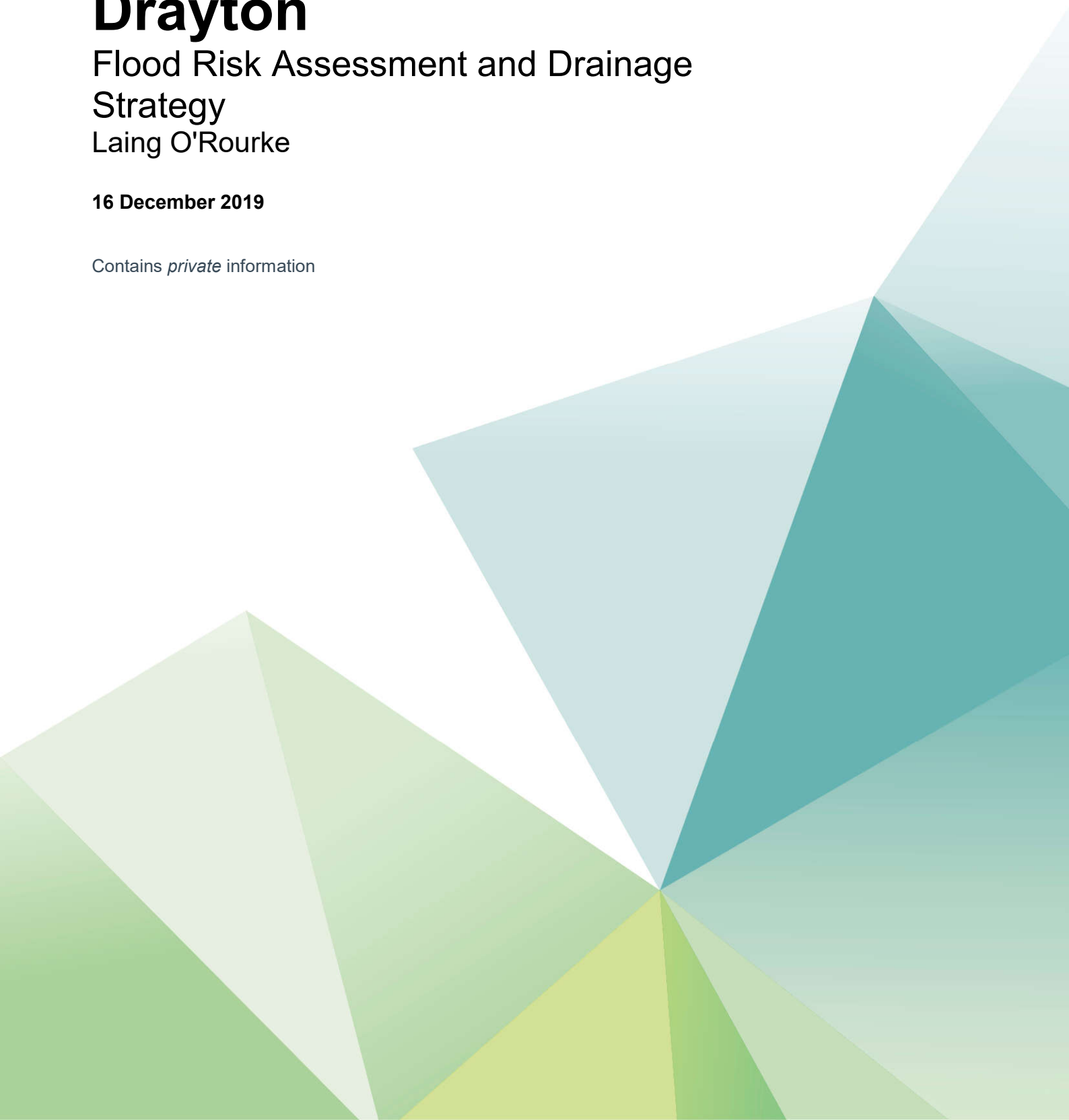


Orchard Hill School, West Drayton

Flood Risk Assessment and Drainage
Strategy
Laing O'Rourke

16 December 2019

Contains *private* information



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This document has 42 pages including the cover.

Document history

Job number: 5187523			Document ref: 5187523 FRA			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	Approval	MH	GC	EG	SA	June 19
Rev 2.0	Approval	MH	GC	EG	SA	Oct 19
Rev 3.0	Draft Planning Review	CH	MH	ME	CD	Dec 19
Rev 4.0	Approval	CH	MH	CR	CD	Dec 19

Table of contents

Chapter	Pages
1. Introduction	6
1.1. Background	6
1.2. Proposed Development	6
1.3. Report Scope	7
1.4. Data Limitations	8
2. Relevant Legislation	9
2.1. Overview	9
2.2. National Policy	9
2.3. Local Policy Documents	11
2.4. The London Plan	14
2.5. Environment Agency - Thames Catchment Flood Management Plan (TCFMP)	14
3. The Site and its Surroundings	16
3.1. Site Location and Description	16
3.2. Topography	16
3.3. Geology and Hydrogeology	16
3.4. Hydrology	17
4. Current Site Flood Classification	19
4.1. Flooding History	19
4.2. Tidal Flooding	20
4.3. River (Fluvial) Flooding	20
4.4. Groundwater Flooding	21
4.5. Surface Water (Pluvial) Flooding	22
4.6. Infrastructure Failure Flooding (Canals, Artificial Waterways, Reservoirs, Lakes, Sewers, Drains and Mains Water)	24
4.7. Effects of Climate Change	26
4.8. The Sequential Test and Flood Zone Compatibility	27
5. Conclusions and Recommendations	28
5.1. Conclusions	28
5.2. Recommendations	28
6. Proposed Drainage Strategy	29
6.1. Existing Drainage	29
6.2. Surface Water Drainage - Pre-Application Advice	29
6.3. Flood Risk Assessment and Drainage Strategy	30
7. Drainage Options for Proposed Development	35
7.1. Surface Water Drainage	35
7.2. Foul Water Drainage	36
Appendix A. Drawings	37
A.1. ORC_ATK_Z1_ZZ_SK_C_(95)_0001 - Foul Water Drainage GA	37
A.2. ORC_ATK_Z1_ZZ_SK_C_(95)_0002 - Surface Water Drainage GA	37
Appendix B. Soakaway Test Results	38
B.1. Extract from Ashdown Site Investigation Ltd Ground Investigation Factual Report ref R17-12386	38
Appendix C. HR Wallingford Storage Volume Estimate	40

Figures

Figure 1-1	Site Location
Figure 1-2	Development Proposals
Figure 2-1	Hillingdon Flood Risk Assessment Map 8.3 from Local Plan
Figure 3-1	Site Location Plan
Figure 3-2	Local Watercourses
Figure 3-3	Extract from Magic groundwater vulnerability map
Figure 4-1	Strategic Flood Risk Assessment Historic Flood Map Extract
Figure 4-2	Environment Agency Flood Map
Figure 4-3	Map Showing Areas Subject to Groundwater Flooding
Figure 4-4	Environment Agency Surface Water Flooding Map
Figure 4-5	Environment Agency Risk of Flooding from Reservoirs Map
Figure 4-6	Flood mapping accounting for climate change
Figure 6-1	Proposed surface and foul connection points



1. Introduction

1.1. Background

Atkins Limited has been commissioned to undertake a Flood Risk Assessment (FRA) for the Orchard Hill School in West Drayton in the Borough of Hillingdon. The current site houses a school (Chantry School) with associated soft and hard landscaped areas and the intention is to establish the new school to the north of the existing site prior to demolition of the existing buildings.

The site is located immediately to the north of Falling Lane in Viewsley, centred at approximate National Grid Reference (NGR) 506129, 180973 occupying an approximate 1.2 hectares (12,350m²) area.

The report will provide an overview of the susceptibility of the proposed school redevelopment to flooding from various sources based on analysis of historical records and existing regional flood risk assessments produced by the Environment Agency and discuss the risk posed by the development.

The site is bounded as outlined in Figure 1-1 with housing to the south and east, an existing primary school to the west and open parkland to the north. The nearest watercourse is the River Pinn to the north west of the site which runs north to south before it converges with Fray's River (over 500m to the south-west of the site) and the River Colne to the south over 2km away.

Figure 1-1 Site Location



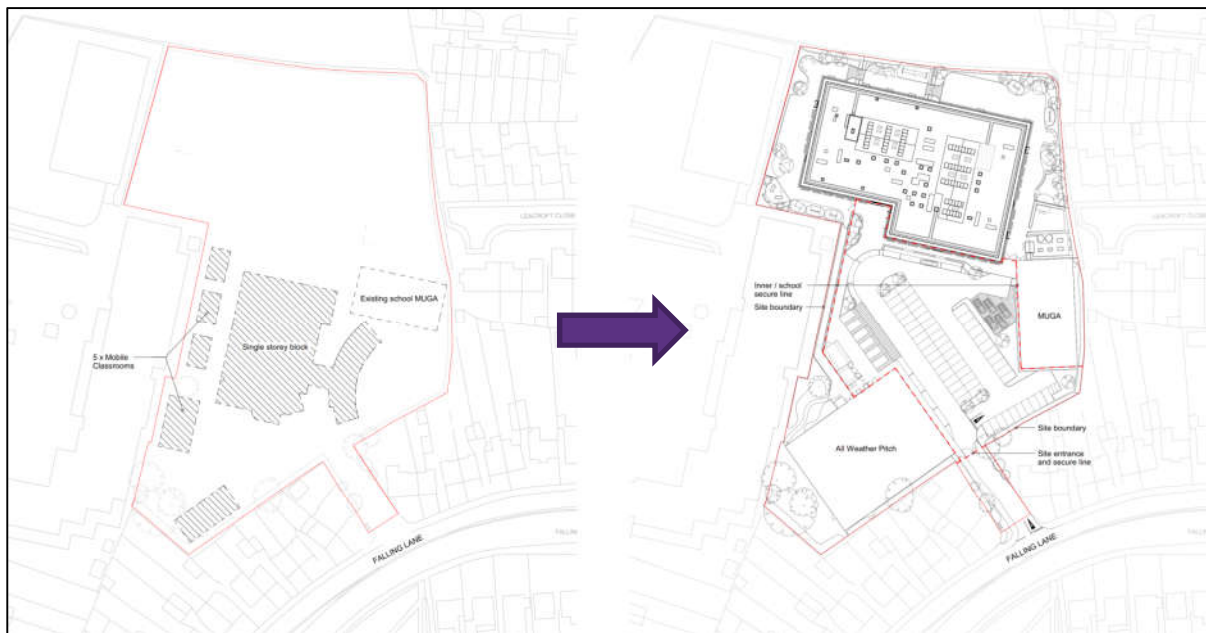
1.2. Proposed Development

The proposal is to develop the existing site from its current use, developing the playing field in the north of the site before demolishing the existing school buildings in the centre of the site and developing these areas for soft and hard landscaping providing 110 car parking spaces as outlined in Figure 1-2. There will be a single access point off Falling Lane to the south of the site as existing to gain both pedestrian and vehicular access/egress to the car park.

With reference to National Planning Policy Framework (NPPF) and as we will establish in Section 4, based on the site being in Flood Zone 1, the proposed school would be considered 'less vulnerable' in terms of the flood

risk vulnerability classification and is therefore considered compatible with the flood risk designation for the site area.

Figure 1-2 Development Proposals



1.3. Report Scope

This report presents a Level 1 Screening Study for flood risk for the site of the Orchard Hill School. It is based on readily available existing information, including Environment Agency Flood Maps¹ and the West London Strategic Flood Risk Assessment (SFRA)² covering the West London Boroughs of Hillingdon, Barnet, Brent, Ealing, Harrow and Hounslow. The objective of this FRA is to determine the extent and source of potential flood risk within and surrounding the site. The following tasks have been carried out to support this study⁷:

- Review of the site information and likely extent of potential flood risk at the site;
- Identification of flooding or surface water management issues related to the proposed development that may warrant further consideration; and
- Identification and scoping of other flood risks as required i.e. groundwater flooding.

The FRA considers a range of flooding mechanisms to satisfy the following three key objectives:

- To assess the potential flood risk at the existing site and to demonstrate whether any residual risk to the site would be acceptable;
- To identify potential surface water management issues related to the site and future development that may warrant further consideration; and
- To assess and identify existing potential historical surface and foul water management issues.

Flood risk should be considered alongside other spatial planning matters such as transport, housing, economic growth, natural resources, regeneration, biodiversity, the historic environment and the management of other hazards. Policies should recognise the positive contribution that avoidance and management of flood risk can make to the development of sustainable communities, including improving local amenities and better overall quality of life.

¹ Environment Agency (2015). What's in Your Backyard? [online], Available from: <http://apps.environment-agency.gov.uk/wiyby/default.aspx> [Accessed 20/05/2015]

² West London Strategic Flood Risk Assessment <https://westlondonsfra.london/>.

Government guidance indicates that an FRA should be carried out to an appropriate degree at all levels of the planning process. It should assess the risks of all forms of flooding to, and from, the development, taking into account climate change, and should inform the application of the sequential approach if applicable.

The Construction Industry Research and Information Association (CIRIA) C624³ “Development and Flood Risk – Guidance for the Construction Industry” recommend a phased approach with three levels of assessment as defined below:

- Level 1: Screening Study to identify whether there are any flooding or surface water management issues related to a development site that may warrant further consideration. The screening study will ascertain whether a Level 2 or 3 FRA is required.
- Level 2: Scoping Study to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding, or that the site may increase flood risk due to increase run-off. This study should confirm the sources of flooding which may affect the site.
- Level 3: Detailed Study to be undertaken if the Level 2 study concludes that the quantitative analysis is required to assess the flood risk related to the development site.

This report presents a Level 1 Screening Study.

1.4. Data Limitations

The Level 1 FRA report is based on findings from publicly available information only. The information provided by third-party sources is assumed by Atkins to be accurate.

³ Construction Industry Research and Information Association (CIRIA) (2004). CIRIA C624: Development and Flood Risk – Guidance for the Construction Industry.

2. Relevant Legislation

2.1. Overview

This Level 1 FRA has been undertaken using the following legislation and guidance:

- National Planning Policy Framework⁴;
- Planning Practice Guidance;
- Flood and Water Management Act⁵;
- Environment Agency – Thames Catchment River Management Plan;
- The London Plan;
- West London Strategic Flood Risk Assessment;
- Guidance included in the Hillingdon Local Plan Parts 1 and 2.

2.2. National Policy

2.2.1. National Planning Policy Framework

The National Planning Policy Framework (NPPF) published in February 2019⁴, is a key part of the government's reform to make the planning system less complex and more accessible; to protect the environment and to promote sustainable growth.

In addition, the Technical Guidance to the NPPF ⁴ has been reviewed in relation to Flood Risk. This document provides additional guidance to ensure the effective implementation of the planning policy set out in the NPPF on development in areas at risk of flooding.

Local Authorities should only consider development in flood risk areas appropriate where informed by a site-specific FRA, based upon the Environment Agency's Standing Advice on flood risk. The FRA should identify and assess the risks of all forms of flooding to and from the development and demonstrate how flood risks will be managed so that the development remains safe throughout its lifetime, taking climate change into account.

Government guidance states that development should be directed as far as practicable towards Flood Zone 1 areas (Low Probability (less than 0.1 % Annual Exceedance Probability (AEP) of fluvial/ sea flooding)) to avoid fluvial flood risks wherever this is possible.

For development proposed in Flood Zone 1, if the development area is greater than 1 hectare an FRA will still be required to address design issues related to the control of surface water runoff and climate change, as well as considering any other potential sources of flood risk for the development site.

2.2.2. Flood Risk and Flood Probability

The risk framework outlined in the NPPF defines the flood risk using the categories in Table 2.1. The fluvial extent map in the SFRA² defines the geographical extent of Flood Zones 1, 2, 3a and 3b.

Table 2-1 Fluvial Flood Zone Definition

Flood Zone	Further Assessments and Consultation to be Undertaken	Potential Residual Effects
Flood Zone 1	At risk from a flood event greater than the 1 in 1000 year event (greater than 0.1% annual probability).	Low Probability

⁴ Department for Communities and Local Government (February 2019). National Planning Policy Framework.

⁵ Flood and Water Management Act 2010.

Flood Zone	Further Assessments and Consultation to be Undertaken	Potential Residual Effects
Flood Zone 2	At risk from flood event between the 1 in 100 and 1 in 1000 year event (between 0. 1% and 1% annual probability).	Medium Probability
Flood Zone 3a	At risk from a flood event less than or equal to 1 in 100 year event.	High Probability
Flood Zone 3b	Land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0. 1%) flood or otherwise defined by the Local Planning Authority. This zone also comprises land where water must flow or be stored during periods of flooding.	Functional Floodplain

Flooding is a natural process that can present a range of different risks depending on its form. Flood practitioners and professionals define the risks presented by flooding according to an AEP, or as having a 'return period.'

Flood risk includes the statistical probability of an event occurring and the scale of the potential consequences. Flood risk is estimated from historical data and expressed in terms of the expected frequency of a flood of a given magnitude. The 10 year, 50 year, 100 year and the 200 year return period floods have a 10 %, 2 %, 1 % and 0.5 % chance of occurring in any given year, respectively. However, over a longer period the probability of flooding is considerably greater.

For example, for the 100 year return period flood:

- There is a 1 % chance of the 100 year flood occurring or being exceeded at least once in any single year;
- A 26 % chance of it occurring or being exceeded at least once in a 30 year period; and
- A 51 % chance of it occurring or being exceeded at least once in a 70 year period.

Table 2-2 below provides a summary of the relevant AEP and corresponding return period events of a particular sensitivity:

Table 2-2 Definition of AEP and 'Return Period' Flood Events

AEP (%)	Return Period (Years)
100	1 in 1
10	1 in 10
2	1 in 50
1	1 in 100
0. 5	1 in 200
0. 1	1 in 1000

2.2.3. The Flood and Water Management Act 2010

The Flood and Water Management Act (2010)⁵ determined the need for flood risk to be managed within the framework of National Strategies for England and Wales and within Local Strategies for each Local Flood Authority Area. The national strategy for England sets out the principles for flood risk management and which organisations are responsible for implementation.

In accordance with the national strategy for England, Lead Local Flood Authorities (LLFAs) have been allocated responsibility for developing independent Local Flood Risk Management Strategies (LFRMS) to address sources of local flooding. Each LFRMS identifies which local organisation is accountable for managing flood risk and establishes partnership agreements, as well as undertaking an assessment of flood risk and developing plans/actions, for tackling these risks.

2.3. Local Policy Documents

2.3.1. Hillingdon Local Plan Parts 1 and 2

Within the Hillingdon Local Plan, Part 1 sets out the need for flood risk management to be addressed due to the extensive network of waterways in the Borough and number of properties at risk. Primarily, Part 1 identifies the need for development to account for the risks of flooding arising from climate change and mitigating potential flood risk within vulnerable areas and ensure that methods are adopted to attenuate flows as appropriate.

Part 1 states that 'the Council will oppose the increase in impermeable areas where these will have an impact on surface water run-off' highlighting the need for attenuation of flows directing the design to ensure operation up to and including the 1 in 100 year flood including a 30% climate change factor.

DMEI 9 and 10 within Part 2 of the Local Plan seek to address Management of Flood Risk and Water Management, Efficiency and Quality respectively.

DMEI 9 outlines that development needs to account for potential flooding and puts the emphasis on mitigating risk both locally and beyond the immediate site boundary and refers back to NPPF. It also identifies Critical Drainage Areas within Hillingdon Borough and seeks careful consideration of Flood Zone 2 and 3 developments (which does not include the Orchard Hill site).

DMEI 10 seeks developer to ensure that drainage designs reduce the quantity of water entering drains at peak periods to reduce flows down to the equivalent greenfield rate whilst limiting the impact on water quality being discharged to both watercourses and groundwater sources. The Policy also asks developers to engage with infrastructure providers prior to progressing with the planning process.

The Local Plan seeks to work alongside the Strategic Flood Risk Assessment and the London Plan alongside national policy documentation.

2.3.2. West London Strategic Flood Risk Assessment (SFRA)

A Strategic Flood Risk Assessment (SFRA) has been produced which is relevant to the site area. The West London SFRA was produced jointly by the boroughs of Barnet, Brent, Ealing, Harrow, Hillingdon and Hounslow with our site being in the borough of Hillingdon. The complete SFRA document presents an overview of flood risk within the West London area and discusses various common and distinct cross-boundary flood risks within these boroughs.

The West London SFRA aims to enable the following:

- Provide consistency and a steer towards common requirements enabling identification of potential improvements to local flood risk possible through sustainable development.
- Steer development away from areas at risk from all sources of flood risk.
- Allow a sequential and exception approach to site allocation to be undertaken within a flood zone.
- Allow development of the policies and practices required to ensure that development in Flood Zones 2 and 3 satisfy the requirements of the Exception Test.

The findings of the SFRA (<https://westlondonsfra.london>) have been used to inform this report and some of the relevant text has been identified in the paragraphs below.

'Three of the boroughs also fall under Sub-area 5: River Pinn sub-area (Hounslow and Hillingdon) and Lower Lee tributaries sub-area (Barnet). The Thames CFMP preferred policy for Sub-area 5 is Policy Option 6 where partnership actions are needed to store and manage runoff in locations with environmental or overall flood risk reduction benefits. The Policy Option states that the approach to flood risk management in these places uses the natural protection already provided by the river channel and the open spaces in the floodplain.'

'Local Flood Risk Management Strategy Hillingdon's LFRMS was published in 2016. It provides an overview of previously undertaken flood risk studies. It is supported by other documents such as the PFRA, SWMP and SFRA. Appendix 3 of the LFRMS provides a set of objectives, measures and actions. Objective three of the

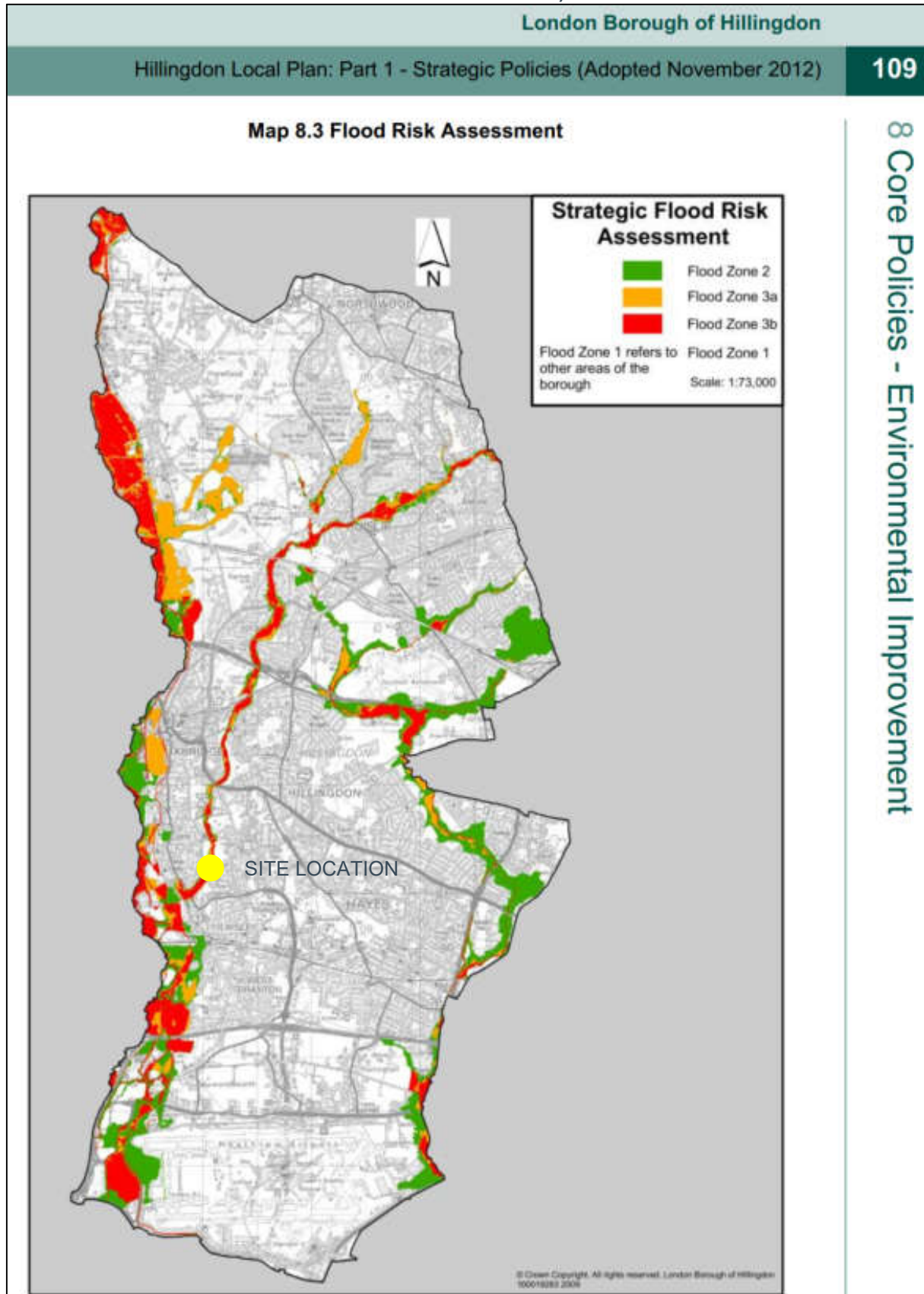
six objectives states "Development in Hillingdon understands and takes account of flood risk issues and plans to reduce flood risk." The measures associated with this objective are:

- Influence the local plan and creation of suitable policies on flood risk.*
- Secure contribution to flood risk reduction from new developments.*
- Major landowners to develop site wide long-term plans for managing water.*
- Continue influencing developments through the planning process to ensure they meet the requirements of National Standards for Sustainable Drainage and London Plan requirements.*

As outlined within the SFRA, the key aspects to take forward are the recommendation for development, where necessary, to be directed to Flood Zone 1 areas. The proposed site falls into this category. Beyond this, the document recommends ensuring that the development has no impact upon the surrounding infrastructure to create issues in the network and to take account for future-proofing. The design strategy needs to enable this through a review of the need for provision of SuDS and design in accordance with requirements set out by the key stakeholders within the consultation process.

The Local Plan references a Flood Risk Assessment Map which we have included in Figure 2-1 below. This shows our site as being outside Flood Zones 2 and 3.

Figure 2-1 Hillingdon Flood Risk Assessment Map 8.3 from Local Plan (Orchard Hill site shown within Flood Zone 1)



2.4. The London Plan

This document acts as a guide to development within the City of London as published by the Mayor of London. Chapter 5 deals with climate change and specifically, Policy 5.12 looks at Flood Risk Management so is relevant to this Flood Risk Assessment.

The primary focus of the London Plan with respect to drainage is to ensure flood resilience and that development is able to deal with flooding and respond quickly in the event of a flood. As such, the development design will need to focus on the ability to manage surface water flows under storm conditions whilst ensuring flood water is contained within the below ground drainage system. Any controlled flooding will need to be retained within the site boundary and away from buildings to mitigate impact on the ongoing use of this and neighbouring properties.

Further detail from the flood plan in terms of hierarchy for drainage design is taken from Policy 5.13 – Sustainable drainage and our approach to this is detailed within the Drainage Strategy Section within this document.

2.5. Environment Agency - Thames Catchment Flood Management Plan (TCFMP)

The TCFMP document was produced by the Environment Agency to provide an overview of the Environment Agency's plan for sustainable flood risk management over the long term. The proposed Orchard Hill site is positioned around 300m from the River Pinn to the north-west which is designated within Sub-area 5 in the TCFMP; Urbanised places with some flood defences. Sub-area 5 covers 2% of the total area of the overall 40km² River Thames catchment.

The TCFMP sets out the number of properties and nature of infrastructure at risk from flooding and identifies the future impact on flood risk from potential climate change. Some relevant extracts from Sub-area 5 of the TCFMP are outlined below.

'There are approximately 6,600 properties with a 1% risk of flooding from rivers. This represents 5% of all properties at risk. Climate change could increase the number of properties at risk from river flooding by between 30% and 50% in these areas.'

The Plan identifies that the preferred management policy is as follows:

Policy option 6: Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, is indicative of our vision of managing run-off, safeguarding open space and potential flood storage.

These are largely urban catchments, but ones where the river corridors have not been over-developed and there is not an over dependence upon flood defence structures that are difficult and expensive to maintain. This does mean that there are opportunities to manage the existing risk effectively and offset some of the impacts of climate change in the future.

The approach to flood risk management in these places uses the natural protection already provided by the river channel and the open spaces in the floodplain. We will maintain, and where possible improve, the flow of water in the rivers as they pass through built up areas. This needs to be complimented by improvements to other parts of the drainage network

We also want to maintain and, if possible improve, the capacity of the floodplain to store water, making use of the open spaces available within the floodplain, and preventing the loss of open spaces. In all of these areas there are opportunities to store water to reduce flood risk; for example Cobbins Brook in North London and in the Crawley area in the Upper Mole catchment.

Redevelopment rates are quite high in some of these areas. It is vital we work with Planning Authorities in these areas to maintain the existing open space in the floodplain, manage urban run-off, take advantage of opportunities for flood storage and increase the resistance and resilience of buildings through redevelopment

This suggests that the intent is to minimise disruption by taking account for future climate change and urban growth as a standard assumption. Alongside this, the Environment Agency wish to maintain existing flood plains and development of existing sites away from flood plains (and Zones 2 and 3) will be important in enabling this.

The findings of the RTCFMP will be considered as part of the drainage strategy and although no significant issues have been identified, the design will be taken forward to ensure that our proposals do no adversely impact on the current scenario.

3. The Site and its Surroundings

3.1. Site Location and Description

The site is located immediately to the north of Felling Lane centred at approximate National Grid Reference (NGR) 506129, 180973 and occupies an approximate 1.2 hectares (12,350m²) area as indicated on Figure 3-1 below.

The site is an existing school and will be used for the same purpose post-development primarily comprising the main school, soft and hard landscaping and car parking. Within the proposals, there will be provision for tarmac and block surfacing alongside MUGA areas. The building itself will be traditionally clad and the boundary fringes of the site will be set aside for soft landscaping.

The drainage system will be designed to control surface water run-off from hard landscaped areas and buildings close to origin and limited to the requirements identified by the key stakeholders. Pollution control devices will be required to remove potential hydrocarbons from the car parking area.

The main structure on site will be the school itself located in the north of the site. Based on this use, the foul requirements will be defined by the staff and pupil facilities housed within the building; these are thought to be similar to existing requiring discharge for kitchens, showers, sinks and WCs alongside external bin stores.

Figure 3-1 Location Plan



3.2. Topography

Ordnance Survey (OS) mapping⁶ and the site topographical survey indicate that the site is relatively flat and situated at an approximate elevation of 30m above Ordnance Datum (AOD).

3.3. Geology and Hydrogeology

From a review of the Ashdown Site Investigation Ltd Ground Investigation Factual Report ref R17-12386, it can be interpreted that infiltration is unlikely to be feasible due to clayey soils and the falling head soakage test results (included in Appendix B), however, the drainage plan for Abbsfarm Primary shows soakaways are in

⁶ www.bing.com/maps# [Accessed 28/05/2019]

use. Based on the investigation findings, infiltration is unlikely to prove a suitable means of surface water disposal.

3.4. Hydrology

No surface water bodies have been identified within the site boundary and the nearest surface water body is the River Pinn to the north west of the site as shown on Figure 3-2.

Figure 3-2 Local watercourses



From an inspection of the Aquifer Designation Map on the Magic website (<https://magic.defra.gov.uk/MagicMap.aspx>) the site designation shows the site surrounded primarily by Principal aquifer alongside Secondary A aquifer but the site itself is not classified. Inspecting the Groundwater vulnerability map on the same website, the site falls within a Major Aquifer, high groundwater vulnerability area. The groundwater vulnerability maps offer an assessment of the vulnerability of groundwater to pollutants discharged at surface level based on the hydrological, geological, hydrogeological and soil properties. Given the high vulnerability indicated on the image below which suggests potential to transmit pollution to groundwater, our drainage solution will need to take this into account, suggesting that an enclosed positive drainage system is likely to be preferable.

Atkins Flood Risk Assessment and Drainage Strategy – Version 4.0 – 16 Dec 2019 - 5187523



4. Current Site Flood Classification

This Level 1 FRA has been prepared to identify potential sources of flooding and the likely mechanisms by which flooding could occur.

Potential sources of flooding and associated mechanisms for review are as follows:

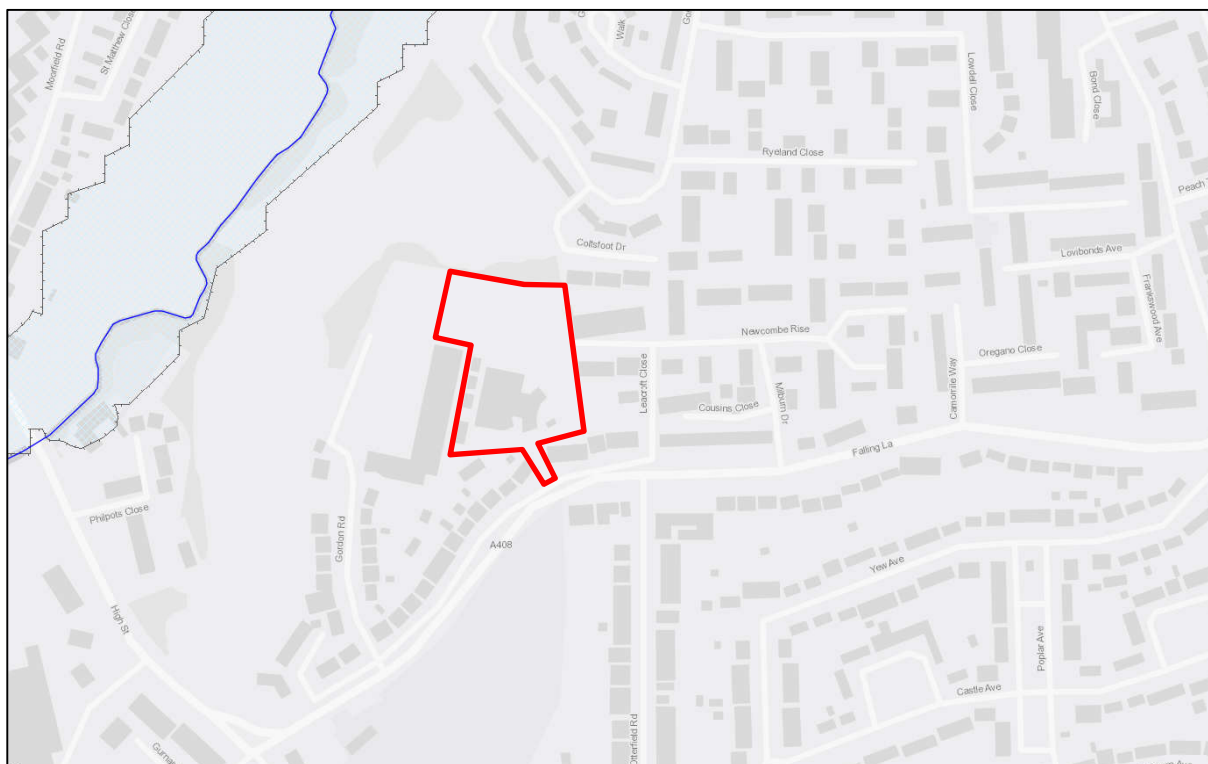
- Tidal sources - flooding resulting from tidal sources.
- Fluvial sources - flooding resulting from watercourses near to the site.
- Groundwater sources - flooding as a result of rising groundwater levels.
- Surface water sources - flooding as a result of surface water flows from adjacent land.
- Sewers and drains - flooding resulting from sewers or drains.
- Canals and artificial waterways – flooding resulting from the breach or overtopping.
- Reservoir / lake flooding - flooding resulting from overtopping or breaching of reservoirs or lakes.

In the following sections of the report, these scenarios have been discussed and the flood risks to the site examined in more detail.

4.1. Flooding History

Based on the historical data and distance from the site to any water bodies, the site has not been subject to a history of flooding and our view is that this scenario is likely to continue given the distance and elevation of the site from the primary flood source of the River Pinn. This is demonstrated in the Strategic Flood Risk Assessment Historic Flood Map Extract shown below; which demonstrates that the site has not previously been subject to flooding.

Figure 4-1 Strategic Flood Risk Assessment Historic Flood Map Extract



With respect to historic flooding, the West London SFRA states as follows:

'Each Borough has differing levels of historic information. The majority of this comes from the EA's Recorded Flood Outline dataset which shows all EA records of historic flooding and the EA's Historic Flood Map which shows the maximum extent of all individual recorded flood outlines. This can be viewed on the Fluvial & Tidal Flood Risk Web Map.'

'The Boroughs can investigate any flood event deemed necessary. Where they, as LLFAs, carry out these investigations, they must notify the relevant RMAs and publish the results of the investigations.'

For Hillingdon, the most recent Flood Risk Investigation Reports provided to detail significant flood events in the Borough indicate no instances of flooding which have impacted on our site in the publicly available reports covering 2013 to date.

4.2. Tidal Flooding

Coastal flooding occurs when sea levels rise above the normal tidal range. This can happen anywhere around the coast, including the estuaries. Tidal flooding is a result of one, or a combination of, high tides, storm or tidal surges, wave action and high sea levels combining with high river flows.

Despite lying inland, according to the West London SFRA, the *'River Thames is at risk of tidal flooding and provides the greatest risk when storm surges coincide with extremely high tide levels.'* Irrespective, *'only the boroughs of Hounslow and Ealing are at risk from this flood source.'*

Based on the findings above, tidal flooding is not a flood risk associated with Orchard Hill and requires no further consideration.

4.3. River (Fluvial) Flooding

Fluvial flooding occurs when the channel of a river or stream cannot cope with the amount of surface water run-off or excess base flow draining into them from the land and eventually causes them to overtop their banks tending to happen after periods of heavy and/or prolonged rainfall.

The Environment Agency's Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences, and show the extent of the natural floodplain and the additional extent of an extreme flood. The Environment Agency's Flood Map for Planning shows the areas which could be impacted by flooding, either from rivers or sea coloured according to Flood Zone.

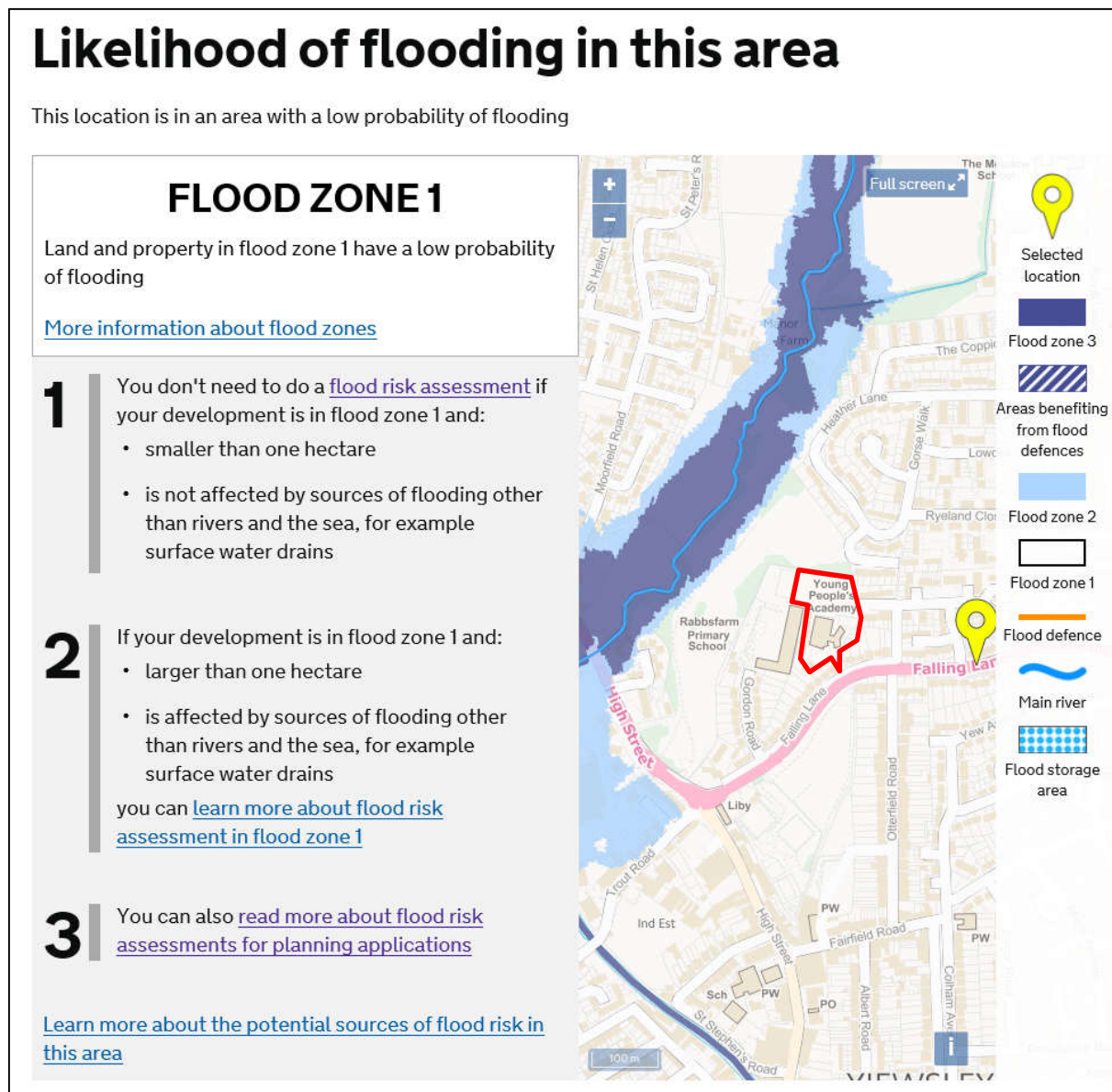
As noted in previous Sections, the site has not been subject to flooding previously. This is likely due to the level difference between the existing ground surface relative to the River Pinn; the nearest watercourse alongside the distance to the River. There is no evidence of any ordinary watercourses in closer proximity to the site than the River Pinn.

Flood Zone maps indicate that large areas of floodplain adjacent to the River Pinn and its tributaries lie within Flood Zones 2 and 3, our school site is outside of both lying within Flood Zone 1 and is at low risk of flooding.

Environment Agency mapping¹ (Figure 4-2) indicates that the site does not lie within the floodplain of any nearby rivers or tributaries. The site is situated entirely within Flood Zone 1 which has the lowest chance of flooding from watercourses and without any ordinary watercourses near the site, the risk of flooding affecting the development site has been assessed as low. The risk of flooding from fluvial sources is therefore less than 0.1 % each year. However, Flood Zones 2 and 3 lie to the north west of the site boundary.

Despite the limitations of the flood maps in relation to the accuracy of ground elevation data and the spatial resolution of the flood level output, there is little potential for Flood Zone 2 to extend onto the Site. However, the information supplied by the Environment Agency is the best available information in relation to flood risk and we should assume it to be accurate in this instance.

Figure 4-2 Environment Agency Flood Map¹



4.4. Groundwater Flooding

Groundwater flooding occurs when groundwater emerges at the surface (and subsequent overland flows) or into subsurface voids as a result of abnormally high groundwater levels. This can have a direct impact on buildings and services, as well as an indirect impact by increasing infiltration of groundwater into sewers and soakaways, reducing their capacity to convey surface water runoff.

It is sporadic in time and location, but when it does occur it is usually of longer duration than surface water flooding and can interfere with property and infrastructure (such as roads). Elevated groundwater levels may result in the reactivation of springs and ephemeral watercourses (often referred to as 'clearwater' flooding) resulting from rainfall. Groundwater flooding may also be a result of rising groundwater (rebound) following

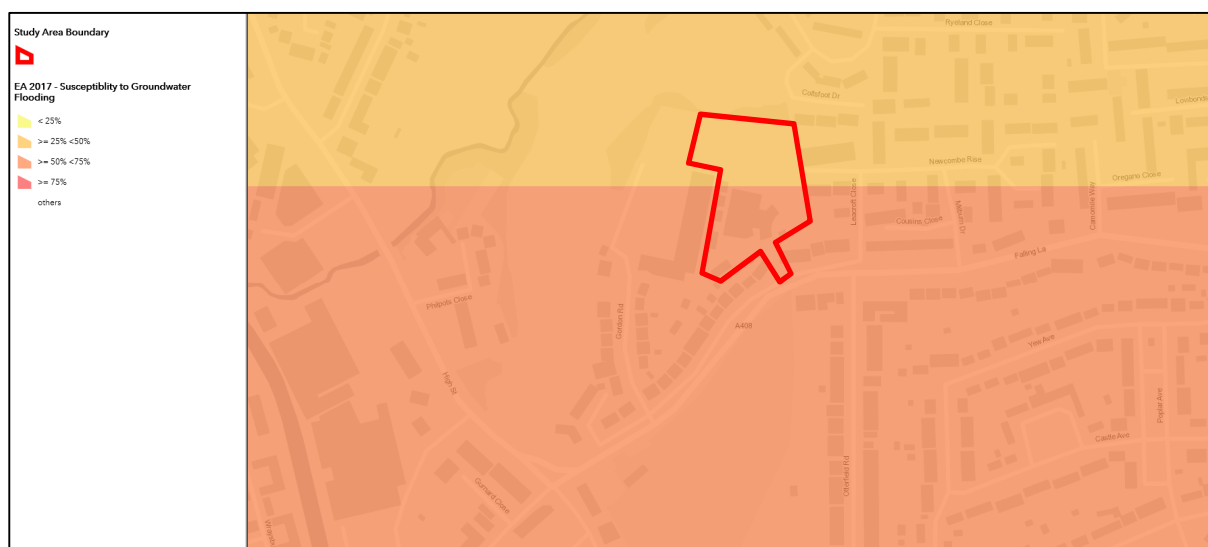
reductions in abstraction, mine water recovering to natural levels following cessation of pumping, and local shallow drainage/flooding problems unrelated to deep groundwater responses.

According to the West London SFRA:

'A majority of the sub-region is underlain by Thames Group (also referred to as London Clay) bedrock, a composition of silty clay/mudstone, sandy silts and sandy clayey silts of marine origin. This geological unit generally has a low hydraulic conductivity which means water does not easily move through it. However, because of this characteristic and poor drainage, ponding can occur if London Clay is downhill of aquifer outcrops. Other predominant bedrock geology types are Lambeth Group compositions and White Chalk, both of which are predominantly found in the northwest of the sub-region. White Chalk in particular can be prone to groundwater flooding due to its high hydraulic conductivity and low effective porosity, meaning it can become saturated quite quickly due to intense rainfall and recharge the water table. In areas with a high water table, water can move through chalk and out onto the surface. Superficial deposits in the region are predominantly River Terrace Deposits which are comprised of sand and gravel, with lenses of silt, clay or peat.'

The West London SFRA provides mapping which indicates susceptibility to groundwater flooding. The extract below shows the result for our site as being a split between 25<50% to the north and 50<75% to the southern end of the site which indicated a medium risk. The same website suggests that there is no increased potential for elevated groundwater based on mapping but based on the risk, we would recommend further investigation as part of a ground investigation to assess the potential.

Figure 4-2 Map Showing Areas susceptible to groundwater flooding



4.5. Surface Water (Pluvial) Flooding

Pluvial and overland flooding is caused by the build-up of water on land causing it to collect in low-lying areas or sheet flow over impermeable, saturated and/or sloping ground. This type of flooding can occur when intense rainfall exceeds the infiltration capacity of the ground, or when the surface water run-off is not intercepted by natural or artificial drainage or if there is a barrier to prevent it from draining away from that area.

The Environment Agency defines surface water flood risk using the categories in Table 2-2, in Section 2.2.2 of this report.

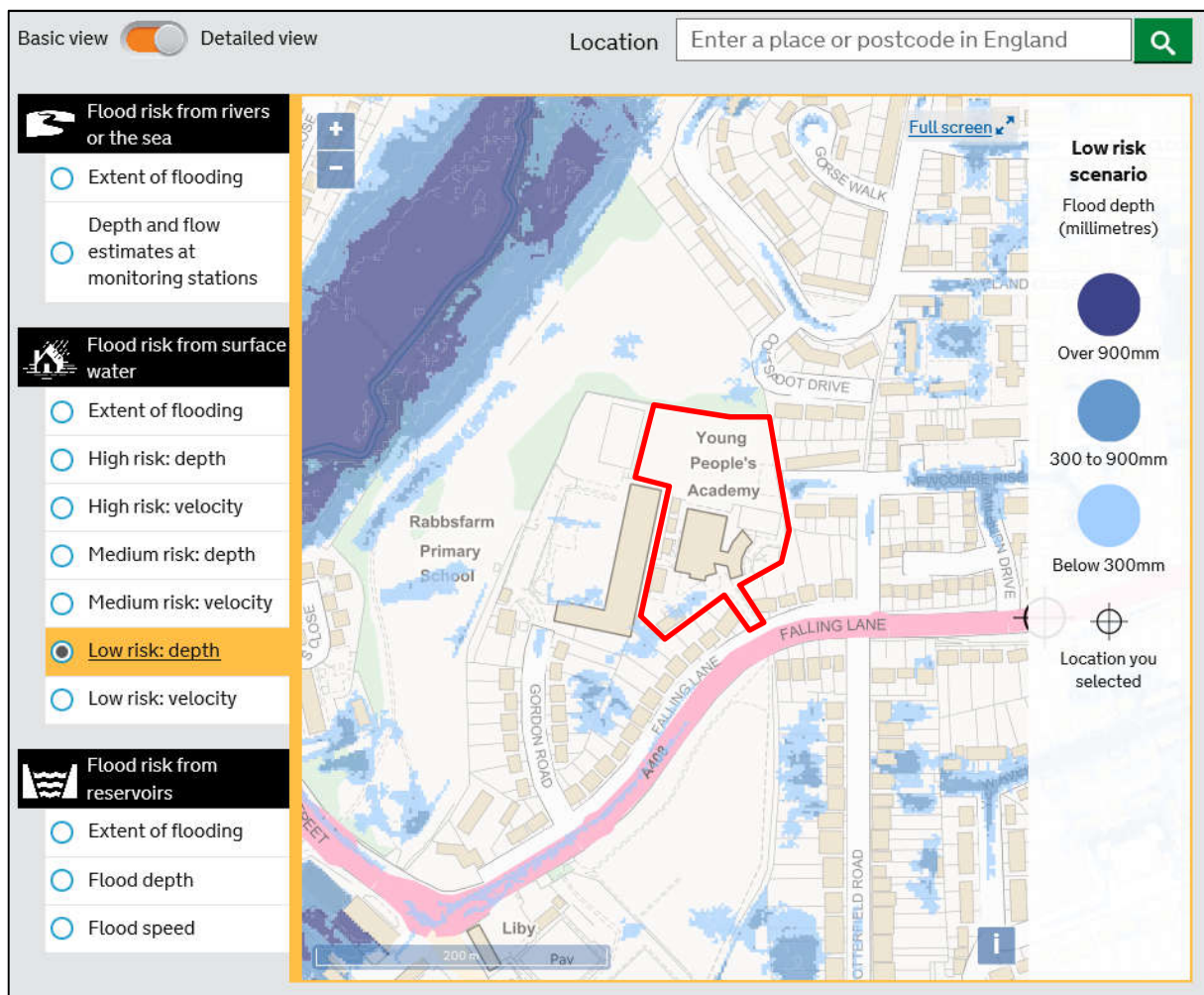
Surface water drainage is an issue in some minor parts of the study area, and back-up of water during heavy rainfall events can cause adjacent areas to become flooded. The Environment Agency maps¹ (Figure 4-3), indicate where surface water may be expected to flood or pond. The map below indicates that whilst the majority of the site lies in a location with a very low risk of flooding, there is a small area on site to the south west where there is a low risk of flooding with a strip within the boundary having recorded a level of less than 300mm; likely due to historic data indicating back-up during a rainfall event.

According to the EA website, 'Low risk means that each year this area has a chance of flooding of between 0.1% and 1%. Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding.'

The site is currently occupied as a school and reasonably level without apparently having any issues with the surface water flows. Based on the localised nature of the flood risk to the south of the site, measures will need to be taken to ensure that surface water flooding potential is addressed within the site infrastructure design through provision of (but not limited to) any of the following:

- Provision of sufficient drainage collection across the site area to mitigate surface ponding
- Positive drainage in this area of the site to accept surface water flows
- Accept the risk of occasional flooding

Figure 4-3 Environment Agency Surface Water Flooding Map¹



Given the indication on the EA mapping, despite a small area having been picked up, it is believed that the general risk of surface water flooding is low however the potential for flooding externally to the site should be considered within the infrastructure design. It should be noted that on the site layout, this area is designated for use as a MUGA area which will allow infiltration from the surface into an underground pipe network. As such, localised flooding is unlikely to cause any issues to the site proposals; particularly in relation to an impact on the built infrastructure or neighbouring sites.

4.6. Infrastructure Failure Flooding (Canals, Artificial Waterways, Reservoirs, Lakes, Sewers, Drains and Mains Water)

Infrastructure which retains water or transmits or controls flows (i.e., canals, reservoirs, Sustainable Urban Drainage Systems (SuDS) features, dams, water supply pipelines or other water bodies) near the site has the potential to fail and cause flooding on site. During flood conditions, it is possible that other water bodies will experience the effects of increased rainfall. If these assets are not able to cope during these conditions, and overtop or fail, flooding can occur. The following sections detail separately the flood risk from local infrastructure.

4.6.1. Impounded Water Body Flood Risk

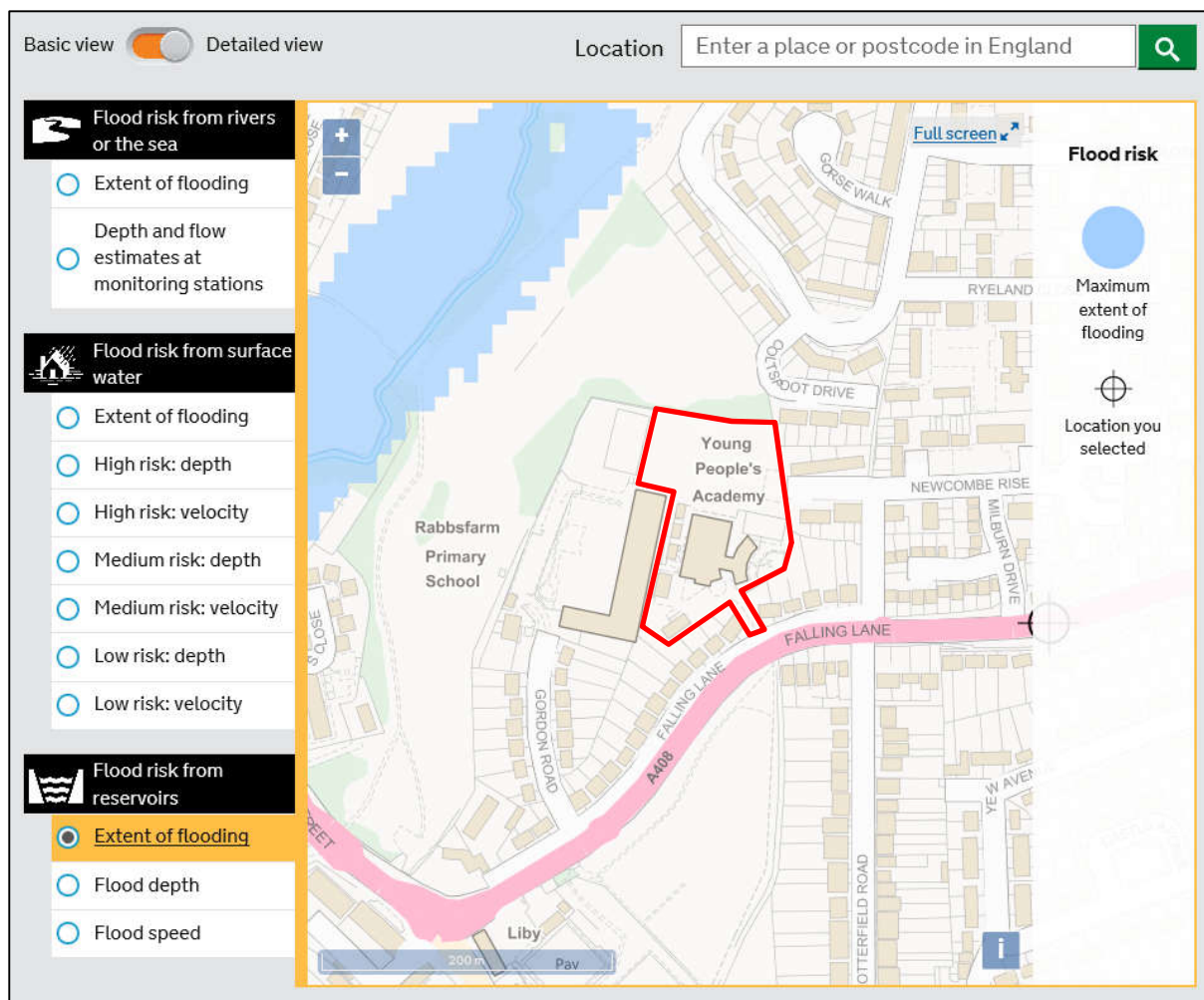
The Environment Agency's Risk of Flooding from Reservoirs Map indicates that the site is unaffected by flooding from any reservoirs, as shown in Figure 4-4.

The Environment Agency website states that '*Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, we ensure that reservoirs are inspected regularly and essential safety work is carried out.*

However, in the unlikely event that a reservoir dam failed, a large volume of water would escape at once and flooding could happen with little or no warning. If you live or work in an area that could be affected, you should plan in advance what you would do in an emergency. You may need to evacuate immediately. Consider where you would go to safety, and be ready to follow the advice of emergency services'

Whilst there is the potential for inundation, the risk of flooding is very low and no further assessment is needed.

Figure 4-4 Environment Agency Risk of Flooding from Reservoirs Map



There is no evidence via Environment Agency mapping⁷ to suggest that the site benefits from protection by flood defence structures.

4.6.2. Sewer Flood Risk

According to the West London SFRA, 'Sewer flooding can occur due to sewer infrastructure failure or due to an increased flow and volume of water entering a sewer system which exceeds its hydraulic capacity, causing the system to surcharge. If sewer outfall points are either blocked or submerged due to high water levels, water can back up in a sewer system and cause flooding. These issues can result in water overflowing from gullies and manholes, causing flooding in the local area. Blockages caused by sediment or debris can further exacerbate the probability of sewer flooding.'

'Drainage in the sub-region is serviced by Thames Water Utilities Ltd (Thames Water), who provide surface water, foul and combined sewer systems. Modern sewer systems are designed to be separate surface water and foul water systems, typically accommodating up to 1 in 30 year rainfall events. However, sewer system segments across London vary in capacity due to age. Older segments have a smaller capacity and may not be designed to accommodate rainfall events as significant as 1 in 30 year events. Combined sewer systems are also prevalent within older areas of London, including eastern parts of Ealing and Hounslow, leading to increased environmental risks were flooding to occur.'

Based on the Sewer, Groundwater and Artificial Flood Risk Map from the West London SFRA website, there are no recorded instances of sewer flooding on the Orchard Hill site and we do not know of sewers crossing the site from other sources out of our control. As such, we believe the risk of sewer flooding impacting on our site to be low.

⁷ Environment Agency (2014). Flood Map for Planning (Rivers and Sea) (Accessed on 29/05/2019).

4.7. Effects of Climate Change

The NPPF requires development to take account of the impacts of climate change. The allowances to be made for climate change impacts when assessing flood risk are related to the lifetime of the development.

In accordance with Section 4.6 of BS8533:2011 'Assessing and managing flood risk in development - Code of Practice', the lifetime of a non-residential development is 75 years.

Under heading 4 in the Site-Specific Flood Risk Assessment Checklist in Section 26 of the Flood Risk and Coastal Change Planning Practice Guidance, it asks how flood risk at the site is likely to be affected by climate change and states that further information on climate change and development and flood risk is available on the Environment Agency's web site. Guidance published by the Environment Agency on 19 February 2016, entitled 'Flood Risk Assessments: Climate Change Allowances' sets out the allowances to be used for peak river flow by river basin district, peak rainfall intensity, sea level rise, offshore wind speed and extreme wave height.

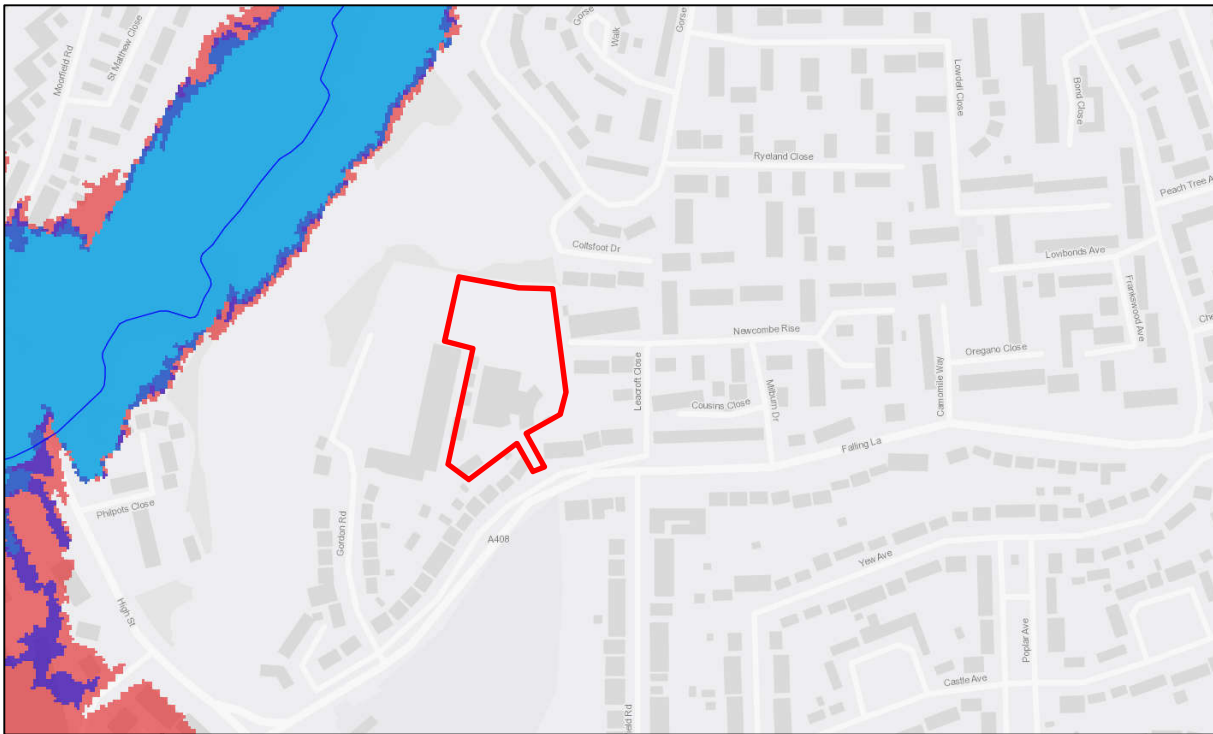
The peak rainfall intensity allowances to be used when designing urban drainage systems are given in Table 2 of "Flood Risk Assessments: Climate Change Allowances". Both the central and upper end allowances need to be assessed to understand the range of impact. The total potential change anticipated for 2060 to 2115 is 20% for the central category, and 40% for the upper end category.

Alongside this, as part of the West London SFRA, the River Pinn has been assessed for impacts of climate change using the allowances defined in the EA Guidance for Flood Risk Assessment (2016). The Fluvial & Tidal Flood Risk Web Map includes flood mapping for the following climate change scenarios for main rivers as below:

- 1 in 100 year probability event
- 1 in 100 year + 25% increase in peak river flow
- 1 in 100 year + 35% increase in peak river flow
- 1 in 100 year + 70% increase in peak river flow

These climate changes scenarios have been modelled in terms of flood risk as identified on the image below (extracted from the West London SFRA).

Figure 4-6 Flood mapping accounting for climate change



4.8. The Sequential Test and Flood Zone Compatibility

Paragraph 100 of the NPPF states that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere.

Paragraph 101 of the NPPF states: 'The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The Strategic Flood Risk Assessment will provide the basis for applying this test. A sequential approach should be used in areas known to be at risk of any form of flooding.'

The site lies within Flood Zone 1 in an area with low probability of flooding and as such, the Sequential Test is passed.

Furthermore, as the Exception Test is only valid if the development is in Zones 2 or 3, we do not need to undertake.

5. Conclusions and Recommendations

5.1. Conclusions

The assessment has focused on the existing flood risk along with the potential for an increase in flood risk resulting from the intended works. The conclusions of the assessment are summarised in Table 5-1.

Table 5-1 Summary of Flood Risk Status

Flood Source	Risk Assessment
The Sea	Extremely low
Rivers	Flood Zone 1 – Low
Groundwater	Medium risk with high groundwater vulnerability
Surface Water	Low
Canals and Artificial Watercourses	Low
Reservoirs and lakes	Low
Sewers	Low risk from public sewers but may be a residual risk from unknown private sewerage and historic drainage systems on the Site.
Drains	Low risk
Water Mains	Low risk
Climate Change	Unlikely to significantly change above assessment but to be accounted for in design

Overall it is concluded that the flood risk of the proposed development as currently understood is at low potential risk of flooding from surface water with the entire site sitting in Flood Zone 1.

It is recommended that the design is progressed in accordance with stakeholder requirements without need for additional special measures arising from this study in line with the vulnerability classification although more detail needs to be established with regard to groundwater risk as part of a ground investigation.

5.2. Recommendations

This Level 1 for the Orchard Hill site has identified the following recommendations to be taken forward into the design:

- Where necessary, appropriate flood proofing measures would be implemented during the anticipated works to ensure that should a flood event occur the school and site users remain unaffected.
- Attenuation and flow control would be used to restrict run-off from the development area to greenfield equivalent rates as defined by the London Plan. This will constrain the volume of surface water to discharge at a rate which will not adversely impact on flood risk.
- Pollution control measures such would be incorporated into the drainage system given the number of car parking spaces present.
- Pre-development enquiry needed to confirm acceptance for proposed foul and surface water connections.
- Any overland flow paths will be controlled and mitigate an impact on both site operation and surrounding property.
- Ground investigation to address requirement to establish more detail with regard to potential for groundwater flooding.
- In the event of changes to the proposed development at the site this FRA should be reviewed and revised if required.

6. Proposed Drainage Strategy

6.1. Existing Drainage

The existing topographical and utility surveys provide a reasonable record of the existing drainage on the site although there is minimal information available regarding drainage beyond the immediate site boundary. At this time no CCTV survey has been undertaken on site but ultimately, the plan is to not utilise much of the existing system beyond connections into the existing manholes. Prior to connecting the new drainage, we will seek permission from Thames Water and also look to establish the condition of existing drainage systems via local CCTV surveys of the relevant pipelines to enable the design to be established.

6.2. Surface Water Drainage - Pre-Application Advice

Further to the pre-application submission, the London Borough of Hillingdon Council (LBHC) provided in April 2018 advised as follows:

'Flood Risk

The site does not fall within a flood zone or Critical Drainage Area. Nevertheless, given the size of the site and the scale of development proposed a Flood Risk Assessment and drainage strategy should be provided, in accordance with the hierarchy set out in London Plan policy 5.13, to ensure surface water run-off can be appropriately managed.

Details on LBH requirements can be found on the Council website including a Design and Evaluation Guide as well as a detailed proforma to speed up review of technical submission.

<http://www.hillingdon.gov.uk/article/12578/Sustainable-drainage-requirements-for-planning-applications>

The scheme should clearly demonstrate the following:

Suds features:

- i. incorporating sustainable urban drainage in accordance with the hierarchy set out in Policy 5.15 of the London Plan. Where the proposal does not utilise the most sustainable solution, justification must be provided.*
- ii. calculations showing storm period and intensity and volume of storage required to control surface water and size of features to control that volume to Greenfield run off rates at a variety of return periods including 1 in 1 year, 1 in 30, 1 in 100, and 1 in 100 plus climate change.*
- iii. overland flooding should be mapped, both designed and exceedance routes above the 100, plus climate change, including flow paths depths and velocities identified as well as any hazards (safe access and egress must be demonstrated).*

Receptors

Capacity demonstrated for Thames Water foul and surface water network and provide confirmation of any upgrade work required having been implemented and receiving watercourse as appropriate.

Where infiltration techniques (soakaway) or a basement are proposed a site investigation must be provided to establish the level of groundwater on the site, and to demonstrate the suitability of infiltration techniques proposed on the site (This should be undertaken at the appropriate time of year as groundwater levels fluctuate).

Where groundwater is found within the site and a basement is proposed suitable mitigation methods must be provided to ensure the risk to others is not increased.

Identify vulnerable receptors, i.e. WFD status and prevent pollution of the receiving groundwater and/or surface waters through appropriate methods;

Minimise water use. The scheme shall also demonstrate the use of methods to minimise the use of potable water through water collection, reuse and recycling and will:

- *incorporate water saving measures and equipment,*
- *provide details of water collection facilities to capture excess rainwater,*
- *provide details of how rain and grey water will be recycled and reused in the development.'*

Further pre-application advice was given by Hillingdon Borough Council in June 2019, the relevant elements of this are included below:

Sustainable Drainage Systems (SuDS) should be incorporated into every drainage strategy and should, where possible, be integrated into the soft landscaping rather than relying on below-ground measures that do not provide wider biodiversity or amenity benefits.

It is understood that the new school building will be constructed while the existing school is in operation. The management of surface water during construction is therefore of importance, when any drainage infrastructure proposed within the car parking area will not be constructed. This should be addressed in any submission to accompany an application.

The scheme shall clearly demonstrate the following:

a) Sustainable Drainage:

i. Evaluation of all sustainable drainage options in accordance with the hierarchy set out in Policy 5.13 of the London Plan. Where the proposal does not utilise the most sustainable solution, justification must be provided.

ii. Calculations showing storm period and intensity and volume of storage required to control surface water and size of features to control that volume to Greenfield runoff rates at a variety of return periods including 1 in 1 year, 1 in 30, 1 in 100, and 1 in 100 plus climate change event.

iii. overland flooding should be mapped, both designed and exceedance routes above the 100, plus climate change, including flow paths depths and velocities identified as well as any hazards (safe access and egress must be demonstrated).

b) Receptors

i. Collected surface water should be disposed of via infiltration where conditions allow. Where infiltration techniques are proposed, a site investigation must be provided to establish the level of groundwater on the site and to demonstrate the suitability of infiltration techniques proposed on the site. This should be undertaken at the appropriate time of year as groundwater levels fluctuate.

ii. Any connection to a watercourse should demonstrate that the watercourse is hydraulically connected to a wider surface water drainage network that has capacity for the proposed flows. Maintenance proposals should include the necessary maintenance of outfalls into watercourses where these are required.

iii. Any proposed connection to a Thames Water sewer must provide evidence to demonstrate that the site will connect into a wider functioning sewer network. Developers are also encouraged to contact Thames Water's free pre planning service as early as possible to discuss their development proposals and intended delivery programme to assist with identifying any potential water and wastewater network reinforcement requirements. You should provide a formal approval from Thames Water as part of your application.

Developments which result in the need for off-site upgrades will be subject to conditions to ensure the occupation does not outpace the delivery of necessary infrastructure upgrades. Information on charging can also be found on their website.

c) Minimise water use

The scheme shall also demonstrate the use of methods to minimise the use of potable water through water collection, reuse and recycling and will:

i. incorporate water saving measures and equipment.

ii. provide details of water collection facilities to capture excess rainwater and or

iii. provide details of how rain and grey water will be recycled and reused in the development.

d) Long Term Management and Maintenance of the drainage system.

i. Provide a management and maintenance plan for the lifetime of the development of arrangements to secure the operation of the scheme throughout its lifetime. Including appropriate details of Inspection regimes, appropriate performance specification, remediation and timescales for the resolving of issues. Where there is overland flooding proposed, the plan should include the appropriate actions to ensure the safety of the users of the site should that be required.

ii. Clear plans showing the responsibility of different parties should be provided, such as the landowner, PMC, sewers offered for adoption and that to be adopted by the Council Highways services. Where it is a PMC the details of the body legally responsible for the implementation of the management and maintenance plan must be provided.

f) During Construction

i. How temporary measures will be implemented to ensure no increase in flood risk from commencement of construction

6.3. Flood Risk Assessment and Drainage Strategy

As identified necessary by LBHC, this Flood Risk Assessment and Drainage Strategy report have been prepared for the site as part of the planning submission.

The Flood Risk Assessment (FRA) takes into consideration the stakeholder recommendations and outlines the necessary mitigation measures ensuring that the development is sustainable and safe in terms of flood risk from tidal, river or groundwater sources.

EA Flood Mapping has been reviewed and the site falls within Flood Zone 1 and as such will present a low flood risk from the primary flood source of river flooding and tidal can be ruled out due to location. The extracts from the EA Flood Mapping included in the FRA show the primary source of flood risk as being the River Pinn and adjacent areas, which the site falls beyond. Another aspect of the FRA which will be accounted for is the need to mitigate flooding elsewhere by effective management of surface water on our site. As part of this, the drainage strategy will ensure runoff from the new development is considered and flows restricted to mitigate an impact on surrounding sites.

Alongside the drainage strategy considerations outlined above, LBHC advise the need to consider sustainable urban drainage within drainage design with proposals being based on the London Plan hierarchy (from Policy 5.13). Reviewing the London Plan drainage hierarchy, we note the requirements in the following order and comment on our ability to enable each in the table below.

Table 6-1 London Plan Policy 5.13 Hierarchy

Hierarchy ref	Description	Feasibility
1	Store rainwater for later use	Rainwater harvesting not believed to be suited to space planning, building services or budgetary constraints. Water butts to be installed to store water ahead of use in growing areas.
2	Use infiltration techniques, such as porous surfaces in non-clay areas	Site ground conditions unsuited to application as stated in GI Factual Report and high groundwater vulnerability.

3	Attenuate rainwater in ponds or open water features for gradual release	Open water features unsuited to SEN status of the school and insufficient space available within site boundary. Provision of a rain garden feasible within the site footprint and consideration of addition for green roofs to outbuilding structures.
4	Attenuate rainwater by storing in tanks or sealed water features for gradual release	Proposed for project via rain garden, MUGA and 3G pitches alongside underground attenuation tank.
5	Discharge rainwater direct to a watercourse	Likely to cause harm to nearby amenity and biodiversity during construction.
6	Discharge rainwater to a surface water sewer/drain	Proposed for project
7	Discharge rainwater to the combined sewer	N/A as surface water discharge preferred

As outlined previously in Section 3, infiltration is assumed unlikely to be feasible due to clayey soils and the falling head soakage test results alongside the high groundwater vulnerability to potential pollutants. Based on the hierarchy, the most likely scenario would be a discharge to an existing sewer having already attenuated flows through a combination of the rain garden feature, 3G pitch, permeable surfacing on the MUGA and underground tanks towards the outfall which provide a back up to the system. Crucially, we are unable to address the ideal scenario of storage of surface water within an open body due to the Special Educational Needs (SEN) nature of the school. Open water features would result in an unacceptable risk of harm to pupils and members of staff which unfortunately rules them out as an option in this instance although provision of a rain garden to the central car park area would suit the site layout and enable attenuation of flows. In this event, our proposal is to attenuate and restrict the flows from the 3G, MUGA, rain garden and attenuation tank to an equivalent greenfield run off rate. This will benefit the local area providing betterment given that the existing system has no form of restriction.

We will seek to utilise the opportunity for permeable surfacing (for the rain garden, 3G pitches and MUGA areas which will serve to filter surface water in line with Part 2 of the Local Plan and reduce the flowrate ahead of discharge) and attenuation where possible on site and restrict flow to an equivalent Greenfield Run Off rate. The volume of attenuation will ensure there is capacity provided on site so that flows are restricted to an acceptable level (equivalent greenfield run-off rate) under storm conditions. Our proposal will be based on an attenuated flow connected to a Thames Water surface water manhole positioned just to the north of our site boundary; positively draining to this point. Thames Water approval has been granted and the demonstration of this is included in the Appendices. Although below a direct discharge to a watercourse on the hierarchy (Table 6-1), the event of constructing across existing parkland would serve to disrupt existing biodiversity across the length of the route and at the outfall into the River Pinn to the extent that its negative impact would outweigh any benefit. The best option for foul drainage is to connect to the existing system with the outfall represented by a manhole to the north side of the access road. This will then route to the Thames Water asset positioned on the access road. Both foul and surface water outfall points are shown on the annotated Thames Water plan extract shown below.

Figure 6-1 Proposed surface and foul connection points

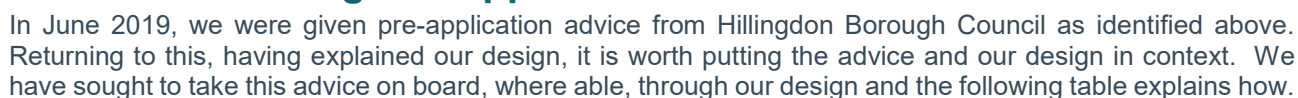


Table 6-1 Flood Risk Pre-Application Advice

HBC Item	Detail	Comment/Impact on Design
a) Sustainable Drainage	i) Evaluation in accordance with London Plan. Where not the most sustainable option, justification to be provided.	Refer to Table 6-1 above
	ii) Calculations to be provided to demonstrate control of run off	Refer to Appendices for greenfield rate and storm event design calculations. 3 sets of design calculations included to highlight difference between model including 3 levels of attenuation and flow restriction as opposed to a single volume and none at all.
	iii) Overland flow to be managed for events over 100 year event	Calculations demonstrate no resulting overland flow for required event.
b) Receptors	i) Surface water to be disposed of via infiltration where possible.	Infiltration not suited to ground conditions. August 2019 report states 'The results of infiltration tests indicate that the Langley Silt Member and Lynch Hill Gravel Member soils possess negligible to poor infiltration characteristics.' Refer to separate infiltration test results within Appendices.
	ii) Connection to watercourse to demonstrate watercourse has capacity for flows.	Not believed to be practical. See Table 6-1.
	iii) Connection to Thames Water sewer to demonstrate approval.	See Thames Water acceptance in Appendices.
c) Minimise water use	Scheme to minimise use of potable water through collection, reuse and recycling.	Rainwater collection to be provided via water butts in growing areas to both restrict flow and allow for reuse of water collected.
d) Management and Maintenance	Provide management and maintenance plan for lifetime of development	Draft version established. Final version to be established and submitted for approval prior to takeover/operation of the site.
f) During construction	Demonstration of no increase in flood risk during construction	Attenuation system to be installed as early site activity. Propose to discharge through this, with flow restriction in place during majority of construction period.

7. Drainage Options for Proposed Development

7.1. Surface Water Drainage

The existing and proposed site uses are consistent but ultimately, given the development, there will be changes to the impermeable surface area. The impermeable areas for the existing and proposed sites are 0.6 ha and 1.0 ha respectively. Given the difference, a key function of our design is to ensure that the increase in impermeable area does not impact on the potential flood risk on site, as such, our surface water flows need to be appropriately managed to mitigate an impact on site flood risk both above and below ground.

A key feature of management of the surface water flow is through provision of underground attenuation volumes across the site; the cumulative size of which has been estimated in accordance with the calculation shown in Appendix C and summarised below. Storm water management aspects have been calculated using IH124 method as follows:

Overall site area = 1.20 ha

Impermeable area = 0.67 ha

Qbar = 1.9 l/s

Approximate total storage volume required (inc 40% CC) = 600 m³.

Our design has been included within the Appendices; this gives a flowrate restriction of 6l/s for surface water drainage which effectively reduces the rate to the equivalent greenfield rate under storm conditions as defined within the Pre-Application Advice agreed with Thames Water. This will limit the discharge from the site to an equivalent sized greenfield; clear betterment over the existing scenario which has no attenuation.

Attenuation will be provided by a combination of the rain garden, 3G and MUGA pitches alongside an underground tank, collectively sized as outlined above. In the previous Section, we outlined that these reflect the most suitable scenario required due to the SEN limitations posed by the school which render traditional open water attenuation features impractical.

Alongside provision of underground storage, one of the main challenges to developing a surface water solution for the development is the relatively flat site; the levels for which will remain consistent with the existing site. Falls in the surface will be created to ensure that surface water reaches the collection points which will tend to feature road gullies, linear drainage and permeable surfacing. Considering the site levels, our key aim during detailed design is to ensure we are able to capture surface water and route this underground without causing disruption above ground. Furthermore, a site maintenance strategy will need to be established to ensure the drainage system remains functional and free from blockages which might otherwise disrupt the passage of surface water. Despite the flat site, the depth of inverts to existing drainage systems on site suggest that there is a good amount of depth to invert available to ensure a connection will be feasible via gravity.

Site survey information provides an invert level for an existing combined sewer at 46.79m (based on local topographical survey grid) on the access road albeit, this is shown on the Thames Water plans as a foul sewer. As such, only foul drainage will be connected at this point.

The drain to the north east beyond the boundary of the site is 1.2m diameter and routes directly to the River Pinn from TW MH ref 1001. Thames Water have advised that based on OS grid, '*manhole 1001 - cover level is 30.02m and invert level is 27.18m*' so there is a depth of around 2.8m at that point. Given the pipe diameter and change in level between the site and the manhole position (approx. 1m), there is likely to be a feasible invert depth to enable connection.

Should the access road system be a combined system, a review has been undertaken of a surface water connection from a feasibility point of view. The survey indicates the combined pipe is 300mm diameter (albeit, the Thames Water plan suggests this is a foul sewer at 225mm diameter) and invert at 46.79m which therefore

indicates a good depth and level of cover to the pipe but this solution does feature lower down the hierarchy than the surface water connection.

Irrespective of the surface water outfall position, given the proposed finished floor level of 50.15m, it can be assumed that there is an adequate amount of fall available to enable drainage via gravity to mitigate the need for pumping systems. At the next stage, the outfall point will be confirmed through discussion with Thames Water as the feasibility of connection will have a fundamental impact on the design of the network.

The primary options available for storage of surface water flows upstream from the flow restriction will feature the rain garden, attenuation structure or permeable surfacing. In this instance, each volume will perform its role within the system, filtering flows before restricting and storage ahead of being restricted to the equivalent greenfield rate.

Structural design of any geocellular tanks will be required to prove their suitability for use in the proposed locations and against the proposed loading and design life. Clay and concrete drainage products can be supplied to suit a longer design life, however, some plastic products are able to demonstrate a 60 year design life and can be specified (Polypipe Rigidrain or similar approved).

Alongside provision of attenuation features, attempts will be made to reduce the surface water flow by diverting water away from the system; temporarily in the case of water butts used to store water for future use and through consideration of introduction of green roofs to outbuilding structures. Before determining the feasibility of a green roof, the habitat and drainage benefits will need to be balanced against the suitability for installation in a special educational needs setting and a decision taken from there.

7.2. Foul Water Drainage

An existing Thames Water foul sewer is present on the site. A 300mm diameter sewer is located on the site access road; the nearest manhole to the development is TW reference 1902 (TW plans suggest a 225mm diameter whilst site survey detail indicates 300mm) although connection will be upstream from there adjacent to the access road. Site surveys and confirmation from Thames Water based on OS grid (*'manhole 1902 cover level is 32.13m and invert level is 28.88m'*) indicate this to be over 3m deep; this is well below the approximate 50.15m (local grid) finished floor level of the proposed building and this depth suggests that a connection via gravity will be achievable. As with surface water, the connection needs to be agreed with Thames Water; initially via a Pre-Development Enquiry.

Assuming an invert level of approximately 48.95m at the upstream end of the system (1.2m below FFL) based on a local grid, there is just over 1m of fall available to the connection point. A foul drainage system can be provided with a worst-case gradient of 1:150 which would be sufficient to enable self-cleansing velocity.

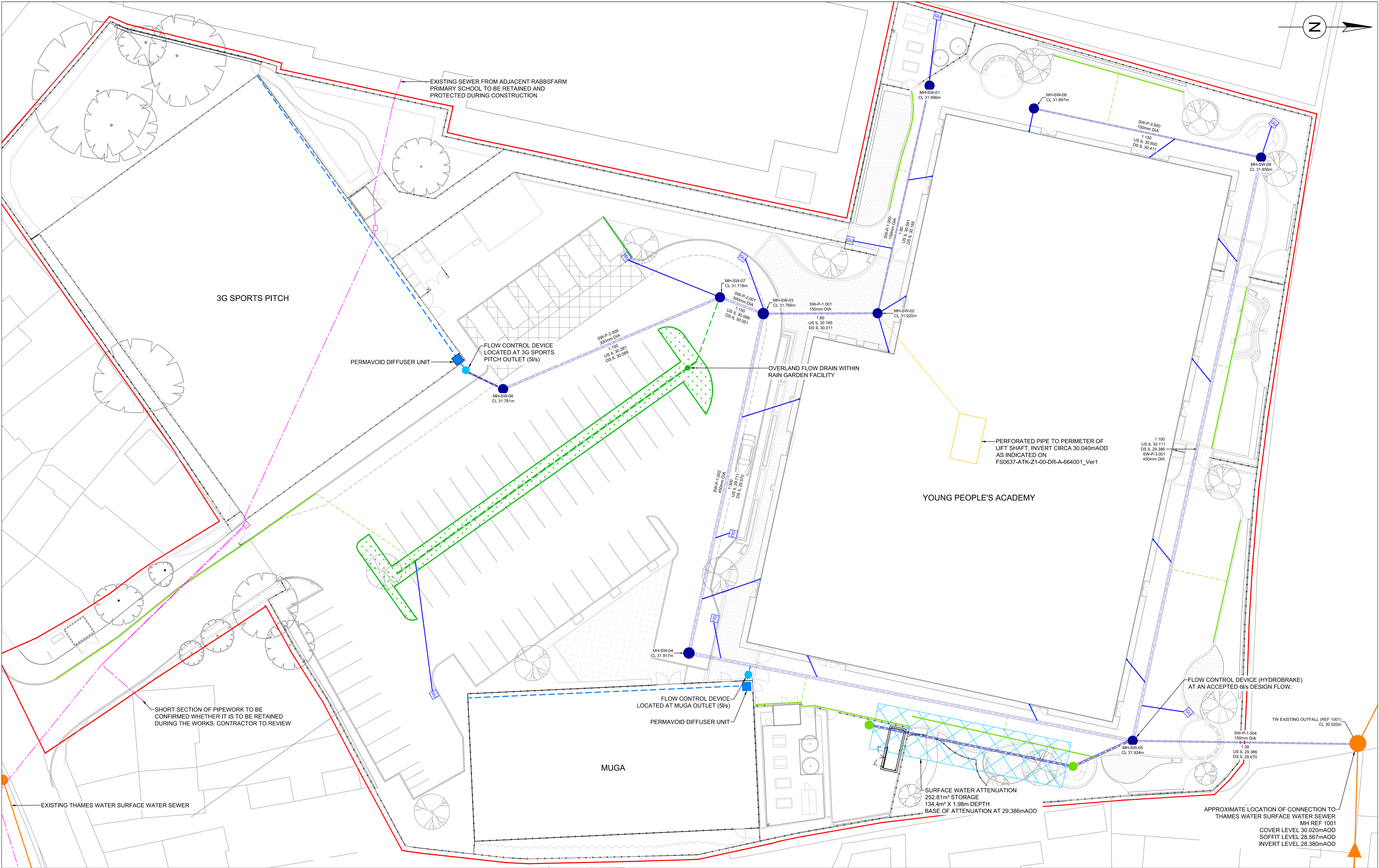
Foul calculations have been carried out based on the guidance in British Water Flows and Loads – Sizing Criteria, Treatment Capacity for Sewage Treatment Systems, which advises an allowance of 90 litres per person per day for non-residential schools with on-site catering.

- Number of pupils approx. 230;
- Number of staff approx. 115;
- 90 litres per person per day;
- Daily volume = $345 \times 90 = 31,050$ litres = 31.05 m^3 . (Note this only includes daytime use)
- Average daily flow rate = 0.36 l/s
- Indicative peak flow at 6 x average daily flow = 2.16 l/s.

To take the design forwards to demonstrate that the system can function via gravity, approval will be sought from Thames Water. We believe that there is an existing site-wide system connecting into the same sewer at the same point and as such believe that the connection is feasible. A key part of the discussions is to agree an acceptable flowrate; ideally based on the figures above with an unrestricted flowrate.

Appendix A. Drawings

- A.1. FS0637-ATK-XX-XX-DR-C-921001 – Surface Water Drainage GA**
- A.2. FS0637-ATK-XX-XX-DR-C-931001 – Foul Water Drainage GA**



NOTES

- DO NOT SCALE FROM THIS DRAWING
- DRAWING TO BE READ IN FULL COLOUR.
- POSITION, SIZE AND DEPTH OF ALL EXISTING SEWERS AND SERVICES SHALL BE ESTABLISHED PRIOR TO COMMENCEMENT ON SITE.
- THE CONTRACTOR SHALL ALLOW FOR THE PROTECTION, TEMPORARY AND PERMANENT SUPPORT, AND TEMPORARY AND PERMANENT DIVERSION WORKS, AS NECESSARY TO ALL EXISTING SERVICES.
- THE CONTRACTOR SHALL ALLOW FOR KEEPING SEWER TRENCHES AND EXCAVATIONS AS DRY AS PRACTICABLE BY PUMPING FROM TEMPORARY SUMPS AND DE WATERING AS APPROPRIATE. THE POINT AND METHOD OF DISCHARGE TO BE AGREED WITH DRAINAGE AUTHORITY.
- ALL MANHOLES AND PIPES ARE TO BE CONSTRUCTED IN ACCORDANCE WITH SEWERS FOR ADOPTION 8th EDITION.
- THE SURFACE WATER SYSTEM PROPOSED OUTFALL BASED ON THAMES WATER MH REF 1001. THAMES WATER HAVE ACCEPTED A PRE-PLANNING APPLICATION TO CONNECT INTO THE EXISTING SEWER, DATED 24/06/19.
- ATTENUATION TANK TO BE STORMBLOC SYSTEM BY HYDRO INTERNATIONAL WRAPPED IN A VISQUEEN HIGH PERFORMANCE URBAN DRAINAGE GEOMEMBRANE (HP UDG) OR SIMILAR 1mm (MINIMUM) POLYPROPYLENE IMPERMEABLE MEMBRANE.

KEY

- SURFACE WATER MANHOLE
- SURFACE WATER NETWORK
- 100mm DIA PVC-U WAVINCOIL PERFORATED PIPE
- SURFACE WATER ATTENUATION TANK
- EXISTING SURFACE WATER SEWER (THAMES WATER)
- INSPECTION CHAMBER FOR ATTENUATION
- PROPOSED ACO DRAIN AND LEAD PIPE
- PROPOSED GULLY AND LEAD PIPE LOCATION
- RAINWATER DOWNPIPE LOCATION
- EXISTING FOUL/COMBINED SEWER TO BE RETAINED
- PROPOSED CATCHPIT
- PROPOSED DRAINAGE AROUND LIFT PIT
- PROPOSED RAIN GARDEN FACILITY
- PERMAVOID DIFFUSER UNIT

C02	22/11/19	For Construction Issue	CH	MH	GC
C01	14/11/19	For Construction Issue	CH	MH	GC
P02	12/11/19	For Construction Issue	CH	MH	GC
P01	07/08/19	Fit for information	RJ	MH	GC
Rev.	Date	Description	By	Chk'd	Appr.

Drawing Title

**SURFACE WATER DRAINAGE
GENERAL ARRANGEMENT**

Drawing Number

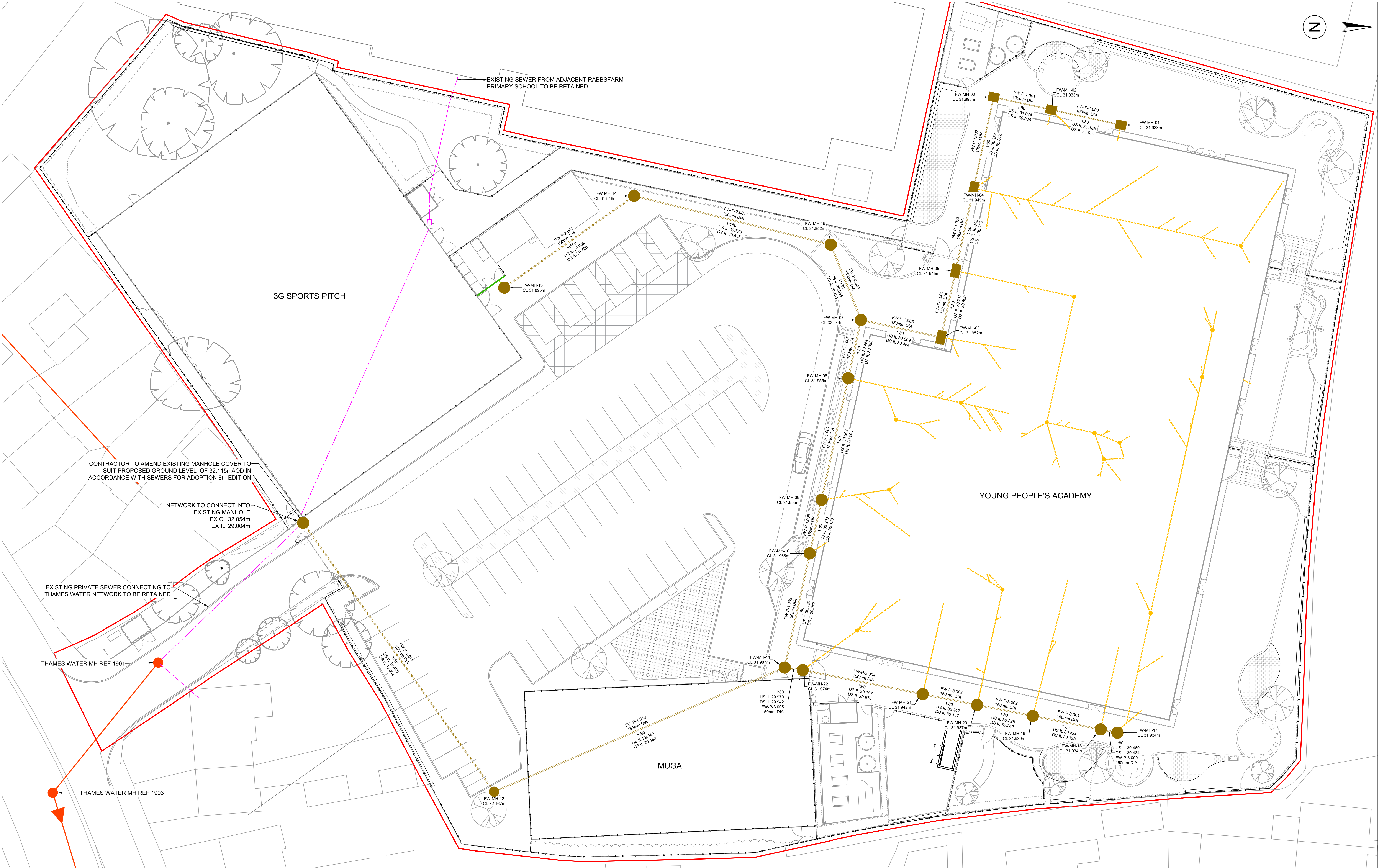
FS0637-ATK-XX-XX-DR-C-921001

Scale

1:200 @ A1

Revision

C02



NOTES

- DO NOT SCALE FROM THIS DRAWING
- DRAWING TO BE READ IN FULL COLOUR.
- POSITION, SIZE AND DEPTH OF ALL EXISTING SEWERS AND SERVICES SHALL BE ESTABLISHED PRIOR TO COMMENCEMENT ON SITE.
- THE CONTRACTOR SHALL ALLOW FOR THE PROTECTION, TEMPORARY AND PERMANENT SUPPORT, AND TEMPORARY AND PERMANENT DIVERSION WORKS, AS NECESSARY TO ALL EXISTING SERVICES.
- THE CONTRACTOR SHALL ALLOW FOR KEEPING SEWER TRENCHES AND EXCAVATIONS AS DRY AS PRACTICABLE BY PUMPING FROM TEMPORARY SUMPS AND DE WATERING AS APPROPRIATE. THE POINT AND METHOD OF DISCHARGE TO BE AGREED WITH DRAINAGE AUTHORITY.

- ALL MANHOLES AND PIPES ARE TO BE CONSTRUCTED IN ACCORDANCE WITH SEWERS FOR ADOPTION 8th EDITION.
- DRAINAGE LAYOUT SHOWS ONLY PRIMARY DRAINAGE ROUTES. ADDITIONAL DRAINS AND MANHOLES WILL BE REQUIRED TO PICK UP ALL CONNECTIONS FROM BUILDINGS.
- CONNECTION INTO EXISTING FOUL WATERSEWER HAS BEEN BY THAMES WATER ACCEPTED VIA A PRE-PLANNING APPLICATION, DATED 24/06/19.
- POP-UP LOCATIONS BASED ON MEP DRAWINGS, REFERENCED ORC-AME-Z1-00-DR-MH(52)-001, REV P01, DATED 12/07/2019.

KEY

- FOUL WATER MANHOLE
- FOUL WATER NETWORK
- FOUL WATER UNDERSLAB DRAINAGE FROM SCHOOL BUILDING (INDICATIVE LOCATIONS)
- EXISTING FOUL WATER SEWER (THAMES WATER)
- FOUL WATER ACO CHANNEL AND LEAD PIPE LOCATION

EXISTING FOUL/COMBINED SEWER TO BE RETAINED

Rev.	Date	Description	By	Chk'd	Appr.
C02	13/12/19	For Construction Issue	CH	MH	GC
C01	14/11/19	For Construction Issue	CH	MH	GC
P02	12/11/19	For Construction Issue	CH	MH	GC
P01	07/08/19	For Construction Issue	RJ	MH	GC

Drawing Title
**FOUL WATER DRAINAGE
GENERAL ARRANGEMENT**

Drawing Number
FS0637-ATK-XX-XX-DR-C-931001

Scale
1:200 @ A1

Revision
C02



ATKINS

Appendix B. Soakaway Test Results

B.1. Extract from Ashdown Site Investigation Ltd Ground Investigation Factual Report ref R17-12386

ASHDOWN SITE INVESTIGATION LIMITED

Site: Hillingdon Young Persons Hub, Falling Lane,
Yiewsley, West Drayton

Report No.: R17-12386
Sheet No.: 1 of 1

SUMMARY OF BOREHOLE FALLING HEAD SOAKAGE TEST RESULTS

WS03		WS05	
Time (mins)	Depth to water (m bgl)	Time (mins)	Depth to water (m bgl)
0	0.00	0	0.00
1	0.02	1	0.01
2	0.03	2	0.06
5	0.11	3	0.12
10	0.13	5	0.15
15	0.18	10	0.18
30	0.21	15	0.23
60	0.28	40	0.28
75	0.30	55	0.33
90	0.34	100	0.38
		160	0.65
Borehole Depth (m bgl)	3.00	Borehole Depth (m bgl)	2.70
Casing Depth (m bgl)	2.00	Casing Depth (m bgl)	2.00
Borehole Diameter (mm)	92.00	Borehole Diameter (mm)	92.00
Casing Diameter (mm)	105.00	Casing Diameter (mm)	105.00

Notes: bgl – below ground level.

Appendix C. Surface Water Design Calculations

- C.1. Greenfield Run Off Calculations**
- C.2. SuDS Storage Report**
- C.3. Microdrainage Summary – Full Design**
- C.4. Microdrainage Summary – Single attenuation volume for comparison**
- C.5. Microdrainage Summary – No attenuation for comparison**

Calculated by:

Site name:

Site location:

Site coordinates

Latitude:

Longitude:

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.

Reference:

Date:

Methodology	IH124
-------------	-------

Site characteristics

Total site area (ha)	50
----------------------	----

Methodology

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

	Default	Edited
SOIL type	2	2
HOST class	---	---
SPR/SPRHOST	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm)	621	621
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?

Normally limiting discharge rates which are less than 2.0 l/s/ha are set at 2.0 l/s/ha.

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

(3) Is $SPR/SPRHOST \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite may be a requirement for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	79.21	79.21
1 in 1 year (l/s)	67.33	67.33
1 in 30 years (l/s)	182.18	182.18
1 in 100 years (l/s)	252.68	252.68

Calculated by:

Site name:

Site location:

Site coordinates

Latitude:

Longitude:

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.

Reference:

Date:

Methodology	IH124
-------------	-------

Site characteristics

Total site area (ha)	1.1973
----------------------	--------

Methodology

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

	Default	Edited
SOIL type	2	2
HOST class	---	---
SPR/SPRHOST	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm)	621	621
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?
Normally limiting discharge rates which are less than 2.0 l/s/ha are set at 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 5.0 l/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 $SPR/SPRHOST \leq 0.3$?
Where groundwater levels are low enough the use of soakaways to avoid discharge offsite may be a requirement for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	1.9	1.9
1 in 1 year (l/s)	1.61	1.61
1 in 30 years (l/s)	4.36	4.36
1 in 100 years (l/s)	6.05	6.05

Calculated by:

Site name:

Site location:

Site coordinates

Latitude:

Longitude:

This is an estimation of the storage volume requirements 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). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the drainage scheme.

Reference:

Date:

Methodology

IH124

Site characteristics

Total site area (ha)	1.2
Significant public open space (ha)	0
Area positively drained (ha)	1.2
Pervious area contribution (%)	0
Impermeable area (ha)	.67
Percentage of drained area that is impermeable (%)	56
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	10
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	10
Compliance factor for rainwater harvesting system design (%)	66
Net site area for storage volume design (ha)	1.2
Net impermeable area for storage volume design (ha)	0.67

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach	Use long term storage	
	Default	Edited
Climate change allowance factor	1.4	1.4
Urban creep allowance factor	1.1	1.1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5
Qbar estimation method	Calculate from SPR and SAAR	
SPR estimation method	Calculate from SOIL type	
	Default	Edited
Qbar total site area (l/s)	1.9	--
SOIL type	2	2
HOST class	N/A	N/A
SPR	0.3	0.3

Hydrology

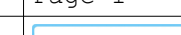
	Default	Edited
SAAR (mm)	621	621
M5-60 Rainfall Depth (mm)	20	20
'r' Ratio M5-60/M5-2 day	0.4	0.4
Rainfall 100 yrs 6 hrs	63	
Rainfall 100 yrs 12 hrs	94.71	
FEH/FSR conversion factor	1.23	1.23
Hydrological region	6	
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 10 year	1.62	1.62
Growth curve factor: 30 year	2.3	2.3
Growth curve factor: 100 year	3.19	3.19

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	1.9	1.9
Qbar net site area (l/s)	1.9	1.9
1 in 1 year (l/s)	5	5
1 in 30 years (l/s)	5	5
1 in 100 years (l/s)	6.1	6.1

Estimated storage volumes

	Default	Edited
Interception storage (m³)	27	27
Attenuation storage (m³)	551	551
Long term storage (m³)	0	0
Treatment storage (m³)	80	80
Total storage (excluding treatment) (m³)	578	578

Atkins		Page 1
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STORM SEWER DESIGN by the Modified Rational Method

Pipe Sizes STANDARD Manhole Sizes STANDARD

Designed with Level Inverts

« - Indicates pipe capacity < flow

Network Results Table

Atkins										Page 2	
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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.002	20.831	0.069	300.0	0.012	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.003	21.591	0.072	300.0	0.024	0.00	0.0	0.600	o	450	Pipe/Conduit	
S4.000	3.296	0.022	149.8	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
S4.001	3.309	0.022	150.0	0.068	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.004	49.885	0.166	300.0	0.069	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.005	5.291	0.018	300.0	0.077	0.00	0.0	0.600	o	450	Pipe/Conduit	
S5.000	28.348	0.189	150.0	0.051	5.00	0.0	0.600	o	150	Pipe/Conduit	
S5.001	67.752	0.678	100.0	0.055	0.00	0.0	0.600	o	450	Pipe/Conduit	
S5.002	5.101	0.051	100.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.006	27.517	0.183	150.0	0.124	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.002	50.00	7.03	29.711	0.521	0.0	0.0	0.0	1.17	185.8	70.5
S1.003	50.00	7.33	29.642	0.545	0.0	0.0	0.0	1.17	185.8	73.7
S4.000	50.00	5.07	30.528	0.000	0.0	0.0	0.0	0.82	14.5	0.0
S4.001	50.00	5.12	30.506	0.068	0.0	0.0	0.0	1.07	42.4	9.2
S1.004	50.00	8.05	29.570	0.682	0.0	0.0	0.0	1.17	185.8	92.3
S1.005	50.00	8.12	29.404	0.758	0.0	0.0	0.0	1.17	185.8	102.7
S5.000	50.00	5.58	30.600	0.051	0.0	0.0	0.0	0.82	14.5	7.0
S5.001	50.00	6.13	30.111	0.106	0.0	0.0	0.0	2.03	323.4	14.3
S5.002	50.00	6.17	29.437	0.106	0.0	0.0	0.0	2.03	323.4	14.3
S1.006	50.00	8.68	29.386	0.988	0.0	0.0	0.0	0.82	14.5«	133.8

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S3	31.829	1.288	Open Manhole	1200	S1.000	30.541	150				
S4	31.920	1.735	Open Manhole	1200	S1.001	30.185	150	S1.000	30.185	150	
S7	32.003	0.460	Open Manhole	600	S2.000	31.543	100				
S7	31.961	1.570	Open Manhole	600	S2.001	30.391	225	S2.000	31.250	100	734
S6	31.773	1.500	Open Manhole	1200	S2.002	30.273	300	S2.001	30.348	225	
S6	31.891	0.850	Open Manhole	600	S3.000	31.041	150				
S7	31.653	1.350	Open Manhole	600	S3.001	30.303	150	S3.000	30.803	150	500
S7	31.703	1.616	Open Manhole	1200	S2.003	30.088	300	S2.002	30.088	300	
								S3.001	30.223	150	
S5	31.759	2.048	Open Manhole	1350	S1.002	29.711	450	S1.001	30.011	150	
								S2.003	30.038	300	177
S6	31.760	2.119	Open Manhole	1350	S1.003	29.642	450	S1.002	29.642	450	
S11	31.969	1.441	Open Manhole	600	S4.000	30.528	150				
S13	31.961	1.455	Open Manhole	600	S4.001	30.506	225	S4.000	30.506	150	
S7	31.918	2.348	Open Manhole	1350	S1.004	29.570	450	S1.003	29.570	450	
								S4.001	30.484	225	689
S8	31.953	2.549	Open Manhole	1350	S1.005	29.404	450	S1.004	29.404	450	
S14	31.897	1.297	Open Manhole	1200	S5.000	30.600	150				
S15	31.856	1.745	Open Manhole	1350	S5.001	30.111	450	S5.000	30.411	150	
S16	31.933	2.499	Open Manhole	1350	S5.002	29.437	450	S5.001	29.433	450	
S9	31.925	2.539	Open Manhole	1350	S1.006	29.386	150	S1.005	29.386	450	
								S5.002	29.386	450	
S	30.020	0.817	Open Manhole	0		OUTFALL		S1.006	29.203	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S3	506089.243	181022.670	506089.243	181022.670	Required	
S4	506117.016	181016.354	506117.016	181016.354	Required	
S7	506089.094	180940.287	506089.094	180940.287	Required	
S7	506124.854	180965.892	506124.854	180965.892	Required	

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Page 4

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Micro Drainage

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S6	506128.194	180971.363	506128.194	180971.363	Required	
S6	506148.346	180956.444	506148.346	180956.444	Required	
S7	506122.184	180993.454	506122.184	180993.454	Required	
S7	506114.453	180995.487	506114.453	180995.487	Required	
S5	506117.069	181002.436	506117.069	181002.436	Required	
S6	506137.417	180997.971	506137.417	180997.971	Required	
S11	506161.092	180988.925	506161.092	180988.925	Required	
S13	506161.614	180992.180	506161.614	180992.180	Required	
S7	506158.490	180993.273	506158.490	180993.273	Required	
S8	506168.137	181042.217	506168.137	181042.217	Required	
S14	506092.033	181035.403	506092.033	181035.403	Required	
S15	506098.022	181063.111	506098.022	181063.111	Required	
S16	506164.188	181048.539	506164.188	181048.539	Required	
S9	506169.161	181047.408	506169.161	181047.408	Required	
S	506169.572	181074.922			No Entry	

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Atkins		Page 5
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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)
S1.000	o	150	S3	31.829	30.541	1.138	Open Manhole	1200
S1.001	o	150	S4	31.920	30.185	1.585	Open Manhole	1200
S2.000	o	100	S7	32.003	31.543	0.360	Open Manhole	600
S2.001	o	225	S7	31.961	30.391	1.345	Open Manhole	600
S2.002	o	300	S6	31.773	30.273	1.200	Open Manhole	1200
S3.000	o	150	S6	31.891	31.041	0.700	Open Manhole	600
S3.001	o	150	S7	31.653	30.303	1.200	Open Manhole	600
S2.003	o	300	S7	31.703	30.088	1.315	Open Manhole	1200
S1.002	o	450	S5	31.759	29.711	1.598	Open Manhole	1350
S1.003	o	450	S6	31.760	29.642	1.668	Open Manhole	1350
S4.000	o	150	S11	31.969	30.528	1.291	Open Manhole	600
S4.001	o	225	S13	31.961	30.506	1.230	Open Manhole	600
S1.004	o	450	S7	31.918	29.570	1.898	Open Manhole	1350
S1.005	o	450	S8	31.953	29.404	2.099	Open Manhole	1350

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)
S1.000	28.482	80.0	S4	31.920	30.185	1.585	Open Manhole	1200
S1.001	13.918	80.0	S5	31.759	30.011	1.598	Open Manhole	1350
S2.000	43.982	150.0	S7	31.961	31.250	0.611	Open Manhole	600
S2.001	6.410	150.0	S6	31.773	30.348	1.200	Open Manhole	1200
S2.002	27.762	150.0	S7	31.703	30.088	1.316	Open Manhole	1200
S3.000	45.324	190.5	S7	31.653	30.803	0.700	Open Manhole	600
S3.001	7.993	100.0	S7	31.703	30.223	1.330	Open Manhole	1200
S2.003	7.426	150.0	S5	31.759	30.038	1.421	Open Manhole	1350
S1.002	20.831	300.0	S6	31.760	29.642	1.669	Open Manhole	1350
S1.003	21.591	300.0	S7	31.918	29.570	1.898	Open Manhole	1350
S4.000	3.296	149.8	S13	31.961	30.506	1.305	Open Manhole	600
S4.001	3.309	150.0	S7	31.918	30.484	1.209	Open Manhole	1350
S1.004	49.885	300.0	S8	31.953	29.404	2.099	Open Manhole	1350
S1.005	5.291	300.0	S9	31.925	29.386	2.088	Open Manhole	1350

Atkins	Page 6
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW	
Date 13/12/2019 11:24	
File Orchard Hill Young Peop...	
Innovyze	Network 2019.1

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd	Diam	MH	C.Level	I.Level	D.Depth	MH	MH DIAM., L*W
	Sect	(mm)	Name	(m)	(m)	(m)	Connection	(mm)
S5.000	o	150	S14	31.897	30.600	1.147	Open Manhole	1200
S5.001	o	450	S15	31.856	30.111	1.295	Open Manhole	1350
S5.002	o	450	S16	31.933	29.437	2.046	Open Manhole	1350
S1.006	o	150	S9	31.925	29.386	2.389	Open Manhole	1350

Downstream Manhole

PN	Length	Slope	MH	C.Level	I.Level	D.Depth	MH	MH DIAM., L*W
	(m)	(1:X)	Name	(m)	(m)	(m)	Connection	(mm)
S5.000	28.348	150.0	S15	31.856	30.411	1.295	Open Manhole	1350
S5.001	67.752	100.0	S16	31.933	29.433	2.049	Open Manhole	1350
S5.002	5.101	100.0	S9	31.925	29.386	2.089	Open Manhole	1350
S1.006	27.517	150.0	S	30.020	29.203	0.667	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall	Outfall	C. Level	I. Level	Min	D,L	W
Pipe Number	Name	(m)	(m)	I. Level (m)	(mm)	(mm)
S1.006	S	30.020	29.203	0.000	0	0

Atkins	Page 7
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW	
Date 13/12/2019 11:24	
File Orchard Hill Young Peop...	
Innovyze	Network 2019.1

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S7, DS/PN: S2.001, Volume (m³): 0.8

Unit Reference	MD-CHE-0093-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	No
Diameter (mm)	93
Invert Level (m)	30.391
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.0
Flush-Flo™	0.228	4.2
Kick-Flo®	0.322	2.4
Mean Flow over Head Range	-	3.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	4.5	3.000	7.0	7.000	10.7
0.200	4.1	1.400	4.8	3.500	7.6	7.500	11.0
0.300	2.5	1.600	5.2	4.000	8.1	8.000	11.4
0.400	2.6	1.800	5.5	4.500	8.6	8.500	11.7
0.500	2.9	2.000	5.8	5.000	9.0	9.000	12.1
0.600	3.2	2.200	6.0	5.500	9.5	9.500	12.4
0.800	3.7	2.400	6.3	6.000	9.9		
1.000	4.1	2.600	6.6	6.500	10.3		

Hydro-Brake® Optimum Manhole: S13, DS/PN: S4.001, Volume (m³): 0.5

Unit Reference	MD-SHE-0098-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	98
Invert Level (m)	30.506
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

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Woodcote Grove
Ashley Road
Epsom Surrey KT18 5BW

Date 13/12/2019 11:24
File Orchard Hill Young Peop...

Innovyze

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Checked by

Network 2019.1

Page 8



Hydro-Brake® Optimum Manhole: S13, DS/PN: S4.001, Volume (m³): 0.5

Control Points

Head (m)

Flow (l/s)

Design Point (Calculated)

1.500

5.0

Flush-Flo™

0.431

4.9

Kick-Flo®

0.878

3.9

Mean Flow over Head Range

-

4.3

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)

0.100

3.2

1.200

4.5

3.000

6.9

7.000

10.3

0.200

4.4

1.400

4.8

3.500

7.4

7.500

10.7

0.300

4.8

1.600

5.1

4.000

7.9

8.000

11.0

0.400

4.9

1.800

5.4

4.500

8.4

8.500

11.3

0.500

4.9

2.000

5.7

5.000

8.8

9.000

11.6

0.600

4.8

2.200

6.0

5.500

9.2

9.500

11.9

0.800

4.3

2.400

6.2

6.000

9.6

1.000

4.1

2.600

6.5

6.500

10.0

Hydro-Brake® Optimum Manhole: S9, DS/PN: S1.006, Volume (m³): 4.9

Unit Reference

MD-CHE-0101-6000-1500-6000

Design Head (m)

1.500

Design Flow (l/s)

6.0

Flush-Flo™

Calculated

Objective

Minimise upstream storage

Application

Surface

Sump Available

No

Diameter (mm)

101

Invert Level (m)

29.386

Minimum Outlet Pipe Diameter (mm)

150

Suggested Manhole Diameter (mm)

1200

Control Points

Head (m)

Flow (l/s)

Design Point (Calculated)

1.500

6.0

Flush-Flo™

0.250

5.3

Kick-Flo®

0.353

3.0

Mean Flow over Head Range

-

4.4

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

Depth (m)

Flow (l/s)

Depth (m)

Flow (l/s)

Depth (m)

Flow (l/s)

Depth (m)

Flow (l/s)

0.100

2.8

0.300

3.9

0.500

3.5

0.800

4.4

0.200

4.9

0.400

3.1

0.600

3.8

1.000

4.9

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Atkins		Page 9					
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW							
Date 13/12/2019 11:24	Designed by HARD8568						
File Orchard Hill Young Peop...	Checked by						
Innovyze	Network 2019.1						
<u>Hydro-Brake® Optimum Manhole: S9, DS/PN: S1.006, Volume (m³): 4.9</u>							
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
1.200	5.4	2.400	7.6	5.000	10.8	8.000	13.6
1.400	5.8	2.600	7.9	5.500	11.4	8.500	14.1
1.600	6.2	3.000	8.4	6.000	11.9	9.000	14.5
1.800	6.6	3.500	9.1	6.500	12.3	9.500	14.8
2.000	6.9	4.000	9.7	7.000	12.8		
2.200	7.2	4.500	10.3	7.500	13.2		
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Atkins	Page 10
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW	
Date 13/12/2019 11:24	
File Orchard Hill Young Peop...	
Innovyze	Network 2019.1

Storage Structures for Storm

Cellular Storage Manhole: S7, DS/PN: S2.001

Invert Level (m) 30.391 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	300.0	0.0	0.351	0.0	0.0
0.350	300.0	0.0			

Tank or Pond Manhole: S7, DS/PN: S3.001

Invert Level (m) 30.303

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	70.0	1.000	70.0

Cellular Storage Manhole: S13, DS/PN: S4.001

Invert Level (m) 30.506 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	133.0	0.0	0.351	0.0	0.0
0.350	133.0	0.0			

Cellular Storage Manhole: S8, DS/PN: S1.005

Invert Level (m) 29.404 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	134.0	0.0	1.981	0.0	0.0
1.980	134.0	0.0			

Atkins		Page 1
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW		
Date 13/12/2019 14:03 File Orchard Hill Young Peop...	Designed by HARD8568 Checked by	
Innovyze	Network 2019.1	

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)	30	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.404	Minimum Backdrop Height (m)	0.000
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)	0.70
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	300

Designed with Level Inverts

Network Design Table for Storm

« - Indicates pipe capacity < flow

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
S1.000	28.482	0.356	80.0	0.034	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	13.918	0.174	80.0	0.048	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.000	43.982	0.293	150.0	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
S2.001	6.410	0.043	150.0	0.141	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.002	27.762	0.185	150.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S3.000	45.324	0.238	190.5	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
S3.001	7.993	0.080	100.0	0.230	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.003	7.426	0.050	150.0	0.056	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)
S1.000	50.00	5.42	30.541	0.034	0.0	0.0	0.0	1.12	19.9	4.6
S1.001	50.00	5.63	30.185	0.082	0.0	0.0	0.0	1.12	19.9	11.1
S2.000	50.00	6.17	31.543	0.000	0.0	0.0	0.0	0.63	4.9	0.0
S2.001	50.00	6.27	30.391	0.141	0.0	0.0	0.0	1.07	42.4	19.1
S2.002	50.00	6.63	30.273	0.141	0.0	0.0	0.0	1.28	90.6	19.1
S3.000	50.00	6.04	31.041	0.000	0.0	0.0	0.0	0.72	12.8	0.0
S3.001	50.00	6.17	30.303	0.230	0.0	0.0	0.0	1.00	17.8«	31.2
S2.003	50.00	6.73	30.088	0.427	0.0	0.0	0.0	1.28	90.6	57.8

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Woodcote Grove
Ashley Road
Epsom Surrey KT18 5BW

Date 13/12/2019 14:03
File Orchard Hill Young Peop...

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Page 2



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Network 2019.1

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
S1.002	20.831	0.069	300.0	0.012	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.003	21.591	0.072	300.0	0.024	0.00	0.0	0.600	o	450	Pipe/Conduit	
S4.000	3.296	0.022	149.8	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
S4.001	3.309	0.022	150.0	0.068	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.004	49.885	0.166	300.0	0.069	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.005	5.291	0.018	300.0	0.077	0.00	0.0	0.600	o	450	Pipe/Conduit	
S5.000	28.348	0.189	150.0	0.051	5.00	0.0	0.600	o	150	Pipe/Conduit	
S5.001	67.752	0.678	100.0	0.055	0.00	0.0	0.600	o	450	Pipe/Conduit	
S5.002	5.101	0.051	100.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.006	27.517	0.183	150.0	0.124	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)
S1.002	50.00	7.03	29.711	0.521	0.0	0.0	0.0	1.17	185.8	70.5
S1.003	50.00	7.33	29.642	0.545	0.0	0.0	0.0	1.17	185.8	73.7
S4.000	50.00	5.07	30.528	0.000	0.0	0.0	0.0	0.82	14.5	0.0
S4.001	50.00	5.12	30.506	0.068	0.0	0.0	0.0	1.07	42.4	9.2
S1.004	50.00	8.05	29.570	0.682	0.0	0.0	0.0	1.17	185.8	92.3
S1.005	50.00	8.12	29.404	0.758	0.0	0.0	0.0	1.17	185.8	102.7
S5.000	50.00	5.58	30.600	0.051	0.0	0.0	0.0	0.82	14.5	7.0
S5.001	50.00	6.13	30.111	0.106	0.0	0.0	0.0	2.03	323.4	14.3
S5.002	50.00	6.17	29.437	0.106	0.0	0.0	0.0	2.03	323.4	14.3
S1.006	50.00	8.68	29.386	0.988	0.0	0.0	0.0	0.82	14.5«	133.8

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Atkins		Page 3
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW		
Date 13/12/2019 14:03	Designed by HARD8568	
File Orchard Hill Young Peop...	Checked by	
Innovyze		Network 2019.1

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)	Pipe Out Diameter (mm)	PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S3	31.829	1.288	Open Manhole	1200	S1.000	30.541	150				
S4	31.920	1.735	Open Manhole	1200	S1.001	30.185	150	S1.000	30.185	150	
S7	32.003	0.460	Open Manhole	600	S2.000	31.543	100				
S7	31.961	1.570	Open Manhole	600	S2.001	30.391	225	S2.000	31.250	100	734
S6	31.773	1.500	Open Manhole	1200	S2.002	30.273	300	S2.001	30.348	225	
S6	31.891	0.850	Open Manhole	600	S3.000	31.041	150				
S7	31.653	1.350	Open Manhole	600	S3.001	30.303	150	S3.000	30.803	150	500
S7	31.703	1.616	Open Manhole	1200	S2.003	30.088	300	S2.002	30.088	300	
								S3.001	30.223	150	
S5	31.759	2.048	Open Manhole	1350	S1.002	29.711	450	S1.001	30.011	150	
								S2.003	30.038	300	177
S6	31.760	2.119	Open Manhole	1350	S1.003	29.642	450	S1.002	29.642	450	
S11	31.969	1.441	Open Manhole	600	S4.000	30.528	150				
S13	31.961	1.455	Open Manhole	600	S4.001	30.506	225	S4.000	30.506	150	
S7	31.918	2.348	Open Manhole	1350	S1.004	29.570	450	S1.003	29.570	450	
								S4.001	30.484	225	689
S8	31.953	2.549	Open Manhole	1350	S1.005	29.404	450	S1.004	29.404	450	
S14	31.897	1.297	Open Manhole	1200	S5.000	30.600	150				
S15	31.856	1.745	Open Manhole	1350	S5.001	30.111	450	S5.000	30.411	150	
S16	31.933	2.499	Open Manhole	1350	S5.002	29.437	450	S5.001	29.433	450	
S9	31.925	2.539	Open Manhole	1350	S1.006	29.386	150	S1.005	29.386	450	
								S5.002	29.386	450	
S	30.020	0.817	Open Manhole	0		OUTFALL		S1.006	29.203	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S3	506089.243	181022.670	506089.243	181022.670	Required	
S4	506117.016	181016.354	506117.016	181016.354	Required	
S7	506089.094	180940.287	506089.094	180940.287	Required	
S7	506124.854	180965.892	506124.854	180965.892	Required	

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Page 4

Woodcote Grove
Ashley Road
Epsom Surrey KT18 5BW

Date 13/12/2019 14:03
File Orchard Hill Young Peop...

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Network 2019.1

Micro Drainage

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S6	506128.194	180971.363	506128.194	180971.363	Required	
S6	506148.346	180956.444	506148.346	180956.444	Required	
S7	506122.184	180993.454	506122.184	180993.454	Required	
S7	506114.453	180995.487	506114.453	180995.487	Required	
S5	506117.069	181002.436	506117.069	181002.436	Required	
S6	506137.417	180997.971	506137.417	180997.971	Required	
S11	506161.092	180988.925	506161.092	180988.925	Required	
S13	506161.614	180992.180	506161.614	180992.180	Required	
S7	506158.490	180993.273	506158.490	180993.273	Required	
S8	506168.137	181042.217	506168.137	181042.217	Required	
S14	506092.033	181035.403	506092.033	181035.403	Required	
S15	506098.022	181063.111	506098.022	181063.111	Required	
S16	506164.188	181048.539	506164.188	181048.539	Required	
S9	506169.161	181047.408	506169.161	181047.408	Required	
S	506169.572	181074.922			No Entry	

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Atkins		Page 5
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW		
Date 13/12/2019 14:03 File Orchard Hill Young Peop...	Designed by HARD8568 Checked by	
Innovyze	Network 2019.1	

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)
S1.000	o	150	S3	31.829	30.541	1.138	Open Manhole	1200
S1.001	o	150	S4	31.920	30.185	1.585	Open Manhole	1200
S2.000	o	100	S7	32.003	31.543	0.360	Open Manhole	600
S2.001	o	225	S7	31.961	30.391	1.345	Open Manhole	600
S2.002	o	300	S6	31.773	30.273	1.200	Open Manhole	1200
S3.000	o	150	S6	31.891	31.041	0.700	Open Manhole	600
S3.001	o	150	S7	31.653	30.303	1.200	Open Manhole	600
S2.003	o	300	S7	31.703	30.088	1.315	Open Manhole	1200
S1.002	o	450	S5	31.759	29.711	1.598	Open Manhole	1350
S1.003	o	450	S6	31.760	29.642	1.668	Open Manhole	1350
S4.000	o	150	S11	31.969	30.528	1.291	Open Manhole	600
S4.001	o	225	S13	31.961	30.506	1.230	Open Manhole	600
S1.004	o	450	S7	31.918	29.570	1.898	Open Manhole	1350
S1.005	o	450	S8	31.953	29.404	2.099	Open Manhole	1350

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)
S1.000	28.482	80.0	S4	31.920	30.185	1.585	Open Manhole	1200
S1.001	13.918	80.0	S5	31.759	30.011	1.598	Open Manhole	1350
S2.000	43.982	150.0	S7	31.961	31.250	0.611	Open Manhole	600
S2.001	6.410	150.0	S6	31.773	30.348	1.200	Open Manhole	1200
S2.002	27.762	150.0	S7	31.703	30.088	1.316	Open Manhole	1200
S3.000	45.324	190.5	S7	31.653	30.803	0.700	Open Manhole	600
S3.001	7.993	100.0	S7	31.703	30.223	1.330	Open Manhole	1200
S2.003	7.426	150.0	S5	31.759	30.038	1.421	Open Manhole	1350
S1.002	20.831	300.0	S6	31.760	29.642	1.669	Open Manhole	1350
S1.003	21.591	300.0	S7	31.918	29.570	1.898	Open Manhole	1350
S4.000	3.296	149.8	S13	31.961	30.506	1.305	Open Manhole	600
S4.001	3.309	150.0	S7	31.918	30.484	1.209	Open Manhole	1350
S1.004	49.885	300.0	S8	31.953	29.404	2.099	Open Manhole	1350
S1.005	5.291	300.0	S9	31.925	29.386	2.088	Open Manhole	1350

Atkins	Page 6
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW	
Date 13/12/2019 14:03 File Orchard Hill Young Peop...	
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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)
S5.000	o	150	S14	31.897	30.600	1.147	Open Manhole	1200
S5.001	o	450	S15	31.856	30.111	1.295	Open Manhole	1350
S5.002	o	450	S16	31.933	29.437	2.046	Open Manhole	1350
S1.006	o	150	S9	31.925	29.386	2.389	Open Manhole	1350

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)
S5.000	28.348	150.0	S15	31.856	30.411	1.295	Open Manhole	1350
S5.001	67.752	100.0	S16	31.933	29.433	2.049	Open Manhole	1350
S5.002	5.101	100.0	S9	31.925	29.386	2.089	Open Manhole	1350
S1.006	27.517	150.0	S	30.020	29.203	0.667	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.006	S	30.020	29.203	0.000	0	0

Atkins	Page 7
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW	
Date 13/12/2019 14:03	
File Orchard Hill Young Peop...	
Innovyze	Network 2019.1

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S9, DS/PN: S1.006, Volume (m³): 4.9

Unit Reference	MD-CHE-0101-6000-1500-6000
Design Head (m)	1.500
Design Flow (l/s)	6.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	No
Diameter (mm)	101
Invert Level (m)	29.386
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	6.0
Flush-Flo™	0.250	5.3
Kick-Flo®	0.353	3.0
Mean Flow over Head Range	-	4.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.8	1.200	5.4	3.000	8.4	7.000	12.8
0.200	4.9	1.400	5.8	3.500	9.1	7.500	13.2
0.300	3.9	1.600	6.2	4.000	9.7	8.000	13.6
0.400	3.1	1.800	6.6	4.500	10.3	8.500	14.1
0.500	3.5	2.000	6.9	5.000	10.8	9.000	14.5
0.600	3.8	2.200	7.2	5.500	11.4	9.500	14.8
0.800	4.4	2.400	7.6	6.000	11.9		
1.000	4.9	2.600	7.9	6.500	12.3		

Atkins		Page 8																		
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW																				
Date 13/12/2019 14:03	Designed by HARD8568																			
File Orchard Hill Young Peop...	Checked by																			
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Storage Structures for Storm Cellular Storage Manhole: S8, DS/PN: S1.005 Invert Level (m) 29.404 Safety Factor 2.0 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95 Infiltration Coefficient Side (m/hr) 0.00000 <table><thead><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr></thead><tbody><tr><td>0.000</td><td>250.0</td><td>0.0</td><td>1.981</td><td>0.0</td><td>0.0</td></tr><tr><td>1.980</td><td>250.0</td><td>0.0</td><td></td><td></td><td></td></tr></tbody></table>			Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	0.000	250.0	0.0	1.981	0.0	0.0	1.980	250.0	0.0			
Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)															
0.000	250.0	0.0	1.981	0.0	0.0															
1.980	250.0	0.0																		
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Atkins		Page 1
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW		
Date 13/12/2019 13:58	Designed by HARD8568	
File Orchard Hill Young Peop...	Checked by	
Innovyze	Network 2019.1	

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)	30	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.404	Minimum Backdrop Height (m)	0.000
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)	0.70
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	300

Designed with Level Inverts

Network Design Table for Storm

« - Indicates pipe capacity < flow

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
S1.000	28.482	0.356	80.0	0.034	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	13.918	0.174	80.0	0.048	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.000	43.982	0.293	150.0	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
S2.001	6.410	0.043	150.0	0.141	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.002	27.762	0.185	150.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S3.000	45.324	0.238	190.5	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
S3.001	7.993	0.080	100.0	0.230	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.003	7.426	0.050	150.0	0.056	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)
S1.000	50.00	5.42	30.541	0.034	0.0	0.0	0.0	1.12	19.9	4.6
S1.001	50.00	5.63	30.185	0.082	0.0	0.0	0.0	1.12	19.9	11.1
S2.000	50.00	6.17	31.543	0.000	0.0	0.0	0.0	0.63	4.9	0.0
S2.001	50.00	6.27	30.391	0.141	0.0	0.0	0.0	1.07	42.4	19.1
S2.002	50.00	6.63	30.273	0.141	0.0	0.0	0.0	1.28	90.6	19.1
S3.000	50.00	6.04	31.041	0.000	0.0	0.0	0.0	0.72	12.8	0.0
S3.001	50.00	6.17	30.303	0.230	0.0	0.0	0.0	1.00	17.8«	31.2
S2.003	50.00	6.73	30.088	0.427	0.0	0.0	0.0	1.28	90.6	57.8

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Ashley Road

Epsom Surrey KT18 5BW

Date 13/12/2019 13:58

File Orchard Hill Young Peop...

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Page 3



InnovyzeNetwork 2019.1

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)
S3	31.829	1.288	Open Manhole	1200	S1.000	30.541	150				
S4	31.920	1.735	Open Manhole	1200	S1.001	30.185	150	S1.000	30.185	150	
S7	32.003	0.460	Open Manhole	600	S2.000	31.543	100				
S7	31.961	1.570	Open Manhole	600	S2.001	30.391	225	S2.000	31.250	100	734
S6	31.773	1.500	Open Manhole	1200	S2.002	30.273	300	S2.001	30.348	225	
S6	31.891	0.850	Open Manhole	600	S3.000	31.041	150				
S7	31.653	1.350	Open Manhole	600	S3.001	30.303	150	S3.000	30.803	150	500
S7	31.703	1.616	Open Manhole	1200	S2.003	30.088	300	S2.002	30.088	300	
								S3.001	30.223	150	
S5	31.759	2.048	Open Manhole	1350	S1.002	29.711	450	S1.001	30.011	150	
								S2.003	30.038	300	177
S6	31.760	2.119	Open Manhole	1350	S1.003	29.642	450	S1.002	29.642	450	
S11	31.969	1.441	Open Manhole	600	S4.000	30.528	150				
S13	31.961	1.455	Open Manhole	600	S4.001	30.506	225	S4.000	30.506	150	
S7	31.918	2.348	Open Manhole	1350	S1.004	29.570	450	S1.003	29.570	450	
								S4.001	30.484	225	689
S8	31.953	2.549	Open Manhole	1350	S1.005	29.404	450	S1.004	29.404	450	
S14	31.897	1.297	Open Manhole	1200	S5.000	30.600	150				
S15	31.856	1.745	Open Manhole	1350	S5.001	30.111	450	S5.000	30.411	150	
S16	31.933	2.499	Open Manhole	1350	S5.002	29.437	450	S5.001	29.433	450	
S9	31.925	2.539	Open Manhole	1350	S1.006	29.386	150	S1.005	29.386	450	
								S5.002	29.386	450	
S	30.020	0.817	Open Manhole	0		OUTFALL		S1.006	29.203	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S3	506089.243	181022.670	506089.243	181022.670	Required	
S4	506117.016	181016.354	506117.016	181016.354	Required	
S7	506089.094	180940.287	506089.094	180940.287	Required	
S7	506124.854	180965.892	506124.854	180965.892	Required	

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Atkins		Page 4																																																																																																																				
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW																																																																																																																						
Date 13/12/2019 13:58 File Orchard Hill Young Peop...																																																																																																																						
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<u>Manhole Schedules for Storm</u> <table><tr><th>MH Name</th><th>Manhole Easting (m)</th><th>Manhole Northing (m)</th><th>Intersection Easting (m)</th><th>Intersection Northing (m)</th><th>Manhole Access</th><th>Layout (North)</th></tr><tr><td>S6</td><td>506128.194</td><td>180971.363</td><td>506128.194</td><td>180971.363</td><td>Required</td><td></td></tr><tr><td>S6</td><td>506148.346</td><td>180956.444</td><td>506148.346</td><td>180956.444</td><td>Required</td><td></td></tr><tr><td>S7</td><td>506122.184</td><td>180993.454</td><td>506122.184</td><td>180993.454</td><td>Required</td><td></td></tr><tr><td>S7</td><td>506114.453</td><td>180995.487</td><td>506114.453</td><td>180995.487</td><td>Required</td><td></td></tr><tr><td>S5</td><td>506117.069</td><td>181002.436</td><td>506117.069</td><td>181002.436</td><td>Required</td><td></td></tr><tr><td>S6</td><td>506137.417</td><td>180997.971</td><td>506137.417</td><td>180997.971</td><td>Required</td><td></td></tr><tr><td>S11</td><td>506161.092</td><td>180988.925</td><td>506161.092</td><td>180988.925</td><td>Required</td><td></td></tr><tr><td>S13</td><td>506161.614</td><td>180992.180</td><td>506161.614</td><td>180992.180</td><td>Required</td><td></td></tr><tr><td>S7</td><td>506158.490</td><td>180993.273</td><td>506158.490</td><td>180993.273</td><td>Required</td><td></td></tr><tr><td>S8</td><td>506168.137</td><td>181042.217</td><td>506168.137</td><td>181042.217</td><td>Required</td><td></td></tr><tr><td>S14</td><td>506092.033</td><td>181035.403</td><td>506092.033</td><td>181035.403</td><td>Required</td><td></td></tr><tr><td>S15</td><td>506098.022</td><td>181063.111</td><td>506098.022</td><td>181063.111</td><td>Required</td><td></td></tr><tr><td>S16</td><td>506164.188</td><td>181048.539</td><td>506164.188</td><td>181048.539</td><td>Required</td><td></td></tr><tr><td>S9</td><td>506169.161</td><td>181047.408</td><td>506169.161</td><td>181047.408</td><td>Required</td><td></td></tr><tr><td>S</td><td>506169.572</td><td>181074.922</td><td></td><td></td><td>No Entry</td><td></td></tr></table>							MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)	S6	506128.194	180971.363	506128.194	180971.363	Required		S6	506148.346	180956.444	506148.346	180956.444	Required		S7	506122.184	180993.454	506122.184	180993.454	Required		S7	506114.453	180995.487	506114.453	180995.487	Required		S5	506117.069	181002.436	506117.069	181002.436	Required		S6	506137.417	180997.971	506137.417	180997.971	Required		S11	506161.092	180988.925	506161.092	180988.925	Required		S13	506161.614	180992.180	506161.614	180992.180	Required		S7	506158.490	180993.273	506158.490	180993.273	Required		S8	506168.137	181042.217	506168.137	181042.217	Required		S14	506092.033	181035.403	506092.033	181035.403	Required		S15	506098.022	181063.111	506098.022	181063.111	Required		S16	506164.188	181048.539	506164.188	181048.539	Required		S9	506169.161	181047.408	506169.161	181047.408	Required		S	506169.572	181074.922			No Entry	
MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)																																																																																																																
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S6	506137.417	180997.971	506137.417	180997.971	Required																																																																																																																	
S11	506161.092	180988.925	506161.092	180988.925	Required																																																																																																																	
S13	506161.614	180992.180	506161.614	180992.180	Required																																																																																																																	
S7	506158.490	180993.273	506158.490	180993.273	Required																																																																																																																	
S8	506168.137	181042.217	506168.137	181042.217	Required																																																																																																																	
S14	506092.033	181035.403	506092.033	181035.403	Required																																																																																																																	
S15	506098.022	181063.111	506098.022	181063.111	Required																																																																																																																	
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Atkins		Page 5																																																																																																																																																																																																																																																																															
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Manhole	1200	S3.000	o	150	S6	31.891	31.041	0.700	Open Manhole	600	S3.001	o	150	S7	31.653	30.303	1.200	Open Manhole	600	S2.003	o	300	S7	31.703	30.088	1.315	Open Manhole	1200	S1.002	o	450	S5	31.759	29.711	1.598	Open Manhole	1350	S1.003	o	450	S6	31.760	29.642	1.668	Open Manhole	1350	S4.000	o	150	S11	31.969	30.528	1.291	Open Manhole	600	S4.001	o	225	S13	31.961	30.506	1.230	Open Manhole	600	S1.004	o	450	S7	31.918	29.570	1.898	Open Manhole	1350	S1.005	o	450	S8	31.953	29.404	2.099	Open Manhole	1350	PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)	S1.000	28.482	80.0	S4	31.920	30.185	1.585	Open Manhole	1200	S1.001	13.918	80.0	S5	31.759	30.011	1.598	Open Manhole	1350	S2.000	43.982	150.0	S7	31.961	31.250	0.611	Open Manhole	600	S2.001	6.410	150.0	S6	31.773	30.348	1.200	Open Manhole	1200	S2.002	27.762	150.0	S7	31.703	30.088	1.316	Open Manhole	1200	S3.000	45.324	190.5	S7	31.653	30.803	0.700	Open Manhole	600	S3.001	7.993	100.0	S7	31.703	30.223	1.330	Open Manhole	1200	S2.003	7.426	150.0	S5	31.759	30.038	1.421	Open Manhole	1350	S1.002	20.831	300.0	S6	31.760	29.642	1.669	Open Manhole	1350	S1.003	21.591	300.0	S7	31.918	29.570	1.898	Open Manhole	1350	S4.000	3.296	149.8	S13	31.961	30.506	1.305	Open Manhole	600	S4.001	3.309	150.0	S7	31.918	30.484	1.209	Open Manhole	1350	S1.004	49.885	300.0	S8	31.953	29.404	2.099	Open Manhole	1350	S1.005	5.291	300.0	S9	31.925	29.386	2.088	Open Manhole	1350
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Atkins	Page 6
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW	
Date 13/12/2019 13:58 File Orchard Hill Young Peop...	
Innovyze	
Designed by HARD8568 Checked by	Network 2019.1

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)
S5.000	o	150	S14	31.897	30.600	1.147	Open Manhole	1200
S5.001	o	450	S15	31.856	30.111	1.295	Open Manhole	1350
S5.002	o	450	S16	31.933	29.437	2.046	Open Manhole	1350
S1.006	o	150	S9	31.925	29.386	2.389	Open Manhole	1350

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)
S5.000	28.348	150.0	S15	31.856	30.411	1.295	Open Manhole	1350
S5.001	67.752	100.0	S16	31.933	29.433	2.049	Open Manhole	1350
S5.002	5.101	100.0	S9	31.925	29.386	2.089	Open Manhole	1350
S1.006	27.517	150.0	S	30.020	29.203	0.667	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.006	S	30.020	29.203	0.000	0	0

Manhole Headloss for Storm

PN	US/MH Name	US/MH Headloss
S1.000	S3	0.500
S1.001	S4	0.500
S2.000	S7	0.500
S2.001	S7	0.500
S2.002	S6	0.500
S3.000	S6	0.500
S3.001	S7	0.500
S2.003	S7	0.500
S1.002	S5	0.500
S1.003	S6	0.500
S4.000	S11	0.500
S4.001	S13	0.500
S1.004	S7	0.500
S1.005	S8	0.500
S5.000	S14	0.500
S5.001	S15	0.500
S5.002	S16	0.500

Atkins		Page 7									
Woodcote Grove Ashley Road Epsom Surrey KT18 5BW											
Date 13/12/2019 13:58	Designed by HARD8568										
File Orchard Hill Young Peop...	Checked by										
Innovyze		Network 2019.1									
<u>Manhole Headloss for Storm</u> <table><thead><tr><th>PN</th><th>US/MH</th><th>US/MH</th></tr><tr><th></th><th>Name</th><th>Headloss</th></tr></thead><tbody><tr><td>S1.006</td><td>S9</td><td>0.500</td></tr></tbody></table>			PN	US/MH	US/MH		Name	Headloss	S1.006	S9	0.500
PN	US/MH	US/MH									
	Name	Headloss									
S1.006	S9	0.500									
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Appendix D. Thames Water Correspondence



MR M Herring
Atkins
Albany Court
Newcastle Business Pk
Newcastle Upon Tyne
NE4 7YB



Our ref: DS6062881



0800 009 3921

Monday to Friday, 8am to 5pm

24th June 2019

Pre-planning enquiry: Wastewater Capacity check

Dear Mr Herring

Thank you for providing details of your development with the Pre-Planning application dated 17th & 18th June 19 for development @ Orchard Hill School 71 Falling Lane UB7 8AB

{ Mixed site developed to a school as per your above application}.

Foul

If your proposals progress in line with the details you've provided as above, we're pleased to confirm that there will be sufficient sewerage capacity to serve your foul discharges from your development, provided the discharge is by gravity

Surface Water

In considering your surface water needs, we support the use of sustainable drainage on development sites, and also adhere to the London Plan.

Typically greenfield run off rates of 5l/s/ha should be aimed for using the drainage hierarchy. The hierarchy lists the preference for surface water disposal as follows; Store Rainwater for later use > Use infiltration techniques, such as porous surfaces in non-clay areas > Attenuate rainwater in ponds or open water features for gradual release > Discharge rainwater direct to a watercourse > Discharge by storing and attenuating rainwater direct to a surface water sewer/drain > Discharge by storing and attenuating rainwater to the combined sewer.

Please refer to the attached document titled "Planning your wastewater" attached to this letter, specifically to notes relating to surface water. **Also I would advise you to liaise with the LA and discuss their criteria regarding surface water discharges in that area and adhere to their stipulation. If you agree & adhere to a LA stipulation then TW will be able to accommodate that agreed discharge.**

However, I would like to add , TW would accept a stored and attenuated discharge of 6.1 l/s , as per your application, and if you agree that with the LA then that discharge can be accepted by both LA & TW.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

Please note that you must keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient sewerage capacity.

What happens next?

Please make sure you submit your connection application, when you are ready, giving us at least 21 days' notice of the date you wish to make your new connection/s.

If you've any further questions, please contact me.

Yours sincerely

Siva Sivarajan

Developer Services- Wastewater Adoptions Engineer
Office:0203 577 7752 Mobile: 07747842608
siva.sivarajan@thameswater.co.uk

Thames Water Utilities Ltd, Clearwater Court, Vastern Road, Reading, Berkshire, RG1 8DB
Find us online at developers.thameswater.co.uk



Tw int ref: DTS 61216

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Newcastle upon Tyne
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