standard/2016_3331846



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 528752,185025

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