R G PARKINS
Meadowside | Shap Road | Kendal | Cumbria | LA9 6NY
Tel:01539 729393
Email: mail@rgparkins.com

Flood Risk Assessment & Drainage Strategy

Housing Development – Ivy Mill, Hensingham, Whitehaven

Gleeson Homes & Regeneration

Ref: K36892.FRA/001

Version	Date	Prepared By	Checked By	Approved By
Original Issue	11 June 2021	C. Abram	O. Sugden	O. Sugden

1. INDEMNITIES

This report is for the sole use and benefit of Gleeson Homes & Regeneration and their professional advisors. RG Parkins & Partners Ltd will not be held responsible for any actions taken, nor decisions made, by any third party resulting from this report.

RG Parkins & Partners Ltd are not qualified to advise on contamination. Any comments contained within this report with regards to contamination are noted as guidance only and the Client should appoint a suitably qualified professional to provide informed advice. The absence of any comments regarding contamination does not represent any form of neglect, carelessness, or failure to undertake our service.

2. COPYRIGHT

3. CONTENTS

4. TABLE OF FIGURES

5. GLOSSARY OF TERMS

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BGL	Below Ground Level
BGS	British Geological Society
CC	Climate Change
CCC	Cumbria County Council
DSM	Digital Surface Model
DTM	Digital Terrain Model
EA	Environment Agency
FEH	Flood Estimation Handbook
FFL	Finished Floor Level
FRA	Flood Risk Assessment
GIS	Geographical Information System
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
NPPF	National Planning Policy Framework
OS	Ordnance Survey
RGP	RG Parkins & Partners Ltd
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage System
UU	United Utilities

6. INTRODUCTION

6.1 BACKGROUND

This report has been prepared by R. G. Parkins & Partners Ltd (RGP) for Gleeson Homes and Regeneration in support of their proposal for a residential development comprising of 26 dwellings at Ivy Mill, Hensingham, Whitehaven.

RGP has been appointed to undertake a Flood Risk Assessment and Outline Surface and Foul Water Drainage Strategy in in accordance with the National Planning Policy Framework (NPPF) to support a planning application that fulfils the requirements of the Local Planning Authority, Environment Agency and the Sewerage Undertaker.

The following study assesses flood risk to the site and proposed development and demonstrates the proposed development will not adversely affect flood risk elsewhere.

6.2 PLANNING POLICY

The NPPF [1] and its Planning Practice Guidance [2] states "a site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in the future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use."

6.3 THE DEVELOPMENT IN THE CONTEXT OF PLANNING POLICY

Owing to the size of the development, it is classed as major development in accordance with The Town and Country Planning Order 2015 [3], due to the development comprising of more than 10 dwellings.

The area covered by the application is 0.911ha (hectares) and by reference to the Environment Agency Flood Map, the site lies in Flood Zone 1. The latest site layout plan by TWENTY10 Management Ltd (drawing number MJG/PL-110-2) is included in Appendix A for reference.

Table 2 of the NPPF's Planning Practice Guidance [2] classifies each development into a vulnerability class, depending on the type of development, as outlined in Figure 6.3.1. As residential dwellings the site is classified as 'More vulnerable'. 'More Vulnerable' development classes are deemed acceptable in terms of flood risk within Flood Zone 1. However due to the site being classed as major development a Flood Risk Assessment is required.

Vulnerability Classification	Development
Essential Infrastructure	Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. Essential utility infrastructure, which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. Wind turbines.
Highly Vulnerable	Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operation during flooding. Emergency dispersal points. Basement dwellings. Caravans, mobile homes, and park homes intended for permanent residential use. Installations requiring hazardous substances consent.
More Vulnerable	Hospitals. Residential institutions such as residential care homes, children's homes, prisons and hostels. Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs, and hotels. Non-residential uses for health services, nurseries, and education establishments. Landfill and sites used for waste management facilities for hazardous waste. Sites used for holiday or short let caravans and camping, subject to a specific warning and evacuation plan
Less Vulnerable	Police, ambulance, and fire stations which are NOT required to be operational during flooding. Buildings used for shops; financial, professional, and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distributions; non-residential institutions not included in the 'more vulnerable' class; and assemble and leisure. Land and buildings used for agriculture and forestry. Waste treatment (except landfill & hazardous waste facilities). Minerals working & processing (except for sand & gravel working). Water treatment works which do not need to remain operational during times of flood. Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
Water-Compatible Development	Flood control infrastructure. Water transmission infrastructure & pumping stations. Sewage transmission infrastructure & pumping stations. Sand & gravel working. Docks, marinas, and wharves. Navigation facilities. Ministry of Defence installations. Ship building, repairing & dismantling, dockside fish processing & refrigeration & compatible activities requiring a waterside location. Water based recreation (excluding sleeping accommodation). Lifeguard and coastguard stations. Amenity open space, nature conservation & biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. Essential ancillary sleeping or residential accommodation for staff required by uses in this category subject to a specific warning & evacuation plan.

Figure 6.3.1 Vulnerability Classification

7. SITE CHARACTERISATION

7.1 SITE LOCATION

The site is located in the centre of Hensingham, off Main Street (B5295) at National Grid Co-Ordinates 299056E 517145N. The site's location is shown in Figure 7.1.1

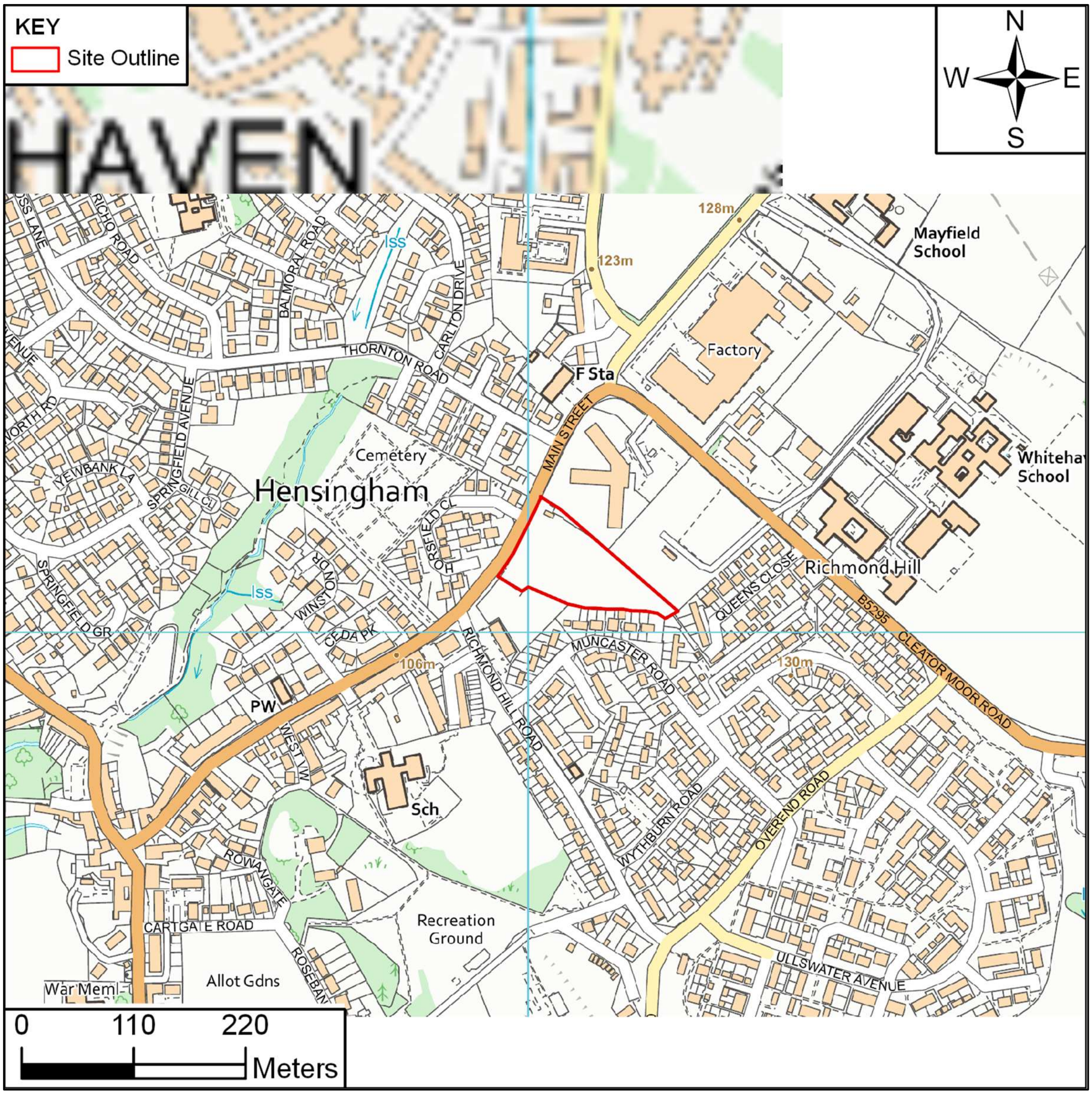


Figure 7.1.1 Site Location

7.2 SITE DESCRIPTION

The 0.91 ha site is located on currently a mix of greenfield and brownfield land. This site was previously occupied by recently demolished workwear production factory buildings and is therefore predominantly covered by demolition rubble/made ground across the majority of the site, with the remaining land comprising of concrete hardstanding and granular hardcore surfacing to the west and overgrown grassed areas to the east.

The site is bounded by the B5295 (Main Street) to the west, further industrial units to the north and existing residential dwellings to the south and east.

Topographically, the site slopes from east to west at an average gradient of approximately 1:14, with the highest elevation of around 126.00 mAOD in the far east of the site and the lowest elevation of approximately 114.30 mAOD in the west.

7.3 GEOLOGY & HYDROGEOLOGY

British Geological Survey (BGS) [4] and Land Information Systems (LandIS) [5] mapping indicates the site is underlain by the geological sequences outlined in Figure 7.3.1.

Geological Unit	Classification	Description	Aquifer Classification
Soil	Soilscape 6	Freely draining slightly acid loamy sails	N/A
Drift	Till, Devensian - Diamicton	Sediments laid down by the direct actions of glacial ice	Summary: Secondary
Solid	Stainmore Formation	Mudstone, Siltstone and Sandstone	Summary: Secondary A

Figure 7.3.1 Site Geological Summary

The Land Information System (LandIS) Soil Portal indicates the site is underlain by Soilscape 6, described as "freely draining, slightly acid loamy soils". Which implies the soil has properties that will not impede drainage, however, the superficial deposits of glacial till, will provide limited infiltration.

Although the above soil conditions are recorded on desktop data it is possible that some of the soils are comprised of fill.

`The Defra Groundwater Vulnerability Map[6] indicates the nearest Groundwater Source Protection Zone is a Zone 3 'Total catchment' which is situated approximately 2 km north of the site. The development site overlies a secondary aquifer with 'Medium to low' vulnerability.

7.4 HYDROLOGY

The closest 'Main River' is Snebra Beck, approximately 0.5 km southwest of the development site. Other main rivers in close proximity are approx. Midgey Gill 1.0 km northwest and Pow Beck approx. 1.3 km west of the development site with the River Keele approximately 1.8km to the east.

An adopted 350 mm culverted surface water sewer crosses Main Street 0.95 km north of the site, flowing in a south westerly direction, under Horsfield Close. At present, it appears that surface water from the existing development is discharged into this watercourse. This is shown on the UU Sewer Records included in Appendix C.

7.5 EXISTING SEWERS

Reference to the United Utilities sewer records indicates that there are no sewers crossing the site. The nearest adopted sewer to the site location is a 225 mm diameter combined sewer which passes the site entrance in Main Street flowing in a south westerly direction.

In the nearby residential estate located on Muncaster Road to the southeast of the site there are both 150mm diameter foul and surface water sewers present. Further investigations have determined that these do not present viable connection points for the new site due to topographical and accessibility restrictions.

7.6 GROUND INVESTIGATION

Ground investigation was undertaken at the site by GEO Environmental Engineering Ltd.

Intrusive ground investigations were carried out at the site in August 2019 where 10 mechanically excavated trial pits with in-situ geotechnical testing to depths of between 1.10m and 3.00m below ground level and 4 no. dynamic sampling boreholes to depths between 1.50m and 5.00m below ground level with gas and groundwater monitoring were carried out at various locations across the site.

As the site is on the location of the recently demolished workwear factory, made ground / crushed demolition rubble was encountered across the majority of the site area at variable depths up to 1.25m below ground level.

The ground conditions in the predominantly grassland areas to the east of the site consist of initially firm becoming stiff, occasionally soft, slightly sandy, slightly gravelly clay with occasional cobbles to a depth of 5.0m below ground level.

The strata below the made ground in the rest of the site was found to comprise of initially firm becoming stiff, slightly sandy, slightly gravelly clay with occasional cobbles to a depth of 4.2m below ground level.

No bedrock was encountered during the investigations.

Groundwater was encountered predominantly on the western side of the site in numerous trial pits at variable depths of between 0.40m and 2.20m below ground level and was noted within the demolition rubble, former foundation runs and the interface of the made ground and natural clay deposits.

Ground water monitoring recorded standing groundwater depths of between 0.35m and 2.58m below ground level at all the borehole locations with perched water most likely originating from the surface. It was also observed that the vegetated area in the east of the site was waterlogged following periods of heavy rainfall.

Based on the ground conditions encountered across the site, the potential for permeable ground is considered negligible to very low and soakaways are not recommended as an appropriate solution and alternative methods should be considered for drainage of surface water run-off.

For reference refer to Geo Environmental Engineering Phase 2 Ground Investigation Report Ref: 2019-3886

8. ASSESSMENT OF FLOOD RISK

8.1 BACKGROUND

The following risk assessment has been carried out in accordance with the National Planning Policy Framework[1] and its Planning Practice Guidance[2] on Flood Risk. The broad aim of the guidance is to reduce the number of people and properties within the natural and built environment at risk of flooding. To achieve this aim, planning authorities are required to ensure that flood risk is properly assessed during the initial planning stages.

Responsibility for this assessment lies with the developers and they must demonstrate:

- Whether the proposed development is likely to be affected by flooding.
- Whether the proposed development will increase flood risk in other parts of the hydrological catchment.
- That the measures proposed to deal with any flood risk are sustainable.
- The developer must prove to the Local Planning Authority and the Environment Agency that the existing flood risk or the flood risk associated with the proposed development can be satisfactorily managed.

8.2 FLOOD RISK TERMINOLOGY

Flood risk considers both the probability and consequence of flooding.

Flood events are often described in terms of their probability of recurrence or probability of occurring in any one year. The threshold between a medium flood and a large flood is often regarded as the 1 in 100-year event. This is an event which statistical analysis suggests will occur on average once every hundred years. However, this does not mean that such an event will not occur more than once every hundred years. Figure 8.2.1 shows the event return periods expressed in years and annual exceedance probabilities as a fraction and a percentage.

For example, a 1 in 100-year event has a 1% probability of occurring in any one year, i.e. a 1 in 100 probability. A 1000-year event has a 0.1% probability of occurring in any one year, i.e. a 1 in 1000 probability.

Return Period (years)	Annual Exceedance Probability (AEP)	
	Fraction	Percentage
2	0.5	50%
10	0.1	10%
25	0.04	4%
50	0.02	2%
100	0.01	1%
200	0.005	0.5%
500	0.002	0.2%
1000	0.001	0.1%

Figure 8.2.1 Flood Return Periods & Exceedance Probabilities

8.3 DATA COLLECTION

The following information was referred to for the Flood Risk Assessment:

a) Environment Agency Flood Map for Planning covering the site and adjacent area

b) Environment Agency Surface Water Flood Risk Map

c) Environment Agency Reservoir Flood Risk Map

d) Environment Agency Historic Flood Map

e) United Utilities sewer records

f) British Geological Survey Groundwater Flooding Susceptibility Map

g) Copeland Borough Council Strategic Flood Risk Assessment

h) Topographic survey

i) Development layout plan provided by Twenty10 Management Ltd (Appendix A)

8.4 STRATEGIC FLOOD RISK ASSESSMENT

Copeland Borough Council undertook a Strategic Flood Risk Assessment (SFRA)[7] in 2007 which refers to the Environment Agency Flood Maps to determine flood risk. (The SFRA maps are regarded as superseded by current EA Flood Map for Planning).

It states there are several historic flooding incidents in Whitehaven, but these are generally attributed to tidal flooding due to the proximity of the town centre to the coastline. Some properties are at risk from the main watercourse Pow Beck, which bisects the town and during extreme events flooding can be exacerbated in certain areas by insufficient sewer capacities.

This site however is located away from the historically affected areas and is not shown to be at risk of fluvial or tidal flooding or localised drainage issues.

8.5 ENVIRONMENT AGENCY FLOOD MAP FOR PLANNING

Figure 8.5.1 is an extract from the EA's Flood Map for Planning[8]. This has been reviewed to assess the level of flood risk to the area. The flood map shows areas that may be at risk of fluvial flooding in a 1% (1 in 100 year, dark blue) or 0.1% (1 in 1000 year, light blue) Annual Exceedance Probability (AEP) event. Alternatively, if the flood risk is tidal the flood map will show areas predicted to be at risk of flooding from the sea in a 0.5% AEP event (1 in 200 year, dark blue) or a 0.1% AEP event (1 in 1000 year, light blue).

The Flood Map shows the current best information on the extent of the extreme flood from rivers or the sea that would occur without the presence of flood defences. The potential impact of climate change is not considered by the mapping.

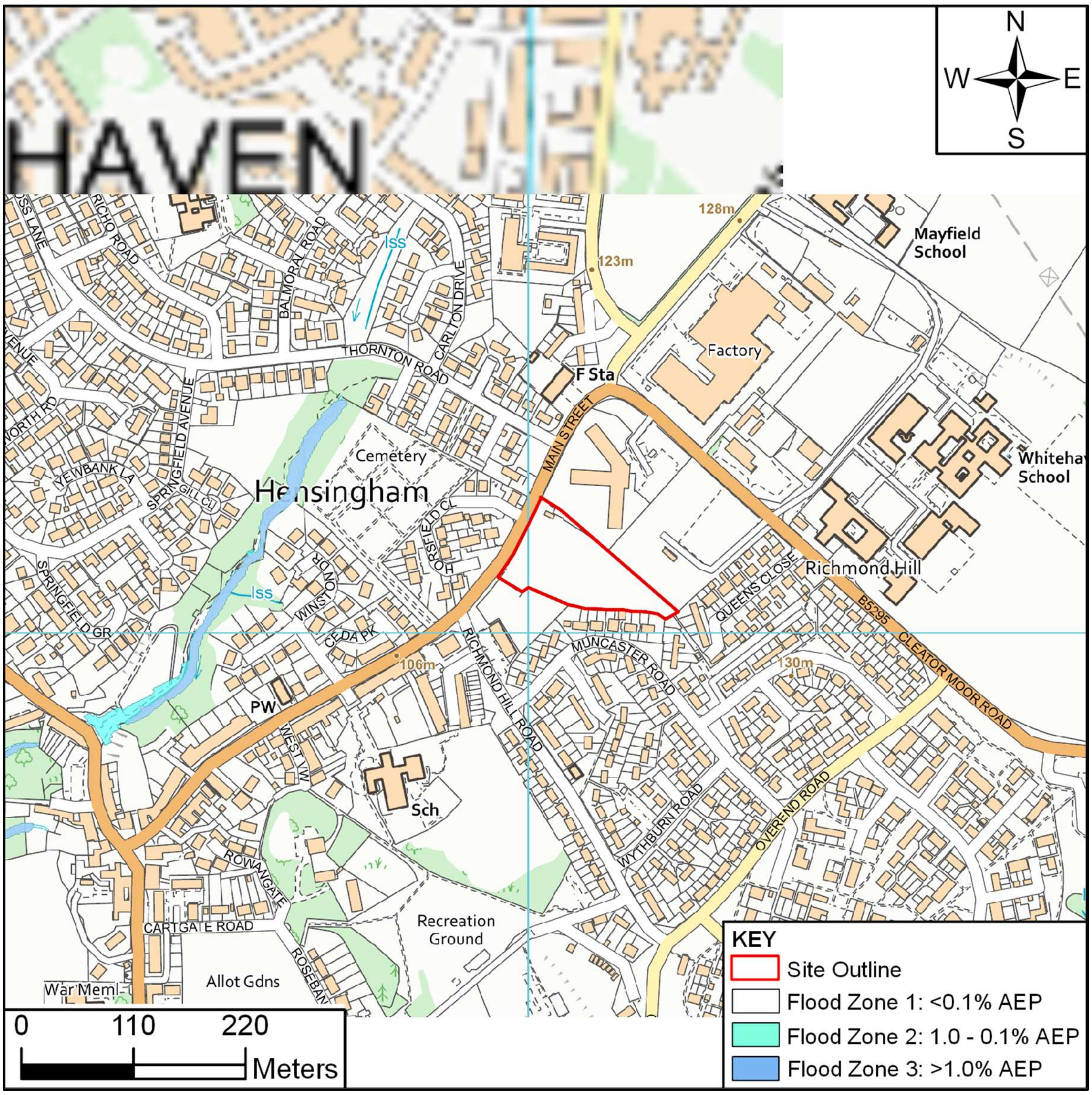


Figure 8.5.1 Environment Agency Flood Map for Planning

Reference to Figure 8.5.1 indicates the site lies within Flood Zone 1 “Low Probability”, land assessed as having a less than 0.1% annual probability of flooding (i.e., rivers, lake or sea) in any year by reference to the NPPF. Given the site is approx. 120 mAOD, the site is not at risk of tidal flooding.

8.6 ENVIRONMENT AGENCY SURFACE WATER FLOOD MAP

Surface water flooding is that which results from extreme rainfall rather than overflowing rivers. This type of flooding typically occurs when extreme rainfall causes water to run down slopes and collect in depressions in the landscape or where runoff is focussed into an area where drainage is insufficient. It can also cause erosion resulting in the partial or complete blockage of drains or culverts.

Figure 8.6.1 shows an extract from the EA surface water flood risk map[8]. This has four risk classifications from very low probability (<0.1% AEP) to high probability (>3.3% AEP).

The EA surface water flood map indicates the site is predominantly at ‘Very Low’ risk of surface water flooding. The risk of flooding is less than 0.1% AEP (1 in 1000 year), However, there is a topographic low point shown at what was the rear of the former factory. This area is considered to be at ‘Medium’ to ‘High’ risk of surface water flooding and has a predicted AEP of between 1% (1 in 100 year) and greater than 3.3% (1 in 30 year).

As the development of the site will include levelling of the topography, the surface water flood map therefore does not provide an accurate model of the post-development surface water flood risk. Levelling during development will remove this risk and mitigate this issue as part of the overall Drainage Strategy. This is discussed in further detail in Section 9.0.

The EA’s map shows that the site has a very low probability of surface water flooding. It should be noted that there are some obvious problems with the mapping at this location relating to predicted flooding within the lake. This should not affect the accuracy of the mapping within the site.

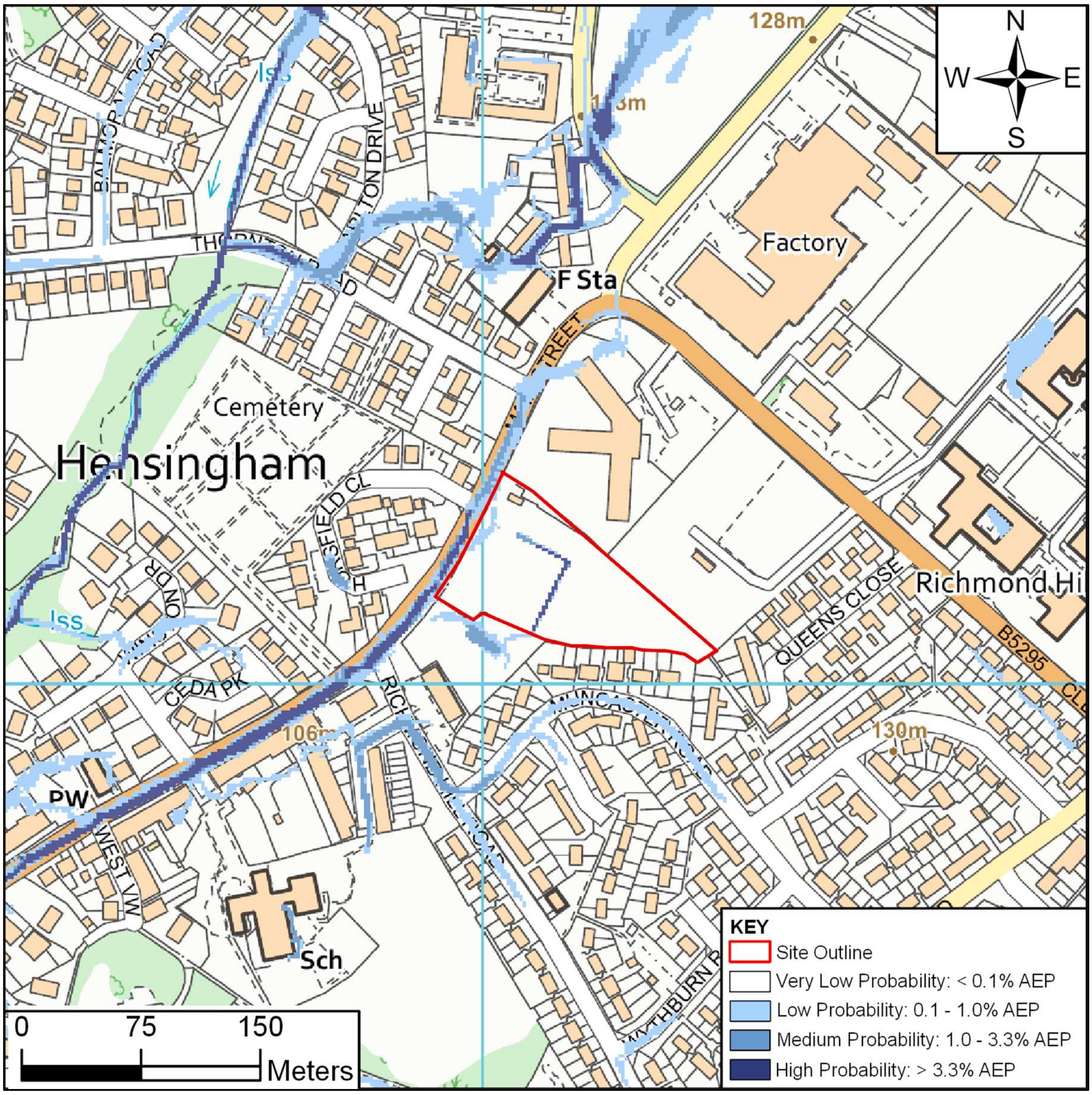


Figure 8.6.1 Environment Agency Surface Water Flood Map

8.7 GROUNDWATER FLOOD RISK

Groundwater flooding occurs when groundwater levels rise above the ground level. It is most likely to occur in low lying areas underlain by permeable drift and rocks.

British Geological Survey (BGS) records (Figure 8.7.1) show the majority of the site lies within an area of 'Limited Potential for Groundwater Flooding to Occur' in the east of the site and 'Potential for Groundwater Flooding of Property Situated Below Ground Level'.

However, the SFRA [6] states the sandstone aquifer is mostly overlain with glacial deposits of clay, and therefore groundwater flooding is considered unlikely. There is no further evidence to suggest the development is at risk of groundwater flooding. In any case, there will be no development of property below the existing ground level and finished floor levels will be situated 150mm above ground level, and as such the development will be at low risk of groundwater flooding.

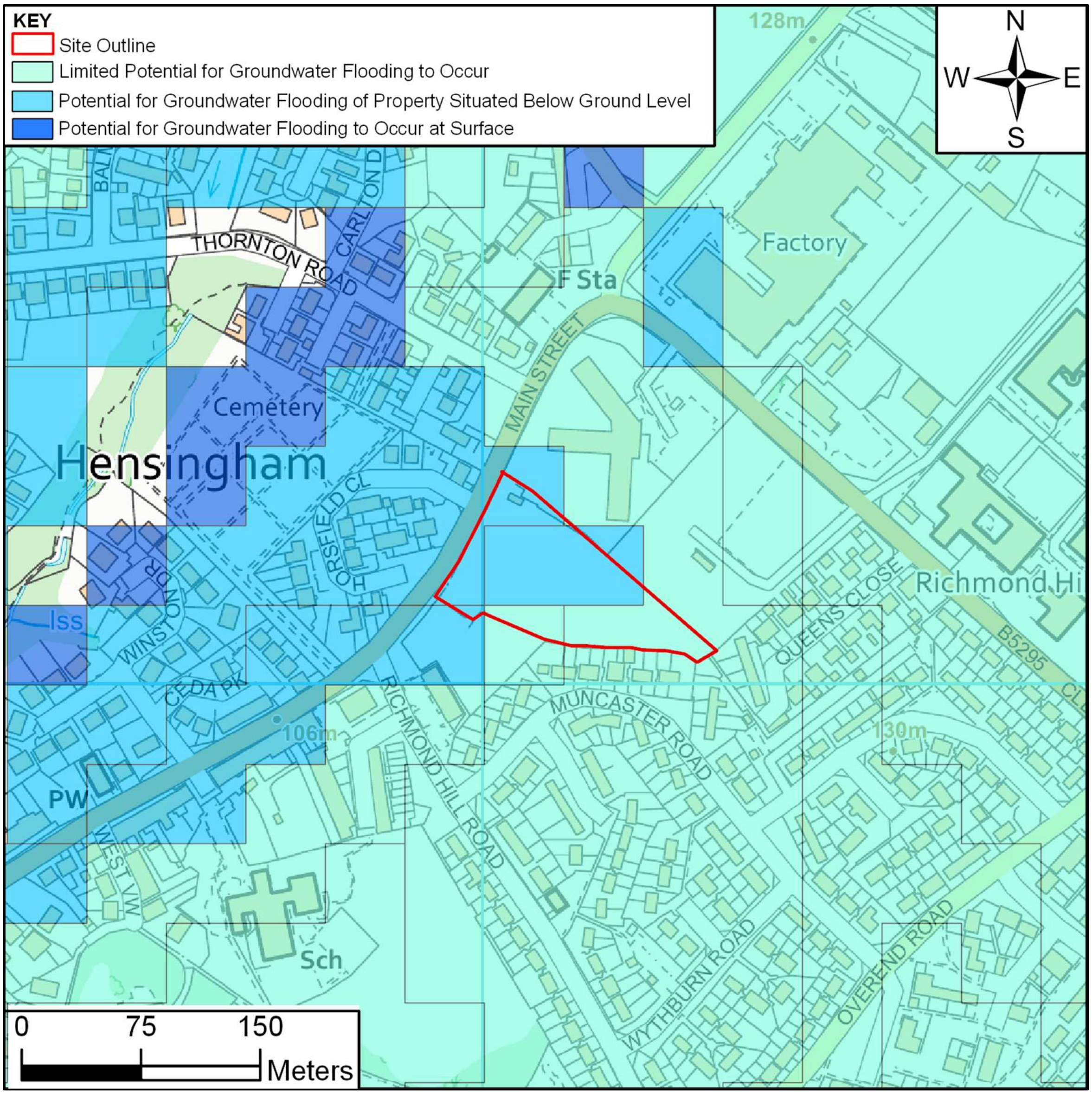


Figure 8.7.1 British Geological Society Ground Water Flood Map

8.8 FLOODING FROM RESERVOIRS, CANALS OR OTHER ARTIFICIAL SOURCES

The likelihood of reservoir flooding is considered to be much lower than other forms of flooding. Current reservoir regulation, which has been further enhanced by the Flood and Water Management Act, aims to make sure that all reservoirs are properly maintained and monitored to detect and repair any problem.

The Ordnance Survey map indicates that there are no reservoirs, canals or artificial structures in the close proximity of the proposed development site and the EA mapping for reservoir flood risk does not show the site to be at risk.

8.9 FLOODING FROM SEWERS

United Utilities (UU) do not provide information on flood risk from their assets and there have been no reports within the SFRA. It is known that a 225 mm diameter combined sewer passes the site entrance in Main Street flowing in a south westerly direction. Should this sewer fail, flooding would follow the topographic gradients away from the site.

9. SURFACE WATER DRAINAGE STRATEGY

9.1 INTRODUCTION

The principal aim of the following drainage strategy is to design the development to avoid, reduce and delay the discharge of rainfall to public sewers and watercourses in order to protect watercourses and reduce the risk of localised flooding, pollution and other environmental damage.

In order to satisfy these criteria this surface water runoff assessment and drainage design has been undertaken in accordance with the following reports and guidance documents:

- SuDS Manual, CIRIA Report C753, 2015[9]
- Code of Practice for Surface Water Management, BS8582:2013, November 2013[10]
- Rainfall Runoff Management for Developments, Defra/EA, SC030219, October 2013[11]
- Designing for Exceedance in Urban Drainage – Good Practice, CIRIA Report C635, 2006[12]
- Flood Estimation Handbook (FEH)[13]
- Flood Studies Report (FSR), Volume 1, Hydrological Studies, 1993[14]
- Flood Studies Supplementary Report No 14 (FSSR14), Review of Regional Growth Curves, 1983[15]
- Flood Estimation for Small Catchments, Marshall & Bayliss, Institute of Hydrology, Report No. 124 (IoH 124), 1994[16]
- Department for Environment, Food and Rural Affairs, Non-Statutory Technical Standards for Sustainable Drainage Systems, March 2015[17]
- Water UK, Design and Construction Guidance for Foul & Surface Water Sewers, Approved Version 2.0, March 2020[18]

The following assessment and drainage strategy are based on the latest site layout plan by TWENTY10 Management Ltd (drawing number MJG/PL-110) included in Appendix A.

Any alterations to the site plan resulting in changes to impermeable areas will require the drainage strategy to be revisited.

9.2 SITE AREAS

To support the exploration of options for site drainage, the spatial extent of different types of proposed land cover on the site have been measured. Table 9.2.1 shows the measured proposed land cover areas. The highest percentage is garden area covering 45% of the total site area. The roof areas cover 16%, parking and paved areas 15% and site road areas 23%.

Land Cover	Area		Percentage of total site area
	m^2	Ha	
Total housing roof area	1486.1	0.149	16%
Total parking and paved area	1391.1	0.139	15%
Total road area	2092.0	0.209	23%
Garden areas	4135.8	0.414	45%

Figure 9.2.1 Land Cover Areas

The site can be subdivided into land cover that could be permeable and that which could be impermeable. Potential impermeable areas are regarded as housing, parking, roads, driveways and walkways. All other areas (principally gardens) are regarded as having a permeable surface. Figure 9.2.2 gives the areas of potentially permeable and impermeable land cover and this shows that impermeable areas could cover 55% of the site and permeable areas 45%.

Land Cover	Area		Percentage of total site area
	m^2	Ha	
Total impermeable area	4969.2	0.497	55%
Remaining permeable area	4135.8	0.414	45%

Figure 9.2.2 Area of Potentially Impermeable & Permeable Land Cover

9.3 SURFACE WATER DESIGN PARAMETERS

The surface water drainage system has been designed on the following basis using the modified rational method and a generated rainfall profile:

9.3.1 CLIMATE CHANGE

Projections of future climate change indicate that more frequent short-duration, high intensity rainfall and more frequent periods of long-duration rainfall are likely to occur over the next few decades in the UK. These future changes will have implications for river flooding and for local flash flooding. These factors will lead to increased and new risks of flooding within the lifetime of planned developments.

Current climate change guidance issued by the Environment Agency came into effect outlining the anticipated changes in extreme rainfall intensity.

Figure 9.3.1 shows anticipated changes in extreme rainfall intensity in small and urban catchments. Guidance states that for site-specific flood risk assessments and strategic flood risk assessments, both the central and upper end allowances should be assessed to understand the range of impacts. A climate change allowance of 40% has been selected for the purpose of drainage design based on the 100-year anticipated design life of the proposed development in accordance with LLFA requirements. No properties are located immediately downstream of the site and therefore the site poses low risk to neighbouring property.

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

Figure 9.3.1 Peak Rainfall Intensity Allowance in Small and Urban Catchments

9.3.2 URBAN CREEP

BS 8582:2013[10] outlines best practice with regard to Urban Creep. Although not a statutory requirement, future increase in impermeable area due to extensions and introduction of impervious positively drained areas has been considered. An uplift of 10% on impermeable areas associated with plots only (excluding roads) has been applied to the contributing area.

The inclusion of 10% is highly conservative due to the provision of adequate parking on the site and the density of the properties.

9.3.3 PERCENTAGE IMPERMEABILITY *(PIMP)*

The percentage impermeability (PIMP) for all impermeable areas is modelled as 100%. The entirety of the impermeable areas is to be positively drained.

9.3.4 VOLUMETRIC RUNOFF COEFFICIENT, CV

The volumetric runoff coefficient describes the volume of surface water which runs off an impermeable surface following losses due to infiltration, depression storage, initial wetting and evaporation. The coefficient is dimensionless. Default industry standard volumetric runoff coefficients are 0.75 for summer and 0.84 for winter.

9.3.5 RAINFALL MODEL

The calculations use the REFH2 unit hydrograph methodology in line with best practice as outlined in the SuDS Manual[9]. The calculations use the most up to date available catchment descriptors (2013) provided by the Centre for Ecology and Hydrology Flood Estimation Handbook web service.

9.4 SURFACE WATER DISPOSAL

Surface water disposal has been considered in line with the hierarchy outlined in the SuDS Manual[9]. The approach considers infiltration drainage in preference to disposal to watercourse, in preference to discharge to sewer.

Cumbria County Council as Lead Local Flood Authority prefer design in accordance with the Cumbria Design Guide which identifies the following hierarchy of techniques to be used:

- **Prevention**: Prevention of runoff by good site design and the reduction of impermeable areas.

- **Source Control**: Dealing with water where and when it falls (e.g. permeable paving).
- **Site Control**: Management of water in the local area (e.g. swales, detention basins).
- **Regional Control**: Management of runoff from sites (e.g. balancing ponds, wetlands).

9.4.1 INFILTRATION

Geotechnical testing indicates underlying soil on the site is unsuitable for the disposal of surface water by this method. For further information refer to Section 7.6

9.4.2 POSITIVE DRAINAGE - WATERCOURSE CONNECTION

The entire impermeable area of the site will require a positive drainage solution. In line with the SuDS hierarchy discharge to a watercourse has been investigated. A watercourse within the site is located at a high level and a gravity connection to this cannot be achieved within the site boundary. A gravity connection to this watercourse further downstream is technically possible but would require a significant length of new sewer crossing the highway and public open space. This watercourse currently causes significant flood risk to property and is undersized. Its route through a cemetery and under private property result in any works to increase its conveyance capacity being involved and prohibitively expensive. Site surface water runoff currently discharges to the combined public sewer and therefore any connection to the watercourse would contribute additional flow to an under-capacity culvert, increasing flood risk in contravention of NPPF. Both Copeland Borough Council and the LLFA have advised that connection to this watercourse is not advisable / permissible.

9.4.3 POSITIVE DRAINAGE – SURFACE WATER SEWER CONNECTION

Surface water sewers exist to the southeast of the proposed development site in the vicinity of Muncaster Road and Crossing Richmond Hill Road. There is no possible route from the east part of the development through third party land to allow connection to this sewer due to construction of extensions and outbuildings. The sewer us located at an elevation above the level of the development site and connection to this would require a surface water pumping station. The LLFA do not permit surface water pumping stations serving new development.

A surface water sewer located at the SPAR supermarket to the south of the development site discharges to the combined sewer.

There are no existing surface water sewers accessible to allow connection.

9.4.4 POSITIVE DRAINAGE – HIGHWAY DRAINAGE CONNECTION

There are highway gullies located within the adjacent highway, Main Street, however in the vicinity of the site these discharge to the combined sewer. Approximately 170m south of the site within Main Street a 150mm diameter highway drain exists however this is too far from the proposed development to allow easy connection and has insufficient spare capacity to receive additional flow.

9.4.5 POSITIVE DRAINAGE – COMBINED SEWER CONNECTION

In line with the SuDS hierarchy, in the absence of feasible alternatives a connection to the combined sewer is proposed. Flows will be attenuated and therefore discharge rate will be lower than the current site contribution to this sewer. The existing site connection to the combined sewer is to be replaced by a new connection and this shall be future proofed to allow future diversion to a potential LLFA / CCC highways scheme to improve highway drainage on Main Street, once infrastructure has been installed.

9.4.6 CONSIDERATION OF SUDS COMPONENTS

A full range of SuDS components and techniques have been considered for the development of the site and their applicability to the site is discussed below.

SOURCE CONTROL:

- **Green roofs –** discounted due to cost and limits of water volume retention.
- **Soakaways –** Insufficient soil permeability.
- **Water butts –** these are suitable for the site but their effectiveness would depend on them being empty prior to a period of significant rainfall. This could occur during the summer when occupiers are likely to use the water but unlikely during the autumn and winter Irrelevant for drainage design due to their inability to provide reliable stormwater storage.
- **Permeable paving –** Insufficient soil permeability for Type A permeable block paving (full infiltration). Type B (partial infiltration) permeable block paving would be suitable for private driveways but would still require a positive drainage connection.
- **Swales –** Would require large areas within the site that are not available.
- **Filter drains –** Insufficient soil permeability.
- **Infiltration trenches and basins** – Insufficient soil permeability.
- **Detention basins** – Would require large areas within the site that are not available.
- **Ponds / wetland –** A detention basin is regarded as more effective and reliable alternative.
- **Rain gardens –** discounted due to high capital and maintenance costs. Maintenance cannot practically be enforced.
- **Geocellular crate systems –** these could be used as an alternative or in conjunction with the preferred option to store private runoff from the individual dwellings roofs and driveways. These tanks would be wrapped and sealed with an impermeable geomembrane to provide a water-tight structure. Offsite flows would need to be controlled via an orifice flow control device. A precast box culvert/ tank is considered a better option for this

particular site as there is no public open space available within the site to house a large shared geocellular crate system.

- **Precast Box Culvert/Tank –** Preferred option for surface water runoff due to site restrictions and the requirements to locate storage under the new development access roads. Precast concrete box culverts/tanks are rectangular in shape to maximise storage capacity and are available in a range of various sizes and are therefore considered more adaptable to suit the locations available for surface water storage on this site. Offsite discharge from the precast concrete storage structures would be controlled via HydroBrake/Orifice flow control devices to an acceptable rate. The required size of the proposed storage structures has been calculated and is detailed in Section 9.6.3.

9.5 PRE-DEVELOPMENT RATE OF RUNOFF ASSESSMENT

Due to site constraints, it will be necessary to positively drain the entire impermeable area of the site. The total site area is 0.911 ha (9,105 m^2). Following development, the proposed impermeable area to be positively drained is 4,969m^2.

The site has been designated as Brownfield for planning land use however for completeness greenfield runoff calculations have also been undertaken. As the site covers an area of less than 200 ha, (2.5 ha) the Greenfield calculations have been undertaken in accordance with methodology described in IoH 124[16]. For catchments of less than 50 ha the Greenfield runoff rate is scaled according to the size of the catchment in relation to a 50-hectare site.

Full details of the calculations and the methodology for deriving the Peak Rate of Runoff are in included in Appendix B. A summary of the results is included in Figure 9.5.1.

Rate of Runoff (l/s)			
Event	**Greenfield**	**Brownfield**	**Post Development**
Q1	3.7	41.7	5.0
QBAR	4.2	61.1	5.0
Q10	5.9	83.4	5.0
Q30	7.2	101.9	5.0
Q100	8.8	130.6	5.0
Q100 + 40% CC	12.4	182.9	5.0

Figure 9.5.1 Pre Development Runoff Results

Without attenuation or infiltration, the proposed development would not alter the Rate of Runoff from the developed areas of the site. A Sustainable Drainage System (SuDS) solution consisting of precast box culvert storage systems with flow control devices is proposed, attenuating runoff and controlling discharge from the site to an acceptable rate of 5 l/s which is as far as is practical to be comparable to the pre-development Greenfield Qbar rate of 4.2 l/s, which in turn is a considerable improvement on the existing unattenuated discharge from the former brownfield (factory) site.

9.6 SURFACE WATER DRAINAGE DESIGN

The proposed surface water network serving the impermeable access roads and plots has been modelled using Causeway Flow.

The drainage design has been sized to store a future 1% AEP event of critical duration. Future climate change (40%) and urban creep (10% to housing area only) is accounted for in the design.

Due to the impermeability of the soils, all parking areas and private driveways are to be constructed of impermeable surfaces or block paving, with drainage connections to the proposed surface water sewer.

Roof water will connect directly into the surface water pipe network. This will require ground levels to fall consistently around the site in order to enable a gravity connection into the drainage system.

Due to space restrictions, it is proposed to provide three separate box culverts around the site to attenuate the surface water runoff from both the highways and plot drainage.

A series of gullies will be located within the site roads to collect and discharge highways run off into a new pipe network. The highways drainage network will be directed into the nearest localised box culvert.

Silt traps are to be provided at each plot and upstream of all storage structures.

An outline storage estimate model has been undertaken, which indicates that approximately 312m^3 of storage will need to be provided to accommodate the combined highway and plot surface water runoff within the development for a Q100 + CC (40%) design storm event.

To control surface water runoff from the properties to the north of the site (Plots 10-19) upstream storage will be provided by a box culvert situated within the shared access road with a flow control device regulating flow to the main drainage network and 2 No. downstream box culvert storage structures as required.

A hydrobrake optimum vortex type flow control device will then limit discharge from the site to a new offsite public highways surface water sewer which is proposed for construction in the near future within Main Street to a rate of 5 l/s. It is acknowledged that this is greater than the estimated Greenfield Qbar of 4.2 l/s, however, current best practice dictates that 5 l/s is the minimum practical rate for discharge through a flow control device and approval will therefore need to be sought from Cumbria County Council.

Should the independent construction timescales for both the proposed development and the new public highways sewer in Main Street differ to an extent where disposal of surface water runoff is not possible through this method, the only feasible alternative connection point would be to the existing combined sewer located in Main Street and agreement would have to be sought with

United Utilities prior to construction. Dialogue has begun to this effect and at the time of writing a formal response to this proposal is being considered by UU.

The surface water drainage network for the positively drained areas shall be constructed to adoptable standards wherever possible.

For further detail refer to the Outline Drainage Layout Plan (K36892/A1/103) included in Appendix A.

It is concluded the site is suitable for SuDS, however other options could be considered including a hybrid strategy comprising of individual geocellular crates for each dwelling, with potentially reduced box culvert sizes servicing the highways runoff. This will be looked at during the detailed design stage as it may prove to be more economical.

9.6.1 EXISTING CULVERTED WATERCOURSE

The existing culverted watercourse shown on the UU records emanating from the western site boundary is known to be in to be in very poor condition downstream and is therefore not considered a viable option for disposal of the development site surface water runoff. Further consultation with the LLFA is required to determine the extent of repairs required by owners outside of the proposed site boundary, and to safeguard the local area and future proof the existing culvert it is recommended that the LLFA liaise directly with the downstream Riparian owners to undertake the necessary repairs.

9.6.2 RUNOFF CONTROL

Cumulative discharge from the development shall be controlled to a rate of 5l/s to be comparable to the pre-development greenfield runoff Qbar rate of 4.2 l/s. This rate will allow adoption of the surface water system and mitigate blockage risk.

An upstream flow control device will control flow discharge to 4.5 l/s from one of the box culvert storage structures located in a higher part of the site before filtering into the lower storage structures and joining the main drainage network.

The upper site Hydrobrake optimum flow control device is therefore specified with the following parameters:

Design Head	=	1.300 m
Design Flow	=	4.5 l/s
Orifice diameter	=	96 mm
Unit Reference:		MD-SHE-0096-4500-1300-4500

A separate device will then restrict the overall surface water discharge from the site via the lower box culvert storage structures and will control the flow to 5 l/s via a Hydrobrake flow control device.

The main site Hydrobrake optimum flow control device is therefore specified with the following parameters:

Design Head	=	1.400 m
Design Flow	=	5.0 l/s
Orifice diameter	=	100 mm
Unit Reference:		MD-SHE-0100-5000-1400-5000

9.6.3 STORAGE VOLUME

Three number precast box culverts are proposed as outlined on the drainage layout plan (K36892/A1/103), which would provide a combined storage volume of approx 312m³.

The upper box culvert servicing the shared road and plots 10 to 19 would provide storage of approx. 60 m³. The lower box culvert servicing the lower shared road and plots 1 to 5 would provide approx. 87 m³ storage and the main site box culvert servicing the remaining majority of the site surface water runoff would provide approx. 165 m³ of storage capacity.

9.6.4 OUTFALL DESIGN

A 150mm diameter outfall pipe is proposed from the main hydrobrake chamber to the discharge point in the proposed offsite surface water drainage pipeline situated in Main Street, or in the absence of this sewer, to the public combined sewer.

9.7 DESIGNING FOR LOCAL DRAINAGE SYSTEM FAILURE

In accordance with the general principles discussed in CIRIA Report C635 – Designing for Exceedance in Urban Drainage[12] the proposed surface water drainage, where practical, should be designed to ensure there is no increased risk of flooding to the buildings on the site or elsewhere as a result of extreme rainfall, lack of maintenance, blockages or other causes.

9.7.1 BLOCKAGE AND EXCEEDENCE

The site drainage will be designed to attenuate a 100-year design storm including a 40% allowance for climate change. The drainage system will also provide capacity for lower probability (greater design storm events) which are not critical duration. Exceedance flows shall be retained on site within the drainage system as far as practical however for storms of a greater return period it may be necessary to pass forward more flow or spill flows.

In the unlikely case of blockage of the box culvert storage systems, associated silt traps and/or flow control chamber, spills would occur from the lowest access cover onto the new access roads. Runoff would occur along the highway and levels shall be designed such that water is constrained by kerbs and flows directed towards the existing highways drainage situated in Main Street away from the properties.

The new dwellings would not be at risk of flooding due to the proposed topography of the site and careful design of the access roads / parking areas, falling away from property.

9.8 SURFACE WATER QUALITY

The treatment of surface water is not a statutory requirement. Water quality remains a material consideration but there are no prescriptive standards to be imposed in terms of treatment train management. In the absence of a design standard, the SuDS manual has been used which outlines best practice.

Pollutants such as suspended solids, heavy metals and organic pollutants may be present in surface water runoff, the quantity and composition of the runoff is highly dependent upon site use. For housing developments the pollutant load is very low.

The SuDS Manual[9] outlines best practice with regards to treatment of surface water by SuDS components prior to discharge to the environment. SuDS components can be effective in reducing the amount of pollutants within the surface water discharged and therefore environmental impact of the development. SuDS components may be installed in series to form a treatment train to treat the runoff.

The simple index approach as outlined in the SuDS manual has been used to assess the pollution hazard indices and proposed treatment components, the calculations are included in Appendix C. For the three categories of runoff areas served by the drainage system, Roof areas, residential parking and residential roads, treatment is proposed by use of a Downstream Defender hydrodynamic vortex separator (or similar device) which removes sediments, oils and floatables from the site stormwater runoff. Tables 9.8.1 – 9.8.3 summarise the pollution hazard and mitigation indices for this type of runoff.

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.2	0.2	0.05
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	ADEQUATE	ADEQUATE	ADEQUATE

Figure 9.8.1 Pollution Hazard & Mitigation Indices- Roof Areas

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.4
Treatment Suitability	ADEQUATE	ADEQUATE	ADEQUATE

Figure 9.8.2 Pollution Hazard & Mitigation Indices- Residential Parking

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	ADEQUATE	ADEQUATE	ADEQUATE

Figure 9.8.3 Pollution Hazard & Mitigation Indices- Residential Roads

9.9 OPERATIONS AND MAINTENANCE RESPONSIBILITY

Adoption of surface water drainage systems and SuDS components by the sewerage undertaker and/or the highways authority is intended wherever possible. During the detailed design stage a full review and consideration of UU requirements shall ensure the maximum practical extent of adoptable drainage in accordance with the Design and Construction Guidance for Foul and Surface Water Sewers[18] and subject to a Section 104 Agreement.

Any private individual plot drainage is to be maintained by the property owners. Where required a private management company will be responsible for maintenance of any non-adoptable drainage runs or storage systems.

Highways gullies and associated pipework will be put forward for adoption by Cumbria County Council under a Section 38 Agreement.

Any areas associated with social housing will be managed by the relevant social housing association.

In addition to the above measures, where applicable, a *SuDS Operations & Maintenance Plan* will be made available to the site owners detailing the requirements for future maintenance of the drainage system.

9.10 POTENTIAL NEIGHBOURING DEVELOPMENT

Gleeson Homes and Regeneration are currently looking at the option of constructing another housing development in the local vicinity. The potential site in question is located off the nearby Cleator Moor Road and backs on to this site sharing a common boundary to the northeast of the (Ivy Mill) development. Should this adjacent site be acquired for development purposes it is anticipated that due to the site topography one of the more viable potential routes for surface water drainage would be through the Ivy Mill development site. It is therefore preliminarily proposed to provide a connection point from the new site located at the nearest point to the boundary at the upper most manhole shown on the outline drainage plan (MHS1) to receive surface water runoff from the new site. Should this be required in the future any surface water discharge from the new site would enter this proposed drainage network at a controlled flow rate and would require minor alterations to the Ivy Mill site outfall flow control chamber and discharge rates to accommodate the additional runoff serving both sites.

Any such proposals would require further consultation and approval from the Lead Local Flood Authority and acceptable discharge rates would need to be agreed prior to development in the usual manner via the planning process.

10. FOUL WATER DRAINAGE STRATEGY

It is proposed that foul water from the development shall be drained via gravity within the site before being connected to the existing manhole on the 225mm diameter combined sewer situated within the adjacent highway, Main Street, near the proposed site entrance.

Under Section 106 of The Water Industry Act 1991, 'the owner / occupier of any premises shall be entitled to have his drain or sewer communicate with the public sewer of any sewerage undertaker and thereby to discharge foul water and surface water from those premises or that private sewer.' Unless 'the making of the communication would be prejudicial to the undertaker's sewerage system'.

The drainage system shall be designed to adoptable standards to allow adoption by United Utilities under Section 104 of the Water Industry Act 1991. A pre-development enquiry has been submitted to United Utilities and their response provides an agreement in principle for a connection to the existing foul network.

Preliminary foul water discharge calculations have been undertaken for the whole site in accordance with the Design and Construction Guidance for Foul and Surface Water Sewers[18], see Figure 10.1 below.

Sewerage Sector Design and Construction Guidance Clause B3.1	
Peak Load based on number of dwellings, 26 No units @ 4000l/day (l/day)	104,000
Total Foul Flow Rate from Site (l/s)	1.2

Figure 9.10.1 Peak Foul Flow Rates

The estimated peak foul flow rate from the development is 1.2 litres/second.

A drainage connection via gravity to the existing 225mm combined sewer situated in Main Street is achievable, however investigations are required to determine the exact level of the combined sewer at the connection point proposed.

For further detail refer to the Drainage Layout Plan included in Appendix A.

11. CONCLUSIONS AND RECOMMENDATIONS

In consideration of the Flood Risk Assessment and proposed Drainage Strategy for the site the following conclusions and recommendations are made:

- The site is located in Flood Zone 1 with a predicted annual probability of flooding from rivers or the sea of less than 0.1% AEP (1 in 1000).
- By reference to the National Planning Policy Framework [1] on Flood Risk, More Vulnerable development is acceptable within this flood zone.
- Following development and reprofiling of the existing topography the site is not considered to be at significant risk of flooding from surface water, groundwater, sewers, reservoirs, canals or any artificial structures.
- Surface water runoff from the site shall be positively drained and attenuated prior to discharge. Despite being a predominantly brownfield site with formerly unrestricted discharge rates, the total offsite discharge rate will be controlled to be comparable to the pre-development Greenfield Qbar rate.
- The minimum orifice size to allow adoption shall be specified which results in discharge rate of 5l/s.
- In line with the SuDS hierarchy discharge shall be to the public combined sewer in absence of any suitable alternatives. However, the surface water drainage shall be designed to allow easy diversion of flow to a new highway drain which may be installed by Cumbria County Council in future.
- A new surface water drainage network will convey the combined plot and highways drainage along the new site roads to the proposed connection point in Main Street to the west of the site via a series of attenuation structures.
- A volume of approximately 312m^3 storage will be provided by precast box culverts situated within the site to accommodate the proposed development surface water run-off.
- It is anticipated that discharge from the development, shall be controlled to a rate of 5 l/s via a HydroBrake before connecting into a proposed new offsite public highways surface water drainage pipe network due to be constructed within Main Street in the near future.
- The foul drainage will connect via gravity into the existing 225mm combined sewer located within Main Street which runs parallel to the new site entrance to the west of the proposed development. A pre-development enquiry has provided an agreement in principle from UU.
- Full repair of the existing culverted watercourse to the west of the site boundary is recommended to prevent any risk of surface water flooding in this area.

- To safeguard the local area and future proof the existing culvert it is recommended that the LLFA liaise directly with the downstream Riparian owners to undertake the necessary repairs.

- The drainage system will be designed to ensure that there is no increased flood risk on or off the site as a result of extreme rainfall, lack of maintenance or blockages. A series of safety features within the development and careful design of building layout will mitigate against this.

- In addition to these measures, a SuDS Operations and Maintenance Plan will be made available to the site owners detailing future maintenance requirements of all sustainable drainage systems.

12. REFERENCES

[1] Ministry of Housing, Communities and Local Government, National Planning Policy Framework, May 2021.

[2] Ministry of Housing, Communities and Local Government, Planning Practice Guidance to the National Planning Policy Framework, May 2021

[3] Defra/Environment Agency, The Town and Country Planning Order 2015, 2015 No.595, May 2021

[4] British Geological Survey, 2020. Geoindex. http://mapapps2.bgs.ac.uk/geoindex/home.html May 2021

[5] Land Information System (LANDIS)- Soilscapes viewer, Accessed May 2021. http://www.landis.org.uk/soilscapes

[6] Defra Magic Maps, 2020. https://magic.defra.gov.uk/MagicMap.aspx.

[7] Copeland Borough Council, Strategic Flood Risk Assessment (SFRA), August 2007.

[8] Environment Agency Spatial Data Catalogue, WMS Links, May 2021. http://environment.data.gov.uk/ds/catalogue/#/catalogue

[9] CIRIA, The SuDS Manual, Report C753, 2015.

[10] BS8582:2013, Code of Practice for Surface Water Management, November 2013.

[11] DEFRA/EA, Rainfall Runoff Management for Developments, SC030219, October 2013.

[12] CIRIA, Designing for Exceedance in Urban Drainage – Good Practice, Report C635, London, 2006.

[13] Centre for Ecology and Hydrology, Flood Estimation Handbook, Vols. 1 – 5 & FEH CD-ROM 3, 2009.

[14] Institute of Hydrology, Flood Studies Report, Volume 1, Hydrological Studies, 1993.

[15] Institute of Hydrology, Flood Studies Supplementary Report No 14 – Review of Regional Growth Curves, August 1983.

[16] Marshall & Bayliss, 1994. Flood Estimation for Small Catchments, Report No. 124 (IoH 124), Institute of Hydrology.

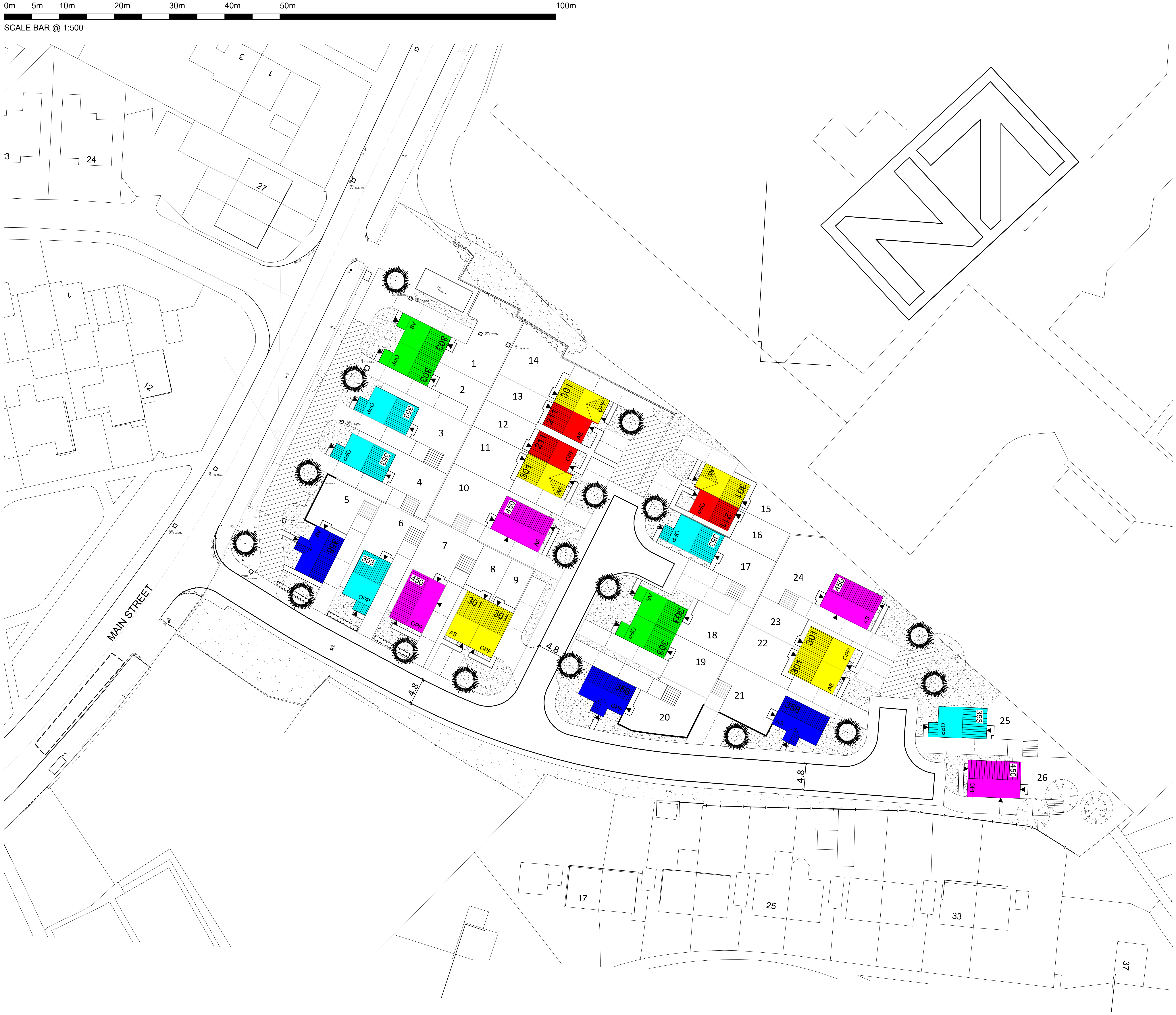
[17] Department for Environment, Food and Rural Affairs, Non-Statutory Technical Standards for Sustainable Drainage Systems, March 2015

[18] Water UK, Design and Construction Guidance for Foul & Surface Water Sewers Offered for Adoption Under the Code for Adoption Agreements for Water and Sewage Companies Operating Wholly or Mainly in England, Approved Version 2.0, March 2020

APPENDIX A

ARCHITECTS PROPOSED LAYOUT

OUTLINE DRAINAGE LAYOUT PLAN



DWELLING KEY

211	2 BED SEMI-DETACHED HOUSE	3
301	3 BED SEMI-DETACHED HOUSE	7
303	3 BED SEMI-DETACHED HOUSE	4
353	3 BED DETACHED HOUSE	5
358	3 BED DETACHED HOUSE	3
450	4 BED DETACHED HOUSE	4
		26No.

REV	DESCRIPTION	DATE
B	315 & 401 REPLACED WITH 353 & 450.	MAY'21
A	HIGHWAYS COMMENTS ADDED.	FEB'21

gleeson

GLEESON HOMES & REGENERATION

DRAWING

PLANNING LAYOUT (colour coded)

PROJECT

IVY MILL, WHITEHAVEN

SCALE	1:500@A2	REV.	B	DRAWING No.
DATE	JULY '20			MJG/PL-110-2
DRAWN	TWENTY10			

TWENTY 10

DESIGN AND PLANNING

Twenty10 Management Limited, 62 Hawkshead Avenue, Euxton, Chorley, Lancashire. PR7 6TE
Tel: (01257) 277 100 Email: info@twenty10.biz Fax: (01257) 266 911

IVY MILL, WHITEHAVEN


DO NOT SCALE – IF IN DOUBT ASK
USE FIGURED DIMENSIONS ONLY
Stockpile 01
MHF06 1050ø CL~116.500 IL~115.150
MHS08 1200ø CL~116.316 IL~113.938
Box Culvert 02 Inlet IL~113.825
Precast Concrete Box culvert 1.8m 02 wide x 40.5m long x 1.2m deep. Laid at 1:150 gradient
Connection to existing Foul Manhole 1350ø CL~114.332 IL~112.786
MHF07 1050ø CL~115.350 IL~114.000
MHF05 1350ø CL~114.500 IL~113.150
Box Culvert 02 Inlet IL~112.580
Box Culvert 01 Outlet IL~112.548
MHC07 1350ø IL ~114.000 Connection Invert Level ~112.427
Downstream Defender MHS06 1200ø CL~114.400 IL~112.504
Hydrobrake (discharge 5 l/s) MHS05 1800ø CL~114.500 IL~112.530
Precast Concrete Box culvert 01 3.0 wide x 46m long x 1.2m deep. Laid at 1:200 gradient
Box Culvert 01 Inlet IL~113.753
MHS04 1500ø CL~116.950 IL~114.200
Hydrobrake (Discharge 4.5 l/s) MHS10 1500ø CL~117.200 IL~114.230
Precast Concrete Box culvert 03 1.8m wide x 28m long x 1.2m deep. Laid at 1:84 gradient
Box Culvert 03 Outlet IL~114.240
Box Culvert 03 Inlet IL~115.625
MHS09 1200ø CL~120.350 IL~117.425
MHF08 1200ø CL~120.450 IL~118.400
MHF04 1350ø CL~117.305 IL~115.950
MHF03 1200ø CL~119.300 IL~116.310
MHS03 1200ø CL~120.350 IL~117.444
MHF02 1200ø CL~122.350 IL~120.250
MHF01 1050ø CL~122.200 IL~120.650
MHS01 1050ø CL~122.350 IL~121.000
MHS02 1200ø CL~122.600 IL~120.888
225ø combined sewer
350ø Culverted Watercourse
150ø uPVC 55.07m 1:50
150ø uPVC 20.81m 1:10
150ø uPVC 31.69 1:10
150ø uPVC 44.89m 1:11
150ø uPVC 39.80 1:12
OUTLINE DRAINAGE KEY
Proposed Surface Water Drainage
Proposed SW Plot Drainage
Precast Concrete Box Culvert
Proposed Foul Water Sewer
Proposed Foul Plot Drainage
Highways Drainage
Land Drainage
Existing Culverted Watercourse
Existing Combined Sewer
Exceedence Flows
N NE E SE S SW W NW
Drainage amended to suit layout alterations 11/06/21 CA B
Drainage amended to suit layout alterations 13/04/21 CA A
Revisions Date Initial Suffix
© Reserved 2021
Client: GLEESON HOMES AND REGENERATION
Project: IVY MILL WHITEHAVEN
Drawing Title: OUTLINE DRAINAGE LAYOUT PLAN
R. G. PARKINS & PARTNERS LTD
CONSULTING CIVIL & STRUCTURAL ENGINEERS
Meadowside Kendal LA9 6NY Tel: 01539 729393 Fax: 01539 740609 Email: mail@rgparkins.com
97 King Street Lancaster LA1 1RH Tel: 01524 32548 Fax: 01524 843998 Email: office@rgparkinslancaster
Drawn by: CA
Checked by:
Issue Purpose: INFORMATION
Scale: 1:200
Issue Date: 16/12/20
Drawing Number: K36892/A1/103 B

APPENDIX B

PRE-DEVELOPMENT RUNOFF CALCULATIONS

CAUSEWAY FLOW DRAINAGE CALCULATIONS

SUSTAINABLE DRAINAGE TREATMENT CALCULATIONS

DESIGN BASIS MEMORANDUM - PEAK RATE OF RUN-OFF CALCULATION

Design Brief

The following peak rate of run-off calculations have been undertaken to determine changes in peak flow resulting from the development of a greenfield or brownfield site. These calculations are for the **Peak Rate of Run-Off** requirements only.

Background Information & References

The site area **is less than** 200ha and the Greenfield (pre-development) calculation has been undertaken in accordance with methodology described by Marshall & Bayliss, Institute of Hydrology, Report No. 124, Flood Estimation for Small Catchments, 1994 (IoH 124).

In addition, the following references have been used in the preparation of these calculations:

- Interim Code of Practice for Sustainable Drainage Systems (SUDS), CIRIA, 2004
- CIRIA, The SUDS Manual, Report C753, 2015
- Designing for Exceedance in Urban Drainage - good practice, CIRIA Report C635, 2006
- Flood Estimation Handbook (FEH)
- Flood Studies Report (FSR), Volume 1, Hydrological Studies, 1993
- Flood Studies Supplementary Report No 2 (FSSR2), The Estimation of Low Return Period Floods
- Flood Studies Supplementary Report No 14 (FSSR14), Review of Regional Growth Curves, 1983
- Planning Practice guidance of the National Planning Policy Framework, Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights.

Proposed Land Use Changes

Changes to the existing site are as follows:

Brownfield Site to Brownfield Site (Reduced Impermeable Area)

Results Summary

Rate of Run-Off (l/s)			
Event	**Greenfield**	**Brownfield**	**Post-Development**
Q1	3.7	41.7	5.0
QBAR	4.2	61.1	5.0
Q10	5.9	83.4	5.0
Q30	7.2	101.9	5.0
Q100	8.8	130.6	5.0
Q100 + 40% CC	12.4	182.9	5.0

SITE AREAS (LAND COVER AREAS)

Existing Impermeable & Permeable Land Cover

Total Site Area: **0.9105** **ha** **9105** **m²**

Existing Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	ha	
Total impermeable area	9105.0	0.911	100%
Remaining permeable area	0.0	0.000	0%

Proposed Land Cover Areas

Land Cover	Area		Percentage of total site area
	m²	ha	
Total housing roof area	1486.1	0.149	16%
Total parking and paved area	1391.1	0.139	15%
Total road area	2092.0	0.209	23%
Garden & landscaped areas	4135.8	0.414	45%

Proposed Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	ha	
Total impermeable area	4969.2	0.497	55%
Remaining permeable area	4135.8	0.414	45%

ESTIMATION OF QBAR (RURAL) (GREENFIELD RUNOFF RATE)

IoH 124 based on research on small catchments < 25 km2

Method is based on regression analysis of response times
using catchments from 0.9 to 22.9 km^2

$QBAR_{rural}$ is mean annual flood on rural catchment
$QBAR_{rural}$ depends on SOIL, SAAR and AREA most significantly

$QBAR_{rural} = \boxed{0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}}$

For SOIL refer to FSR Vol 1, Section 4.2.3 and 4.2.6 and IoH 124

Contributing watershed area

Area, A	=	500000	m^2	insert 50 ha for EA
	=	0.500	km^2	small catchment method
	=	50.000	ha	
SAAR	=	**1140**	mm	From UKSuds website (point data)

Soil index based on soil type, SOIL $= \dfrac{(0.1S1+0.3S2+0.37S3+0.47S4+0.53S5)}{(S1+S2+S3+S4+S5)}$

Where: S1	=		%	
S2	=		%	
S3	=		%	
S4	=	**100**	%	
S5	=		%	
		100	%	
So, SOIL	=	**0.47**		

UK Suds website provides a value of 4 based on the equivalent Host value. This seems reasonable based on ground investigation.

Note: for very small catchments it is far better to rely on local site investigation information.

$QBAR_{rural}$	=	0.427	m^3/s
	=	427.1	l/s

Small rural catchments less than 50 ha
The Environment Agency recommends that this method should be used for development sizes from 0 to 50 ha and should linearly interpolate the formula to 50 ha.

So, catchment size	=	**4969**	m^2
	=	0.005	km^2
	=	0.497	ha
$QBAR_{rural\ site}$	=	0.00424	m^3/s
	=	**4.24**	l/s

Excluding significant open space which would remain disconnected from the positive drainage system during flood events.

R G PARKINS & PARTNERS LTD	CALCULATION		Job No.	K36892	Page	4 of 6
Meadowside	Job	Ivy Mill	Drg no.	N/A	Date	10/06/2021
Shap Road		Whitehaven	Revision	A	Initial	CA
KENDAL LA9 6NY	Title	Rate of Run-Off			Checked	OS

GREENFIELD RETURN PERIOD ORDINATES

QBAR can be factored by the UK FSR regional growth curves for return periods <2 years and for all other return periods to obtain peak flow estimates for required return periods.

These regional growth curves are constant throughout a region, whatever the catchment type and size.

See Table 2.39 for region curve ordinates
Use FSSR2 Growth Curves to estimate Qbar

Reference- Pg 173-FSR V.1, ch 2.6.2

Region = **10**

Use Figure A1.1 to determine region

GREENFIELD RETURN PERIOD FLOW RATES

Return Period	Ordinate	Q (l/s)
1	0.87	3.69
2	0.93	3.95
5	1.19	5.05
10	1.38	5.86
25	1.64	6.96
30	1.7	7.22
50	1.85	7.85
100	2.08	8.83
200	2.32	9.85
500	2.73	11.59
1000	3.04	12.90

Ordinate from FSSR2

Interpolation taken from Figure 24.2 (pg 515) SuDS Manual

ESTIMATE OF BROWNFIELD RUNOFF

Total site impermeable area, A = **4969** m²

M5-60 rainfall depth **17** mm *[Flood Studies Report (NERC, 1975)]*

Ratio M5-60/M5-2Day, r **0.30** *[The Wallingford Proceedure - V4 Modified Rational Method, Fig A.2 (Hydraulics Research, 1983)]*

Storm Duration 15 mins Anticipated critical duration for the site - usually 15 minutes

Duration factor, Z1 0.59 *[The Wallingford Proceedure - V4 Modified Rational Method, Fig A.3b (Hydraulics Research, 1983)]*

M5-15 rainfall depth = 10.0 mm

Return period ratio, Z2

M1-15	0.61
M10-15	1.22
M30-15	1.49
M100-15	1.91

[The Wallingford Proceedure - V4 Modified Rational Method, Table A1 (Hydraulics Research, 1983)]

Rainfall

	Depth (mm)	**Intensity, i (mm/hr)**
M1-15	6.1	24
M10-15	12.2	49
M30-15	14.9	60
M100-15	19.2	77

Peak discharge, Qp = Cv Cr i A

Where:

Cv = Volumetric Runoff Coefficient
Cr = Routing Coefficient
i = Rainfall intensity (mm/hour)

Cv = 0.95
Cr = 1.3

Peak Runoff

	l/s
Q1	41.7
Q10	83.4
Q30	101.9
Q100	130.6

ESTIMATION OF QBAR (BROWNFIELD RUNOFF RATE)

See Table 2.39 for region curve ordinates

Use FSSR2 Growth Curves to estimate Qbar

Reference- Pg 173-FSR V.1, ch 2.6.2

Region = **10**

Use Figure A1.1 to determine region

Return Period	Ordinate
1	0.87
2	0.93
5	1.19
10	1.38
25	1.64
30	1.70
50	1.85
100	2.08
200	2.32
500	2.73
1000	3.04

Ordinate from FSSR2

Interpolation taken from Figure 24.2 (pg 515) SuDS Manual

Qbar

Ordinate used	l/s
10 year	60.5
30 year	59.9
100 year	62.8

Proposed Brownfield Runoff, Qbar = 61.07 l/s

Using the average Qbar derived from three ordinates.

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	40	Minimum Backdrop Height (m)	0.200
CV	0.840	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.019	5.00	122.350	1050	299103.582	517044.145	1.350
2	0.053	5.00	122.600	1200	299101.861	517025.111	1.727
3	0.055	5.00	120.350	1200	299062.168	517027.980	2.906
4	0.024	5.00	116.950	1500	299031.335	517035.293	2.750
BC1 Inlet			116.600		299025.491	517037.746	3.822
BC1 Outlet			114.600		298984.938	517059.460	2.052
5 HB	0.144	5.00	114.500	1800	298981.772	517061.162	1.970
6			114.400	1200	298978.260	517062.859	1.896
OUTFALL			114.000	1350	298967.903	517067.863	1.573
8	0.027	5.00	116.316	1200	299004.567	517106.849	2.378
BC2 Inlet			116.100		299004.002	517104.665	3.250
BC2 Outlet	0.014	5.00	114.680		298985.585	517068.592	2.100
9	0.066	5.00	120.350	1200	299054.208	517080.906	2.925
BC3 Inlet	0.050	5.00	118.700		299046.654	517065.842	4.125
BC3 Outlet			117.250		299034.103	517040.812	3.010
10 HB	0.052	5.00	117.200	1500	299033.209	517039.029	2.970

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	19.112	0.600	121.000	120.873	0.127	150.0	150	5.39	50.0
1.001	2	3	39.797	0.600	120.873	117.444	3.429	11.6	150	5.61	50.0
1.002	3	4	31.688	0.600	117.444	114.200	3.244	9.8	150	5.78	50.0
1.003	4	BC1 Inlet	6.338	0.600	114.200	113.753	0.447	14.2	225	5.81	50.0
1.004	BC1 Inlet	BC1 Outlet	46.000	0.600	112.778	112.548	0.230	200.0	3000	6.04	50.0
1.005	BC1 Outlet	5 HB	3.594	0.600	112.548	112.530	0.018	199.7	300	6.09	50.0
1.006	5 HB	6	3.901	0.600	112.530	112.504	0.026	150.0	225	6.15	50.0
1.007	6	OUTFALL	11.502	0.600	112.504	112.427	0.077	149.4	225	6.33	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.000	0.818	14.5	4.0	1.200	1.577	0.019	0.0
1.001	2.973	52.5	15.3	1.577	2.756	0.072	0.0
1.002	3.242	57.3	27.0	2.756	2.600	0.127	0.0
1.003	3.493	138.9	67.8	2.525	2.622	0.319	0.0
1.004	3.287	11832.0	67.8	2.622	0.852	0.319	0.0
1.005	1.109	78.4	67.8	1.752	1.670	0.319	0.0
1.006	1.065	42.3	107.1	1.745	1.671	0.504	0.0
1.007	1.067	42.4	107.1	1.671	1.348	0.504	0.0

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
2.000	8	BC2 Inlet	2.256	0.600	113.938	113.825	0.113	20.0	225	5.01	50.0
2.001	BC2 Inlet	BC2 Outlet	40.502	0.600	112.850	112.580	0.270	150.0	1800	5.21	50.0
2.002	BC2 Outlet	5 HB	8.351	0.600	112.580	112.530	0.050	167.0	300	5.33	50.0
3.000	9	BC3 Inlet	16.852	0.600	117.425	115.625	1.800	9.4	150	5.08	50.0
3.001	BC3 Inlet	BC3 Outlet	28.001	0.600	114.575	114.240	0.335	83.6	1800	5.19	50.0
3.002	BC3 Outlet	10 HB	1.995	0.600	114.240	114.230	0.010	199.5	225	5.22	50.0
3.003	10 HB	4	4.180	0.600	114.230	114.200	0.030	139.3	225	5.29	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
2.000	2.939	116.8	5.7	2.153	2.050	0.027	0.0
2.001	3.413	7372.8	5.7	2.050	0.900	0.027	0.0
2.002	1.213	85.8	8.7	1.800	1.670	0.041	0.0
3.000	3.312	58.5	14.0	2.775	2.925	0.066	0.0
3.001	4.577	9886.4	24.7	2.925	1.810	0.116	0.0
3.002	0.922	36.7	24.7	2.785	2.745	0.116	0.0
3.003	1.106	44.0	35.7	2.745	2.525	0.168	0.0

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	19.112	150.0	150	Circular	122.350	121.000	1.200	122.600	120.873	1.577
1.001	39.797	11.6	150	Circular	122.600	120.873	1.577	120.350	117.444	2.756
1.002	31.688	9.8	150	Circular	120.350	117.444	2.756	116.950	114.200	2.600
1.003	6.338	14.2	225	Circular	116.950	114.200	2.525	116.600	113.753	2.622
1.004	46.000	200.0	3000	Culvert	116.600	112.778	2.622	114.600	112.548	0.852
1.005	3.594	199.7	300	Circular	114.600	112.548	1.752	114.500	112.530	1.670
1.006	3.901	150.0	225	Circular	114.500	112.530	1.745	114.400	112.504	1.671
1.007	11.502	149.4	225	Circular	114.400	112.504	1.671	114.000	112.427	1.348
2.000	2.256	20.0	225	Circular	116.316	113.938	2.153	116.100	113.825	2.050
2.001	40.502	150.0	1800	Culvert	116.100	112.850	2.050	114.680	112.580	0.900
2.002	8.351	167.0	300	Circular	114.680	112.580	1.800	114.500	112.530	1.670
3.000	16.852	9.4	150	Circular	120.350	117.425	2.775	118.700	115.625	2.925
3.001	28.001	83.6	1800	Culvert	118.700	114.575	2.925	117.250	114.240	1.810

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	1	1050	Manhole	Adoptable	2	1200	Manhole	Adoptable
1.001	2	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
1.002	3	1200	Manhole	Adoptable	4	1500	Manhole	Adoptable
1.003	4	1500	Manhole	Adoptable	BC1 Inlet		Junction	
1.004	BC1 Inlet		Junction		BC1 Outlet		Junction	
1.005	BC1 Outlet		Junction		5 HB	1800	Manhole	Adoptable
1.006	5 HB	1800	Manhole	Adoptable	6	1200	Manhole	Adoptable
1.007	6	1200	Manhole	Adoptable	OUTFALL	1350	Junction	
2.000	8	1200	Manhole	Adoptable	BC2 Inlet		Junction	
2.001	BC2 Inlet		Junction		BC2 Outlet		Junction	
2.002	BC2 Outlet		Junction		5 HB	1800	Manhole	Adoptable
3.000	9	1200	Manhole	Adoptable	BC3 Inlet		Junction	
3.001	BC3 Inlet		Junction		BC3 Outlet		Junction	

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
3.002	1.995	199.5	225	Circular	117.250	114.240	2.785	117.200	114.230	2.745
3.003	4.180	139.3	225	Circular	117.200	114.230	2.745	116.950	114.200	2.525

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
3.002	BC3 Outlet		Junction		10 HB	1500	Manhole	Adoptable
3.003	10 HB	1500	Manhole	Adoptable	4	1500	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
1	299103.582	517044.145	122.350	1.350	1050	0	1.000	121.000	150
2	299101.861	517025.111	122.600	1.727	1200	1	1.000	120.873	150
						0	1.001	120.873	150
3	299062.168	517027.980	120.350	2.906	1200	1	1.001	117.444	150
						0	1.002	117.444	150
4	299031.335	517035.293	116.950	2.750	1500	1	3.003	114.200	225
						2	1.002	114.200	150
						0	1.003	114.200	225
BC1 Inlet	299025.491	517037.746	116.600	3.822		1	1.003	113.753	225
						0	1.004	112.778	3000
BC1 Outlet	298984.938	517059.460	114.600	2.052		1	1.004	112.548	3000
						0	1.005	112.548	300
5 HB	298981.772	517061.162	114.500	1.970	1800	1	2.002	112.530	300
						2	1.005	112.530	300
						0	1.006	112.530	225
6	298978.260	517062.859	114.400	1.896	1200	1	1.006	112.504	225
						0	1.007	112.504	225
OUTFALL	298967.903	517067.863	114.000	1.573	1350	1	1.007	112.427	225
8	299004.567	517106.849	116.316	2.378	1200	0	2.000	113.938	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
BC2 Inlet	299004.002	517104.665	116.100	3.250		1	2.000	113.825	225
						0	2.001	112.850	1800
BC2 Outlet	298985.585	517068.592	114.680	2.100		1	2.001	112.580	1800
						0	2.002	112.580	300
9	299054.208	517080.906	120.350	2.925	1200	0	3.000	117.425	150
BC3 Inlet	299046.654	517065.842	118.700	4.125		1	3.000	115.625	150
						0	3.001	114.575	1800
BC3 Outlet	299034.103	517040.812	117.250	3.010		1	3.001	114.240	1800
						0	3.002	114.240	225
10 HB	299033.209	517039.029	117.200	2.970	1500	1	3.002	114.230	225
						0	3.003	114.230	225

Node 5 HB Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	112.530	Product Number	CTL-SHE-0100-5000-1400-5000
Design Depth (m)	1.400	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.0	Min Node Diameter (mm)	1200

Node 10 HB Online Hydro-Brake® Control

Flap Valve	✓	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	114.230	Product Number	CTL-SHE-0096-4500-1300-4500
Design Depth (m)	1.300	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	4.5	Min Node Diameter (mm)	1200

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 98.80%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	121.096	0.096	10.1	0.1102	0.0000	OK
15 minute winter	2	10	120.967	0.094	37.9	0.1638	0.0000	OK
15 minute winter	3	12	118.060	0.616	66.7	0.9305	0.0000	SURCHARGED
960 minute winter	4	840	114.405	0.205	11.1	0.3978	0.0000	OK
960 minute winter	BC1 Inlet	840	114.404	1.626	11.1	0.0000	0.0000	SURCHARGED
960 minute winter	BC1 Outlet	840	114.404	1.856	7.4	0.0000	0.0000	FLOOD RISK
960 minute winter	5 HB	840	114.404	1.874	8.1	7.5100	0.0000	FLOOD RISK
960 minute winter	6	840	112.561	0.057	5.7	0.0640	0.0000	OK
960 minute winter	OUTFALL	840	112.482	0.055	5.7	0.0000	0.0000	OK
960 minute winter	8	840	114.404	0.466	1.2	0.6332	0.0000	SURCHARGED
960 minute winter	BC2 Inlet	840	114.404	1.554	2.7	0.0000	0.0000	SURCHARGED
960 minute winter	BC2 Outlet	840	114.404	1.824	3.9	0.2426	0.0000	FLOOD RISK
15 minute winter	9	10	117.511	0.086	34.9	0.1361	0.0000	OK
120 minute winter	BC3 Inlet	116	115.796	1.221	30.7	0.2954	0.0000	SURCHARGED
120 minute winter	BC3 Outlet	116	115.796	1.556	24.6	0.0000	0.0000	SURCHARGED
120 minute winter	10 HB	116	115.796	1.566	10.3	3.3142	0.0000	SURCHARGED

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)
15 minute winter	1	10	121.096	0.096	10.1	0.1102	0.0000
15 minute winter	2	10	120.967	0.094	37.9	0.1638	0.0000
15 minute winter	3	12	118.060	0.616	66.7	0.9305	0.0000
960 minute winter	4	840	114.405	0.205	11.1	0.3978	0.0000
960 minute winter	BC1 Inlet	840	114.404	1.626	11.1	0.0000	0.0000
960 minute winter	BC1 Outlet	840	114.404	1.856	7.4	0.0000	0.0000
960 minute winter	5 HB	840	114.404	1.874	8.1	7.5100	0.0000
960 minute winter	6	840	112.561	0.057	5.7	0.0640	0.0000
960 minute winter	OUTFALL	840	112.482	0.055	5.7	0.0000	0.0000
960 minute winter	8	840	114.404	0.466	1.2	0.6332	0.0000
960 minute winter	BC2 Inlet	840	114.404	1.554	2.7	0.0000	0.0000
960 minute winter	BC2 Outlet	840	114.404	1.824	3.9	0.2426	0.0000
15 minute winter	9	10	117.511	0.086	34.9	0.1361	0.0000
120 minute winter	BC3 Inlet	116	115.796	1.221	30.7	0.2954	0.0000
120 minute winter	BC3 Outlet	116	115.796	1.556	24.6	0.0000	0.0000
120 minute winter	10 HB	116	115.796	1.566	10.3	3.3142	0.0000

R G PARKINS & PARTNERS LTD	CALCULATION		Job No.	K36892	Page	1 of 4
Meadowside	Job	Ivy Mill	Drg no.		Date	10/06/2021
Shap Road		Whitehaven	Revision		Initial	CA
KENDAL LA9 6NY	Title	Sustainable Drainage - Treatment			Checked	OS

DESIGN BASIS MEMORANDUM - SUSTAINABLE DRAINAGE TREATMENT OF SURFACE WATER

Design Brief

The following calculations outline the recommended treatment requirements for a sustaionable drainage system as outlined in the SuDS Manual 2015. The method used is the simple index approach outlined in section 26. The requirement for oil interceptors has been assessed in line with the now withdrawn Pollution Prevention Guidance document PPG3, produced by the Environment Agency. An oil interceptor is not required for the proposed development.

Treatment within SuDS components is affected by the flow rate and volume of water which passes through the component. It is not reasonable or practical to treat the entirety of the runoff for infrequent greater intensity design storms. In any case the majority of the pollutants are removed from surfaces by the more frequent rainfall events and in the first flush resulting from the initial runoff from the larger events.
and to a certain capacity.

The following references have been used in the preparation of these calculations:

- SUDS Manual, CIRIA Report C753, 2015
- Pollution Mitigation Indicies provided by Hydro International

Results Summary

Roof Area:

Treatment component 1 Hydo International Downstream Defender

Treatment component 2 None

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.2	0.2	0.05
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	**Adequate**	**Adequate**	**Adequate**

Residential Parking:

Treatment component 1 Hydo International Downstream Defender

Treatment component 2 None

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	**Adequate**	**Adequate**	**Adequate**

Residential Roads

Treatment component 1 Hydo International Downstream Defender
Treatment component 2 None

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
Treatment Suitability	**Adequate**	**Adequate**	**Adequate**

POLLUTION HAZARD INDEX

Source of Runoff	Pollution Hazard	Pollution Hazard Indices		
		Suspended Solids	Metals	Hydro-carbons
Residential roofing	Very low	0.2	0.2	0.05

POLLUTION MITIGATION INDEX

The receiving water body shall be: Surface Water

Suds Component		Pollution Mitigation Indices		
		Suspended Solids	Metals	Hydro-carbons
1	Hydo International Downstream Defender	0.5	0.4	0.8
2	None	0	0	0
3	None	0	0	0
4	None	0	0	0
	Total Pollution Mitigation Index	**0.5**	**0.4**	**0.8**

ASSESSMENT OF TREATMENT PROPOSAL

Indices	Suspended Solids	Metals	Hydro-carbons
Pollution Hazard	0.2	0.2	0.05
Pollution Mitigation	0.5	0.4	0.8
	Adequate	**Adequate**	**Adequate**

POLLUTION HAZARD INDEX

Source of Runoff	Pollution Hazard	Pollution Hazard Indices: Suspended Solids	Metals	Hydro-carbons
Residential parking	Low	0.5	0.4	0.4

POLLUTION MITIGATION INDEX

The receiving water body shall be: Surface Water

Suds Component		Pollution Mitigation Indices: Suspended Solids	Metals	Hydro-carbons
1	Hydo International Downstream Defender	0.5	0.4	0.8
2	None	0	0	0
3	None	0	0	0
4	None	0	0	0
	Total Pollution Mitigation Index	**0.5**	**0.4**	**0.8**

ASSESSMENT OF TREATMENT PROPOSAL

Indices	Suspended Solids	Metals	Hydro-carbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
	Adequate	**Adequate**	**Adequate**

R G PARKINS & PARTNERS LTD	CALCULATION		Job No.	K36892	Page	4 of 4
Meadowside	Job	Ivy Mill	Drg no.		Date	10/06/2021
Shap Road		Whitehaven	Revision		Initial	CA
KENDAL LA9 6NY	Title	Sustainable Drainage - Treatment			Checked	OS

POLLUTION HAZARD INDEX

Source of Runoff	Pollution Hazard	Pollution Hazard Indices		
		Suspended Solids	Metals	Hydro-carbons
Low traffic roads (e.g. residential roads and general access roads, < 300 traffic movements/day)	Low	0.5	0.4	0.4

POLLUTION MITIGATION INDEX

The receiving water body shall be: Surface Water

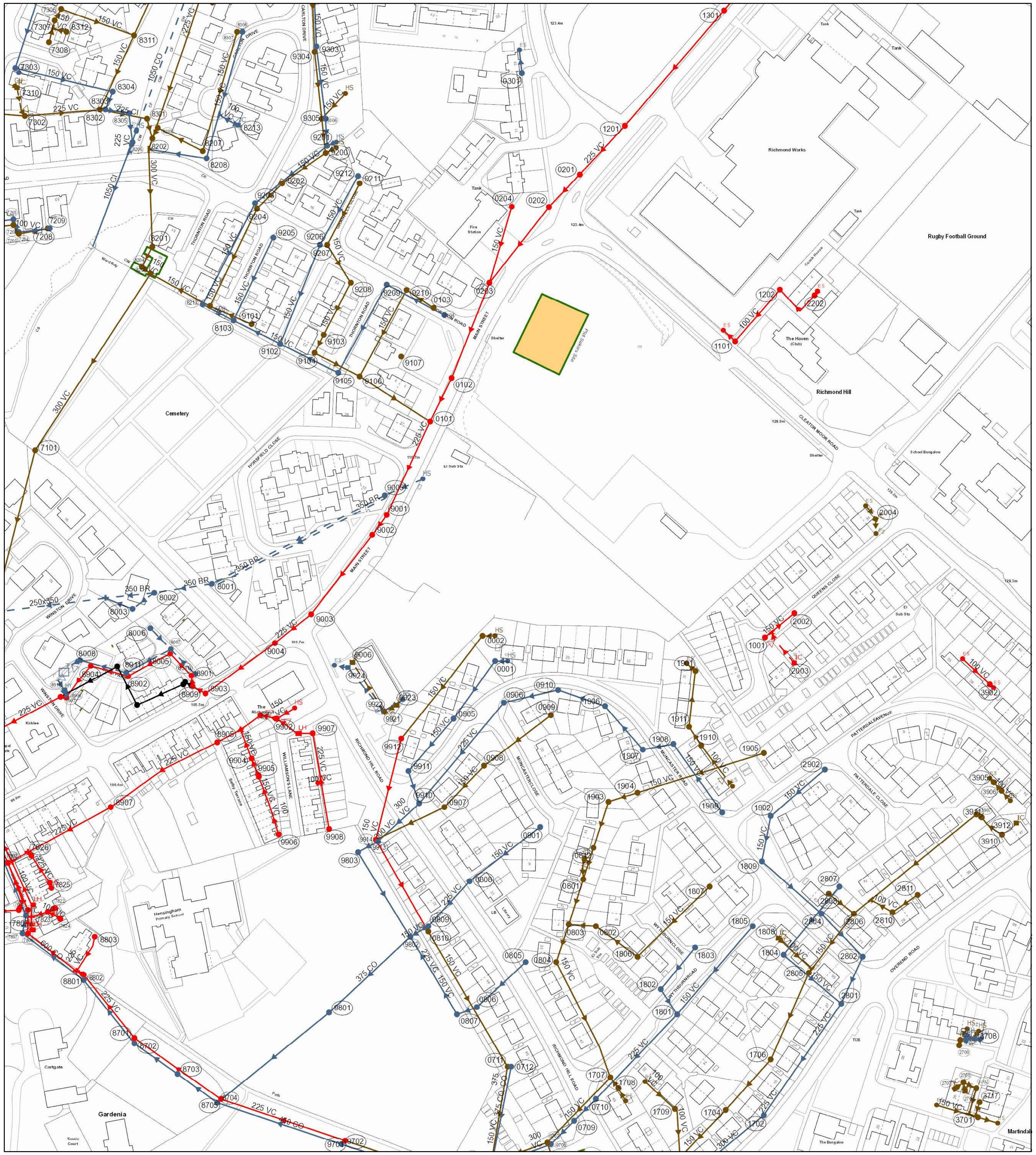
Suds Component		Pollution Mitigation Indices		
		Suspended Solids	Metals	Hydro-carbons
1	Hydo International Downstream Defender	0.5	0.4	0.8
2	None	0	0	0
3	None	0	0	0
4	None	0	0	0
	Total Pollution Mitigation Index	**0.5**	**0.4**	**0.8**

ASSESSMENT OF TREATMENT PROPOSAL

Indices	Suspended Solids	Metals	Hydro-carbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.4	0.8
	Adequate	**Adequate**	**Adequate**

APPENDIX C

UNITED UTILITIES SEWER RECORDS



The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad
7205	111.27	FO	109.66	100			VC	5.830952	
9210		FO	0	150			VC	54.58937	
7307		FO		150			VC	7.305812	
0905		SW	0	150			VC	38.28838	
3701		FO		150			VC	11.46706	
7302		FO		225			VC	41.82094	
9908	108.29	CO	107.49	225			VC	53.75872	1 in 358
8301	112.85	FO	110.52	225			VC	11.40175	1 in 190
9103		FO	0	150			VC	11.18034	
1809	129.15	SW	127.74	225			VC	43.93177	
0102	118.87	CO	117.22	225			VC	26.83282	1 in 23
8001		SW		350			BR	32.38827	
8911	102.68	SW	100.61	225			UN	26.59152	1 in 16
8305	113.38	SW	110.51	225			VC	16.12452	1 in 806
9201		SW	0	150			VC	51.22499	
9203		SW	0	150			VC	63.06346	
2802	127.66	SW	125.59	225			VC	28.63564	1 in 14
7306		FO		150			VC	42.97927	
1910		FO		100			VC	12.34532	
1301	126.9	CO	124.53	225			VC	84.38602	1 in 62
0805		SW	0	150			VC	36.79674	
0910	121.39	SW	119.67	225			VC	30.80584	1 in 15
2805		FO	0	150			VC	52.39275	
9102	116.65	SW	114.58	150			VC	29.06888	
9004	109.56	CO	107.97	225			VC	47.61593	1 in 14
1706		FO	0	150			VC	37.53665	
3902		CO		100			VC	2.687138	
8801	98.32	CO	95.89	225			VC	4.472136	
9003	111.09	CO	109.48	225			VC	25.6125	1 in 18
0803		FO	0	150			VC	22.13594	
9910	115	SW	112.81	300			VC	31.14482	1 in 27
1902		SW	0	150			VC	25.4951	
8312		FO		150			VC	7.962008	
1807		FO	0	150			VC	55.86591	
0907	116.67	FO	114.03	150			VC	42.04759	
8704	99.94	SW	98.17	600			CO	27.20294	1 in 45
8909	106	CO	104.26	225			UN	5.955877	1 in 11
9702	104.75	SW	102.67	450			CO	72.73238	1 in 16
8006	104.93	SW	103.33	150			VC	16.21264	1 in 101
7822	97.07	CO	96.33	100			VC	4.472136	
1903		FO	0	150			VC	26.87345	
2807		SW	0	150			VC	49.0408	
8008	100.6	SW	98.84	300			UN	5.49099	1 in 78
9200		FO	0	150			VC	29.41088	
0203	122.1	CO	120.4	225			VC	57.00877	1 in 18
8205	111.84	FO	109.8	300			VC	117.047	1 in 16
0801		FO	0	150			VC	26.24881	
8003		SW	0	350			BR	16.15549	
1804		SW	0	150			VC	41.86884	
7823	96.82	CO	96.42	100			VC	9.486833	
9212		SW	0	150			VC	43.41659	
8803		CO	0	225			VC	21.74234	
3910		FO		100			VC	14.80265	
9801		SW	0	375			CO	79.64923	
9207		FO	0	150			VC	24.69818	
1708		FO		100			VC	7.324072	
9202		FO	0	150			VC	19.79899	
0710	117.12	SW	115.67	225			VC	16.97056	1 in 11
8906	99.06	CO	97.37	225			UN	3.154247	1 in 158
8701	98.78	CO	96.59	225			VC	44.82187	1 in 73
1805		SW	0	150			VC	64.53681	
7209	111.06	FO	110.35	100			VC	16.27882	1 in 25
8802	98.37	SW	96.17	600			CO	42.80187	1 in 39
9803	110.45	SW	108.52	375			CO	55.22681	1 in 167
0802	123.15	FO	121.47	150			VC	15.0333	
1911		FO		100			VC	30.99374	
8307		FO	0	150			VC	68.68042	
8904	100.75	CO	99.06	225			UN	22.14258	1 in 13
1901		FO		100			VC	6.317659	
0809	113.17	SW	111.09	225			VC	5.830952	1 in 4
7806	96.28	CO	94.32	300			VC	28.23119	
9205		SW	0	150			VC	50.9902	
9911		SW	0	150			VC	18.97367	
8204	111.34	FO	109.99	300			VC	6.033846	1 in 75
1908	127.46	SW	126.06	150			VC	17.26268	1 in 9
1907	125.8	SW	123.94	150			VC	31.89044	1 in 11
0806	114.49	SW	112.36	150			VC	11.7047	
1909		SW	0	150			VC	46.61545	
1803		SW	0	150			VC	29.83287	
2710		FO		100			VC	3.002564	
7817	96.24	CO	95.09	100			VC	5.385165	
8002		SW		350			BR	15	
1101		CO		100			VC	8.96483	
2202		CO		100			VC	28.11523	
9304		FO	0	150			VC	37.21559	
8007	105.05	SW	103.17	150			UN	27.84954	1 in 11
9209		SW	0	150			VC	55.9464	
8102		FO	0	150			VC	37.58989	
9303		SW	0	150			VC	40.31129	
0901		SW	0	150			VC	49.20366	
9005		SW		350			BR	107.7822	
9206		SW	0	150			VC	59.23681	
0001		SW	0	150			VC	39.40812	
8902	102.82	CO	101.13	225			UN	21.47883	1 in 10
0707		FO	0	150			VC	32.89377	
1801	122.98	SW	121.05	225			VC	65.06919	1 in 12
9907	108.69	CO	107.26	225			VC	15.40312	
0908		FO	0	150			VC	31.82766	
9905		CO	0	150			VC	5.385165	
0812		FO		150			VC	18.34823	
0708	114.58	SW	112.01	300			VC	35.1141	1 in 13
7203		SW	0	150			VC	25.17936	
8303	115.15	SW	110.67	150			VC	7.071068	1 in 54
9106		FO	0	150			VC	46.32494	
9902		CO	0	150			VC	4.123106	
1806		FO	0	150			VC	28.6007	
1906	123.17	SW	120.94	225			VC	27.51363	1 in 23
1802		SW	0	150			VC	16.64332	
0906	118.76	SW	117.6	225			VC	73.1095	1 in 16
0808	115.35	SW	113.2	225			VC	33.97058	1 in 16
7825		CO	0	225			VC	18.02776	
9002	114.48	CO	112.91	225			VC	55.60575	1 in 16
7808	96.72	CO	94.99	225			VC	13	1 in 23
0909		FO	0	150			VC	46.40043	
8302	115.2	FO	110.81	225			CI	26.4764	1 in 91
9005		SW		350			BR	110.0444	
9101		FO	0	150			VC	25.07987	
8901	105.43	CO	103.74	225			UN	16.85093	1 in 46
9913		CO	0	150			VC	58.66856	
0804		FO	0	150			VC	70.80086	
0201	124.01	CO	122.35	225			VC	24.75884	1 in 59
8907	100.67	CO	99.04	225			VC	52.35456	
8702	98.61	SW	96.83	600			CO	44.82187	1 in 70
8913	99.06	SW		150			UN	0.405786	
3906		FO		100			VC	6.374316	
8913	99.06	SW		150			UN	2.961271	
7208	111.1	SW	110.28	100			VC	17.11724	1 in 28
8203		FO	0	150			VC	6.708204	
8002		SW		350			BR	27.16615	
1709		FO		100			VC	27.28363	
3911		FO		100			VC	4.354749	
0101	117.6	CO	116.03	225			VC	57.27129	1 in 23
9211		FO	0	150			VC	38.47077	
8308		SW	0	150			VC	72.8011	
8103		SW	0	150			VC	19.23538	
7101	104.16	FO	100.36	300			VC	80.52328	1 in 25
9305		SW	0	150			VC	15.0333	
9914	113.11	SW	111.58	375			CO	12.52996	1 in 4
0002		FO	0	150			VC	72.62705	
3702		FO		100			VC	15.26878	
9906		CO	0	100			VC	16.76305	
9912		CO	0	150			VC	57.72348	
7308		FO		150			VC	12.47577	
7303		SW	0	150			VC	55.54278	
9802	110.68	SW	108.13	375			CO	61.55486	
1702		SW	0	300			VC	73.87828	
7907	98.81	CO	97.35	225			VC	59.71576	1 in 16
9105		SW	0	150			VC	35.77709	
3905		FO		100			VC	3.268412	
0709	115.86	SW	114.11	225			VC	18.38478	1 in 15
1707		FO	0	150			VC	50.20956	
7802	96.36	SW	93.27	600			CO	69.27621	1 in 57
2801	125.15	SW	123.56	225			VC	75.45197	
7805	96.26	SW	93.96	600			CO	31.38471	1 in 48
1905		FO	0	150			VC	73.37575	
2902		SW	0	150			VC	39.69887	
8703	99	SW	97.54	600			CO	29.41088	1 in 42
1001		CO		150			VC	21.01628	
1202		CO		100			VC	37.94819	
1704		FO	0	150			VC	41.72529	
9701	104.65	CO	102.49	225			VC	72.73238	1 in 16
7824	97.22	CO	96.24	150			VC	3.605551	
0104	120.68	SW	119.53	150			VC	36.23534	
7807	96.76	SW	94.99	600			CO	10.19804	1 in 10
7803	96.41	CO	93.66	300			VC	63.22031	1 in 30
8207		FO	0	150			VC	28.17801	
9208		FO	0	150			VC	32.64965	
2804	128.77	SW	0	225			VC	33.24154	
8905	105.75	CO	103.34	225			VC	69.34605	1 in 16
8903	106.19	CO	104.52	225			VC	8.10885	1 in 45
0810		FO	0	150			VC	86.95401	
9306		FO	0	150			VC	19.10497	
9001	115.06	CO	113.51	225			VC	13.60147	1 in 23
9204		FO	0	150			VC	59.9333	
8304		SW	0	150			VC	10.77033	
0202	123.61	CO	121.91	225			VC	53.41348	1 in 36
0712	114.03	SW	109.94	375			CO	56.08921	1 in 69
7202		FO	0	150			VC	26.1725	
7204	111.26	SW	109.66	100			VC	7.615773	
8910	105.49	SW	103.87	150			UN	19.13424	1 in 27
2705		FO		100			VC	7.800712	
0807		SW	0	150			VC	25.55387	
1904		FO	0	150			VC	16.76305	
8005	105.06	CO	103.37	225			UN	26.42221	1 in 12
0711		FO	0	150			VC	53.75872	
7826		CO	0	225			VC	2.828427	
8705	99.91	CO	97.74	225			VC	58.82177	1 in 51
0103	120.81	FO	119.41	150			VC	18.02776	
8201	111.64	FO	109.99	300			VC	12.67918	
1201	124.46	CO	123.15	225			VC	36.79674	1 in 47
9104		FO	0	150			VC	28.17801	
2806		FO	0	150			VC	41.40191	
2810		FO		100			VC	13.831	
8206	113.49	SW	110.48	225			VC	5.385165	
3717		FO		100			VC	8.108543	
9904		CO	0	150			VC	17.08801	
3907		FO	0	150			VC	87.45856	
8208		SW	0	150			VC	32.38827	
8202	113.65	FO	110.41	300			VC	60.36158	1 in 144
9901	107.79	CO	106.3	225			VC	28.36629	1 in 10

Refno	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad

LEGEND

Abandoned | Foul | Surface Water | Combined

- Public Sewer
- Private Sewer
- Section 104
- Rising Main
- Sludge Main
- Overflow
- Water Course
- Highway Drain

All point assets follow the standard colour convention:
red - combined blue - surface water
brown - foul purple - overflow

- HS Head of System
- ES Extent of Survey
- RE Rodding Eye
- IN Inlet
- DP Discharge Point
- HY Vortex
- PE Penstock
- WO Washout Chamber
- VA Valve
- AV Air Valve
- NRV Non Return Valve
- SO Soakaway
- GU Gully
- CA Cascade
- FM Flow Meter
- HA Hatch Box
- OI Oil Interceptor
- SM Summit
- DS Drop Shaft
- OP Orifice Plate
- Manhole
- Side Entry Manhole
- Outfall
- Screen Chamber
- IC Inspection Chamber
- Bifurcation Chamber
- LH Lamp Hole
- T Junction / Saddle
- CA Catchpit
- VC Valve Chamber
- Vent Column
- Vortex Chamber
- Penstock Chamber
- T Network Storage Tank
- V Sewer Overflow
- WwTW Ww Treatment Works
- Ww Pumping Station
- ST Septic Tank
- CK Control Kiosk
- Change of Characteristic

MANHOLE FUNCTION

- FO Foul
- SW Surface Water
- CO Combined
- OV Overflow

SEWER SHAPE

- CI Circular
- TR Trapezoidal
- EG Egg
- AR Arch
- OV Oval
- BA Barrel
- FT Flat Top
- HO HorseShoe
- RE Rectangular
- UN Unspecified
- SQ Square

SEWER MATERIAL

- AC Asbestos Cement
- BR Brick
- PE Polyethylene
- RP Reinforced Plastic Matrix
- CO Concrete
- CSB Concrete Segment Bolted
- CSU Concrete Segment Unbolted
- CC Concrete Box Culverted
- PSC Plastic / Steel Composite
- GRC Glass Reinforced Plastic
- DI Ductile Iron
- PVC Polyvinyl Chloride
- CI Cast Iron
- SI Spun Iron
- ST Steel
- VC Vitrified Clay
- PP Polypropylene
- PF Pitch Fibre
- MAC Masonry, Coursed
- MAR Masonry, Random
- U Unspecified

Address or Site Reference:

Land at Ivy Mill,

Scale: 1:1250 **Date:** 22/05/2019

Sheet: 1 of 1

Printed by: Property Searches

SEWER RECORDS

United Utilities
helping life flow smoothly