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NPPF: Flood Risk Assessment

Station Road, Wombwell

Hartwood Estates Ltd

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'Experience and expertise working in union'

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Station Road, Wombwell

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Executive Summary

This report presents an FRA in accordance with the NPPF and NPPG ID: 7 guidance, for the proposed residential development, located on land north of Station Road, Wombwell.

The FRA has demonstrated the following:

- The 3.80-hectare (ha) Site is comprised of a field with the foundations of a former commercial building with associated parking.
- The River Dove conveys flow east along the northern boundary of the Site. Bulling Dike conveys flow south-east along the south-western boundary of the Site.
- The risk of flooding is assessed as followed:
    - The risk of fluvial flooding from Bulling Dike and the River Dove is medium for the eastern, southern, and central parts of the Site, with the north-western corner, the south-western part of the Site and small areas towards the centre at low risk.
    - The risk of surface water flooding for most of the Site is assessed as negligible. There are three small areas of ponding in the north of the Site at low risk and a surface water flow pathway along Bulling Dike at high risk.
    - The risk of sewer flooding is low.
    - The risk of flooding from all other sources is assessed as negligible.

Flood Risk from identified sources can be mitigated to a negligible or low risk and therefore acceptable level through the following approach:

- Set the finished floor levels of all buildings above the 1 in 100-year (plus 35% climate change) flood level with freeboard allowance.
- Retain external levels as close to existing as feasible.
- Provide level-for-level compensatory flood storage within Flood Zone 2 when the lifetime of the development is considered.
- Provide an easement free from development along the right bank of the River Dove and along both banks of Bulling Dike.
- Production of a Flood Evacuation Management Plan (FEMP) for the proposed development.
- Utilise flood resilient construction.
- Adoption of a surface water management strategy.
- Undertake maintenance activities to keep Bulling Dike clear from debris and overgrown vegetation to maintain the conveyance of the channel.
- Provide easements free from development along the onsite public sewers.

The proposed residential development is classified as ‘more vulnerable’, which is considered acceptable in Flood Zones 1 and 2. As such, the Sequential Test will be passed, and the Exception Test would not be required.

The FRA has considered the potential impact of the development on surface water runoff rates. It has been demonstrated that surface water can be managed, such that flood risk to and from the Site following development will not increase. This will be achieved through restricted discharge rates and appropriately sized attenuation features, with an outfall to watercourse.

1.0 Introduction

1.1 Background

1.1.1 Enzygo Ltd was commissioned by Hartwood Estates Ltd to carry out a site-specific Flood Risk Assessment (FRA) including a surface water drainage strategy in support of an outline planning application for a proposed residential development, located on land north of Station Road, Wombwell (hereafter referred to as 'the Site').

1.1.2 The proposal is for a 113-unit development, with associated tree plantings, pedestrian route, and access roads on the 3.80-hectare (ha) Site. A copy of the proposed layout is in Appendix 1.

1.1.3 Planning applications for development in England require an FRA[1], when:

- In Flood Zone 2 or 3 including minor development and change of use.
- More than 1 hectare (ha) in Flood Zone 1.
- Less than 1 ha in Flood Zone 1, including a change of use in development type to a more vulnerable class (for example from commercial to residential), where they could be affected by sources of flooding other than rivers and the sea (for example surface water, drains, reservoirs).
- In an area within Flood Zone 1 which has critical drainage problems as notified by the Environment Agency.
- In land identified in a strategic flood risk assessment as being at increased flood risk in future

1.1.4 Initial site screening using Environment Agency online indicative flood mapping shows that areas within the Site are located within Flood Zone 1 and 2 and the Site is more than 1 hectare (ha) in area (3.80ha) and is at risk of surface water flooding. As such, an FRA is required.

1.1.5 The purpose of this FRA is to assess the risk of flooding to the proposed development and where possible provide sufficient mitigation to demonstrate that the future users of the development would remain safe throughout its lifetime, that the development would not increase flood risk on Site and elsewhere and, where practicable, that the development would reduce flood risk overall.

1.2 Scope of the Assessment

1.2.1 Government policy on development and flood risk is set out in the National Planning Policy Framework (NPPF) [2] and the supporting National Planning Practice Guidance: Flood Risk and Coastal Change [NPPG ID7] [3].

1.2.2 NPPF paragraphs 148-169 set out the need for an appropriate assessment of flood risk at all levels of the planning process and requires the application of a sequential risk-based approach to assess the suitability of land for development in flood risk areas.

[1] https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications
[2] Department for Communities and Local Government (2019) National Planning Policy Framework.
[3] Department for Communities and Local Government (2014) Planning Practice Guidance ID7-030-20140306; Flood Risk & Coastal Change.

1.2.3 The FRA should also consider the effects of climate change[4]. The climate change allowances are predictions of anticipated change for:

- Peak river flow by river basin district;
- Peak rainfall intensity;
- Sea level rise; and
- Offshore wind speed and extreme wave height.

1.2.4 They are based on climate change projections and different scenarios of carbon dioxide emissions to the atmosphere. There are different allowances for different periods of time over the next century.

1.2.5 Site-specific FRAs are categorised according to level. Simple Level 1 Screening studies give a general indication of the potential flood risk to a site and identify whether more detailed Level 2 assessment is required. A Level 2 assessment is a qualitative appraisal to develop understanding of flood risk to a site and the effects of the site on flooding elsewhere including recommended mitigation measures. Level 2 reporting is the minimum required to accord with the NPPF. Level 3 assessments are more detailed quantitative studies, for example modelling to establish flood levels at a site in the absence of Environment Agency or other data or providing detailed outline drainage designs.

1.2.6 This report is a Level 2 qualitative FRA but includes a Level 3 assessment of the surface water drainage requirements for the proposed development.

1.3 Aims

1.3.1 This FRA aims to provide sufficient flood risk information to satisfy the requirements of the NPPF, PPG ID7 and regional/local government plans and policies. It describes the potential for the Site to be impacted by flooding, the impacts of the proposed development on flooding elsewhere near the Site, and the proposed measures that could be incorporated into the development to mitigate the identified risks.

1.4 Planning Context

National Policy

1.4.1 The FRA was prepared in accordance with the NPPF and NPPG ID7.

Regional/Local Policy

1.4.2 The FRA also considers the following policies within the Barnsley Metropolitan Borough Council Local Plan (2019 to 2033):

- Policy CC1- Climate Change: Reduce the causes of and adapt to the future impacts of climate change
- Policy CC3- Flood Risk: Reducing the extent and impact of flooding
- Policy CC4- Sustainable Drainage Systems (SuDS): The use of SuDS on major and minor developments

[4] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

1.5 Report Structure

1.5.1 This report is structured as follows:

- Section 2 identifies the sources of information that were consulted;
- Section 3 describes the Site and the existing and proposed development;
- Section 4 outlines the flood risk to the existing site and proposed development;
- Section 5 details the proposed mitigation measures against identified flooding sources;
- Section 6 assesses the potential impacts of the proposed development on surface water drainage and proposes mitigation for those effects; and
- Section 7 presents a summary and conclusions.

2.0 Sources of Information

2.1 Sources of Information

2.1.1 The following information was used in preparation of this FRA:

- Ordnance Survey 1:25,000 mapping (Explorer 278: Sheffield & Barnsley).
- Detailed topographic survey (Appendix 2).
- Environment Agency online mapping (Flood Map for Planning[5], Long Term Flood Risk Assessment for Locations in England[6], Catchment Data Explorer[7] and Main River Map[8]).
- River Basin District (RBD) Maps[9] (Humber RBD) together with guidance on climate change allowances[10].
- National River Flow Archive[11].
- Barnsley Strategic Flood Risk Assessment (SFRA) and associated mapping (Appendix 3).
- The SuDS Manual.
- British Hydrological Society Chronology of British Hydrological Events[12].
- National Soils Resources Institute (NSRI): Soilscapes online mapping[13].
- British Geological Survey [BGS] online mapping: Geology of Britain Viewer[14].
- Landmark's Promap: Flood Data package: Additional flood mapping.
- Geosmart 1 in 100-year groundwater flood risk map.
- Yorkshire Water sewer asset plans (Appendix 4).
- DEFRA's Magic Map[15] for identifying Designated Sites.

2.2 Consultation and Discussion with Regulators

2.2.1 Consultation and discussions were undertaken with the Environment Agency, the Local Planning Authority (LPA)/Lead Local Flood Authority (LLFA), and Water Utility.

Environment Agency

2.2.2 The Environment Agency is a statutory consultee on flood risk and planning and is directly responsible for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas; and it has a strategic overview for all forms of flooding.

[5] https://flood-map-for-planning.service.gov.uk/
[6] https://flood-warning-information.service.gov.uk/long-term-flood-risk/
[7] http://environment.data.gov.uk/catchment-planning/
[8] https://environment.maps.arcgis.com/apps/webappviewer/index.html?id=17cd53dfc524433980cc333726a56386
[9] https://www.gov.uk/government/publications/flood-risk-assessments-river-basin-district-maps
[10] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances
[11] http://nrfa.ceh.ac.uk
[12] http://www.cbhe.hydrology.org.uk/search.php
[13] http://www.landis.org.uk/soilscapes/
[14] http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[15] http://www.natureonthemap.naturalengland.org.uk/

2.2.3 Environment Agency Standing Advice[16] and the NPPF/NPPG ID: 7 was consulted and reviewed.

2.2.4 Correspondence with the Environment Agency is included in Appendix 5.

Barnsley Metropolitan Borough Council

2.2.5 Barnsley Metropolitan Borough Council as the LLFA responsible for surface water, groundwater and ordinary watercourses was consulted on flood risk issues at this Site. The response received stated that Enzygo Ltd have more information on the Site than the Council and should further information be required the Environment Agency and Internal Drainage Board should be contacted.

2.2.6 Correspondence with Barnsley Metropolitan Borough Council is included in Appendix 6.

Yorkshire Water

2.2.7 All Water Companies have a statutory obligation to maintain the DG5 Flood Register of properties which are at risk of flooding from the public sewerage system.

2.2.8 Yorkshire Water is responsible for the disposal of wastewater within the area.

2.2.9 A copy of the Yorkshire Water pre-planning report is included in Appendix 4.

Danvm Drainage Commissioners Internal Drainage Board

2.2.10 Internal Drainage Boards manage water levels, flood risk and land drainage.

2.2.11 Danvm Drainage Commissioners Internal Drainage Board (IDB) is responsible for managing Bulling Dike at the Site.

2.2.12 Correspondence with the IDB is included in Appendix 7.

2.3 Site Walkover

2.3.1 Enzygo staff conducted a walkover of the Site in February 2019. Observations made were used to inform the Site description.

[16] https://www.gov.uk/guidance/flood-risk-assessment-standing-advice

3.0 Site Location and Description

3.1 Location

3.1.1 The Site is located on land north of Station Road, Wombwell, S73 0BJ.

3.1.2 The Site is centred on National Grid Reference (NGR) 440492, 403647.

3.1.3 The Site location is shown in Drawing 001 and in more detail in Drawing 002, which shows the red line boundary enclosing an area of 3.80ha.

3.2 Land Use

3.2.1 The land use comprises a demolished industrial unit which included parking areas and internal roads. The remnants of these areas of hardstanding are still present along with scrubland a number of spoil heaps (Figure 3.1).

3.2.2 The Site is bounded by woodland to the north-west, the River Dove to the north, residential properties and gardens to the east, Station Road to the south-east and commercial units to the south-west (Figure 3.2). Bulling Dike flows through the southern extent of the Site, (see Figure 3.11).

3.2.3 The Site is currently accessed via Station Road on the south-east boundary. A second access is located off Valley Road on the south-western boundary.

Figure 3.1: Photographs of Site (continues over page)

***Top**: View from north west corner of Site looking south. **Bottom:** View from north west corner of Site looking east.*

Figure 3.2: Aerial Photograph of Site

Image © 2018 Digital Globe

3.3 Topographic Information

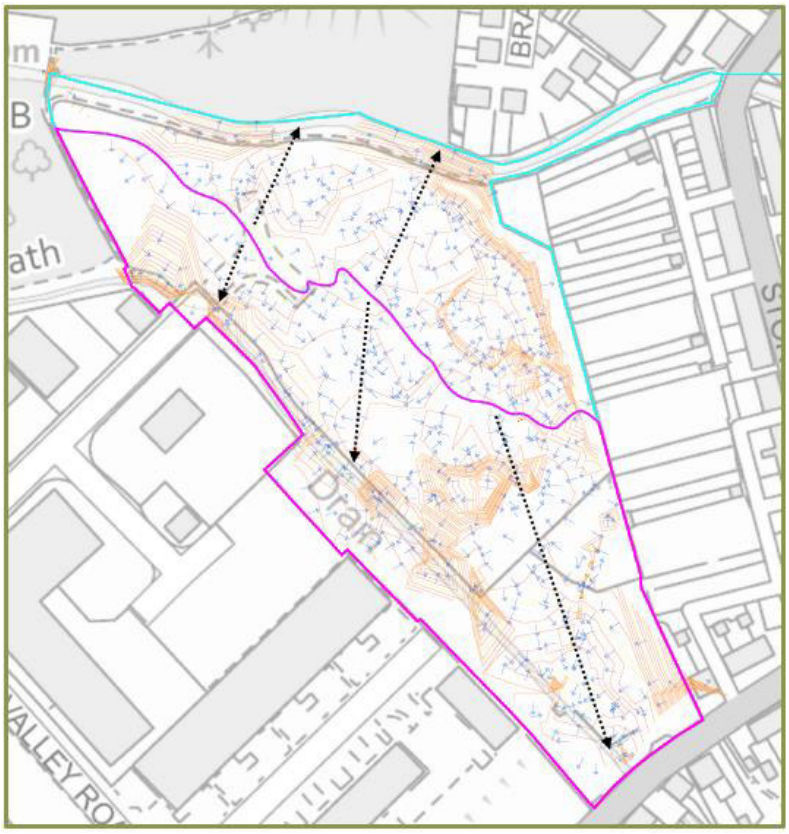
3.3.1 A detailed topographic survey was carried out during March 2019 (Appendix 2). The Site generally falls in a south easterly direction from 27.08 metres Above Ordnance Datum (m

AOD) (located in the north western corner) to 24.82m AOD (located along the south-western boundary). The fall of 2.26m over approximately 305m gives a gradient of 1:135.

3.3.2 In addition, the northern extent of the Site falls north-east towards the River Dove from 26.90m AOD (located within the central-north-western part of the Site) to 26.35m AOD (located close to the River Dove on the central-northern boundary of the Site). The fall of 0.55m over approximately 60m gives a gradient of 1:110.

3.3.3 The south-western extent of the Site falls south-west towards Bulling Dike from 26.90m AOD (located within the central-north-western part of the Site) to 26.27m AOD (located close to Bulling Dike within the central-south-western part of the Site). The fall of 0.63m over approximately 40m gives a gradient of 1:64.

Figure 3.3: Site Topography



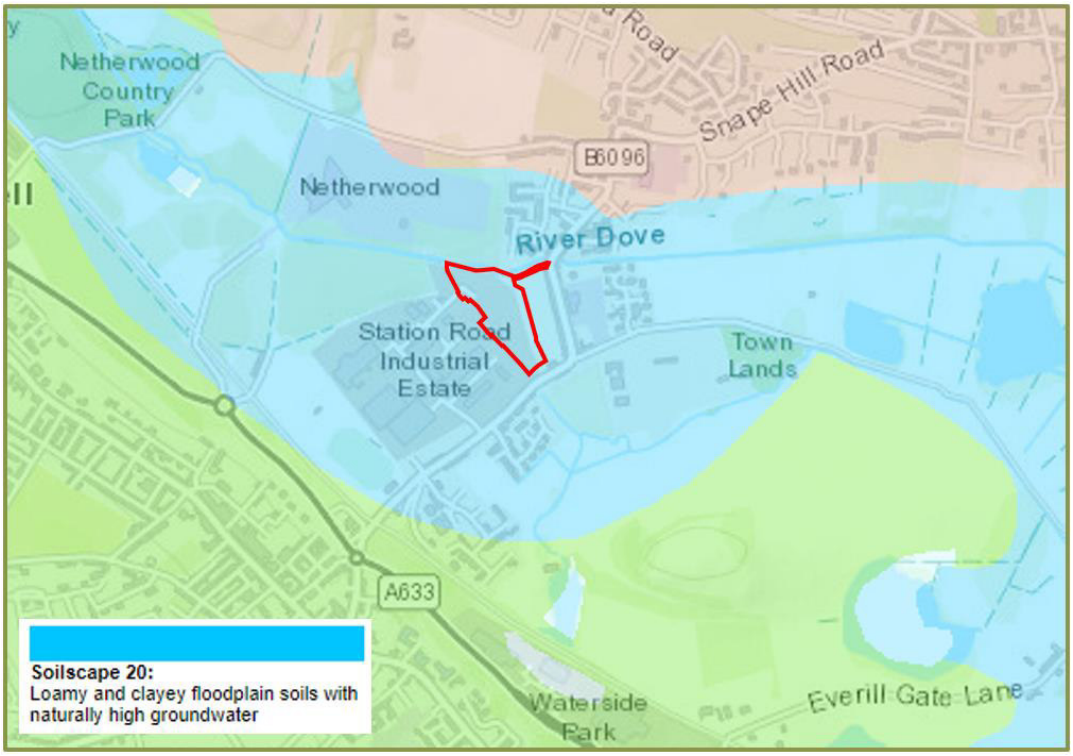
3.4 Soils and Geology

3.4.1 The Soilscapes online soils map viewer shows that the Site is underlain by loamy and clayey floodplain soils with naturally high groundwater (Figure 3.4). The soil is indictive of poor infiltration potential.

3.4.2 The Geology of Britain online map viewer shows that there are Alluvium (clay, silt, sand and gravel) superficial deposits beneath the Site (Figure 3.5). The bedrock beneath most of the Site is Pennine Middle Coal Measures Formation (mudstone, siltstone and sandstone). The bedrock beneath the north-east of the Site is Ackton Rock (sandstone) (Figure 3.5).

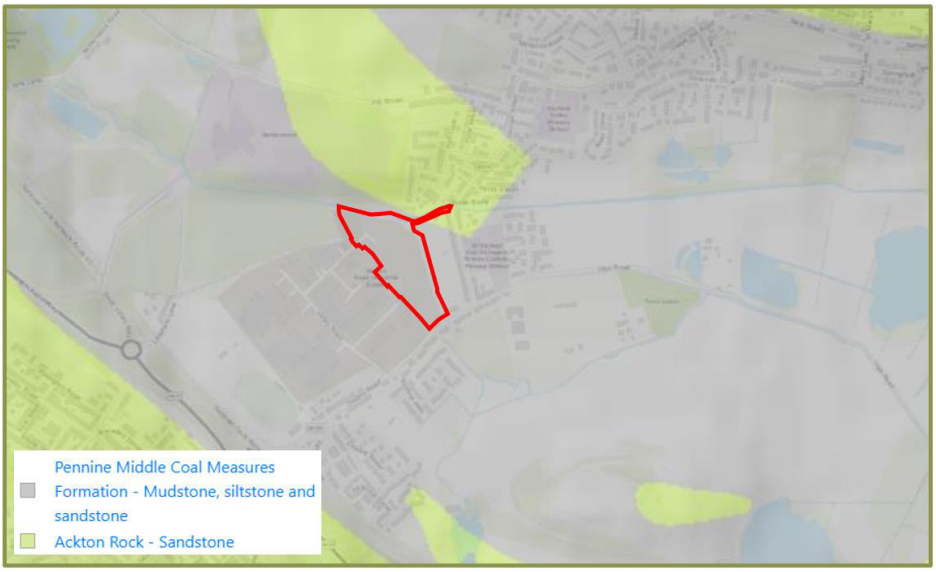
3.4.3 The Site is brownfield (that is, it has previously been developed) and will include Made Ground (man-made deposits such as embankments, infills and spoil heaps on the natural ground surface) of variable composition, location and depth.

Figure 3.4: Soilscapes Soils Mapping



Soils Data © Cranfield University (NSRI) and for the Controller of HMSO [2018].

Figure 3.5: Bedrock Geology and Superficial Deposits (continues over page)

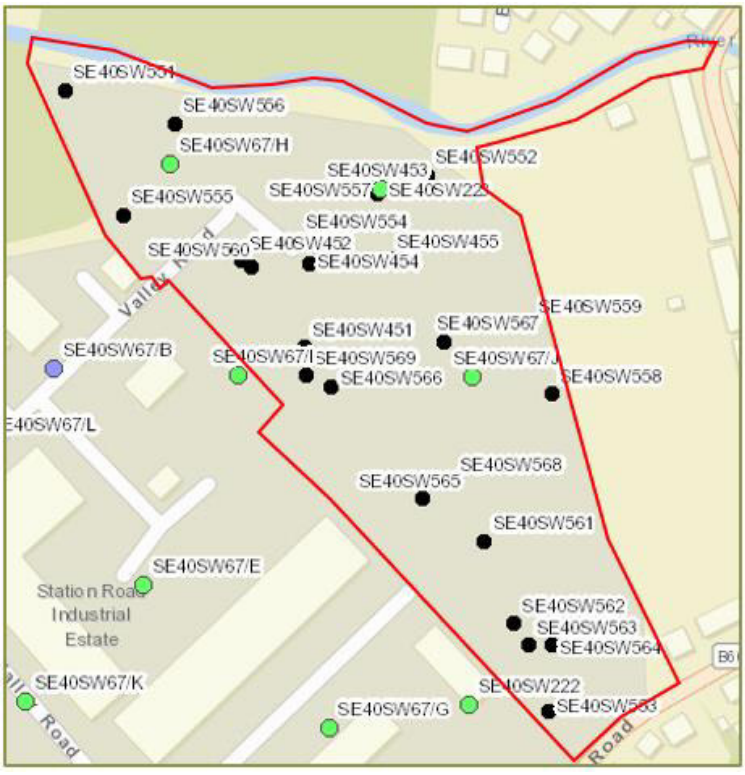


***Top:** Bedrock Geology **Bottom:** Superficial Deposits. Contains British Geological Survey materials © NERC [2018].*

3.4.4 The Geology of Britain online map viewer (Figure 3.6) shows there are five borehole logs located within, or close to, the Site boundary containing accessible data (SE40SW223, SE40SW67/H, SE40SW67/I, SE40SW67/J, and SE40SW222). Numerous additional borehole logs exist within the Site, but these are listed as classified and therefore cannot be accessed.

3.4.5 The borehole logs confirm the bedrock geology as depicted by the Geology of Britain mapping (Table 3.1) as well as the presence of Made Ground at depths up to 2.5m Below Ground Level (bgl). Copies of the borehole logs are included in Appendix 8.

Figure 3.6: Borehole Mapping



Contains British Geological Survey materials © NERC [2018]

Table 3.1: Borehole Summary

Reference	Depth (m)	Groundwater Depth (m)	Geology (mbgl)
SE40SW223	20.55	Not recorded	Topsoil (to 0.20), sand, clay and gravel interbedded (to 7.6), mudstone (to 17.5), sandstone and mudstone interbedded (to 20.55)
SE40SW67/H	16.40	4.65	Topsoil (to 0.20), made ground (to 2.50), clay (to 4.65), sand and gravel (to 9.10), clay (to 9.40), mudstone (to 14.20), siltstone (to 14.50), made ground (to 15.80), mudstone (to 16.40)
SE40SW67/I	14.00	3.25	Topsoil (to 0.20), made ground (to 1.60), clay (to 5.80), sand and gravel (to 7.45), mudstone and siltstone interbedded (to 14.00)
SE40SW67/J	15.50	0.30	Topsoil (to 0.20), made ground (to 2.50), clay (to 4.20), sand and gravel (to 8.90), clay (to 9.00), mudstone and siltstone (to 12.20), made ground (to 14.20), mudstone and siltstone (to 15.50)
SE40SW222	11.35	Not recorded	Topsoil (to 0.20), clayey sand (to 0.35), mudstone (to 1.45), topsoil (to 1.6), clayey sand (to 1.7), sandy clay (to 2.45), sand and gravel (to 7.1), clay (to 7.25, sand (to 7.45), mudstone (to 9.2), workings containing mudstone (to 9.9), mudstone fragments (to 11.05), sandstone (to 11.35)

3.5 Hydrogeology

Borehole Logs

3.5.1 BGS online borehole mapping (Figure 3.6 and Table 3.1) shows groundwater ingress was encountered in four of the five boreholes between 0.30 and 4.65m Below Ground Level (bgl).

Magic Map

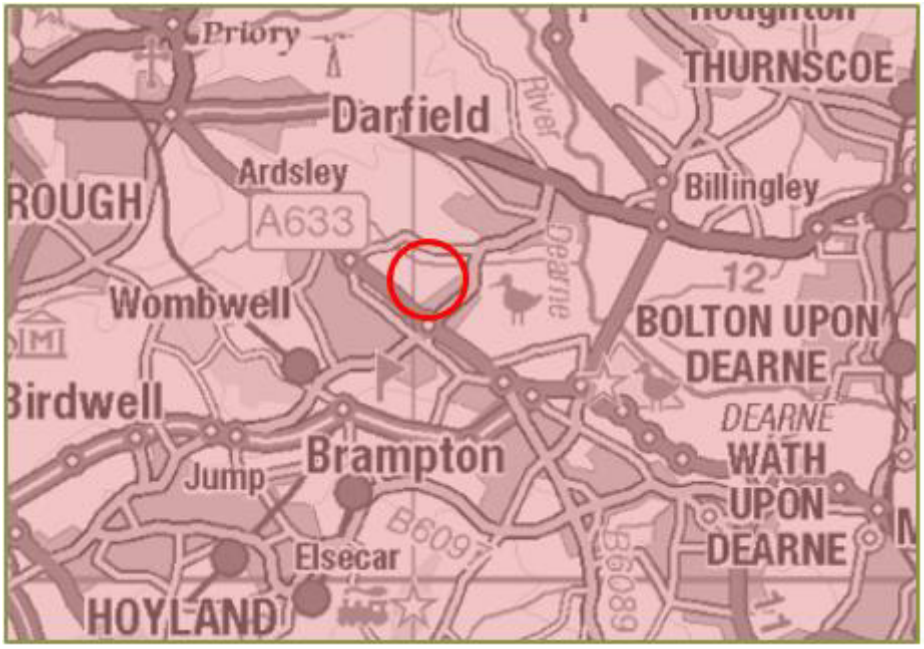
3.5.2 Magic Map online mapping (Figure 3.7) shows the Site is not located in a groundwater Source Protection Zone (SPZ).

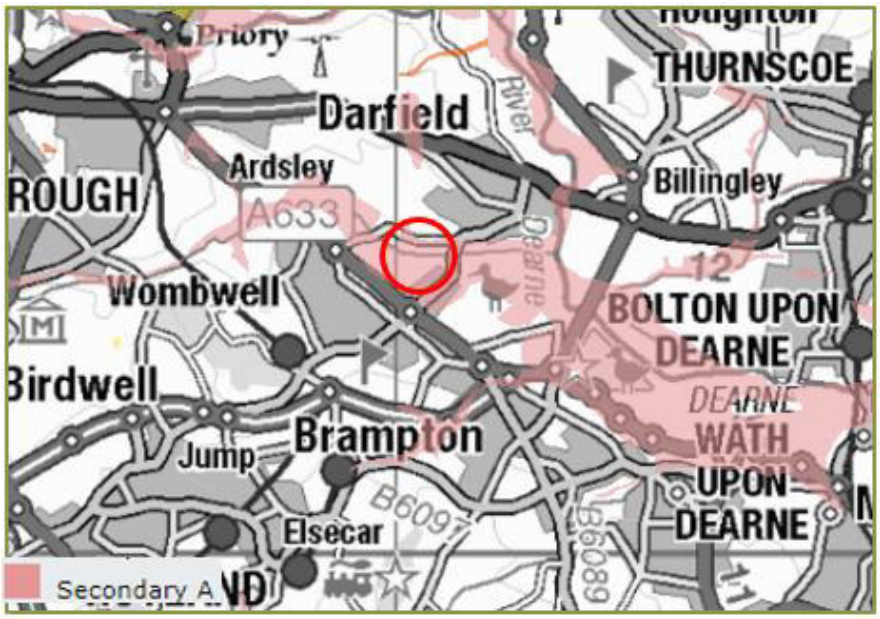
Figure 3.7: Source Protection Zone Map

From Magic Map. Contains Environment Agency information © Environment Agency and database right.

3.1.1 The Site is not located above a Principal Aquifer. The Site is located above a Secondary A bedrock and superficial Aquifer (Figure 3.8)

Figure 3.8: Aquifer Designation Map (continues over page)





Top: *Bedrock Aquifer Mapping* ***Bottom:*** *Superficial Aquifer Mapping.*

From Magic Map. Contains Environment Agency information © Environment Agency and database right.

3.1.2 The superficial Alluvium (clay, silt, sand and gravel) deposits are likely to have a high permeability.

3.2 Catchment Hydrology

Main Rivers Map

3.2.1 The Environment Agency Main Rivers Map identifies the River Dove as the nearest main river (where flood risk work is carried out by the Environment Agency), located along the northern boundary of the Site, which conveys flow east (Figure 3.9).

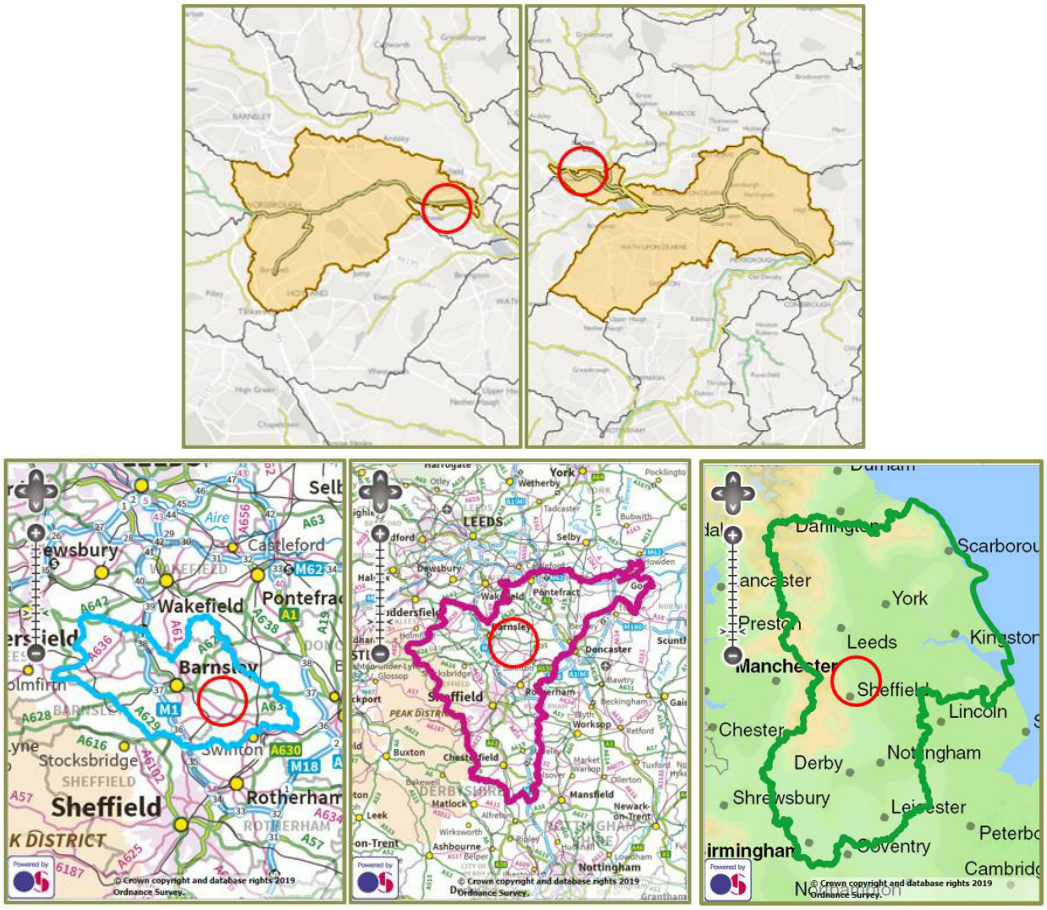
Figure 3.9: Environment Agency Main Rivers Map

Contains Environment Agency information © Crown copyright and database rights 2018

Environment Agency Catchment Data Explorer

3.2.2 The north of the Site is within the Dove from Source to River Dearne Catchment and the south of the Site is in the Dearne Darfield Sewerage Treatment Works to River Catchment. The Site is in the Dearne Operational Catchment, which is in the Don and Rother Management Catchment, both lie within the Humber River Basin District (Figure 3.10).

Figure 3.10: Environment Agency Catchment Explorer Mapping



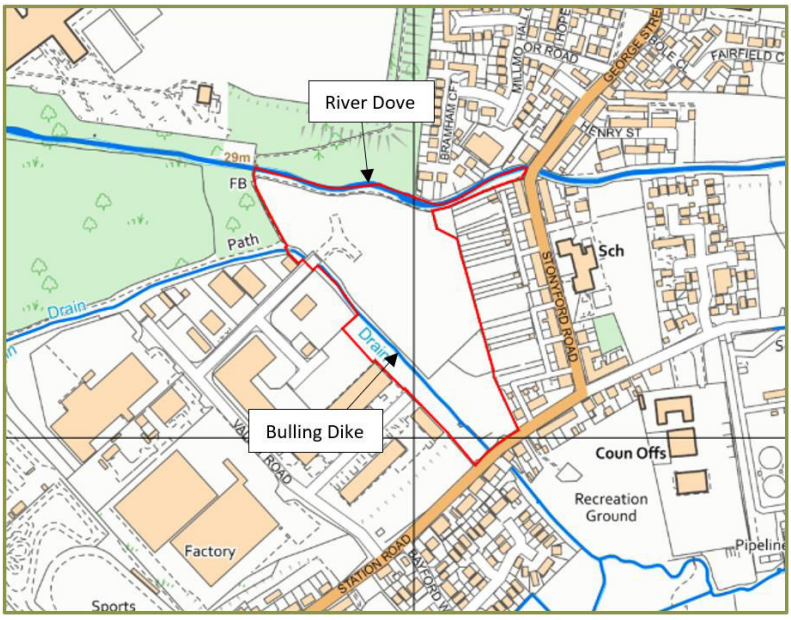
Top Left: *Dove from Source to River Dearne Catchment.* ***Top Right:*** *Dearne Darfield Sewerage Treatment Works to River Don Catchment* ***Bottom Left:*** *Dearne Operational Catchment.* ***Bottom Centre:*** *Don and Rother Management Catchment.* ***Bottom Right****: Humber River Basin District.* Contains Environment Agency information © Environment Agency and database right

3.2.3 The catchment boundaries and areas within the study area have been verified through flow pathway analysis using the topographic survey within Causeway Professional Design Systems (PDS) (Drawing 011). The 'Northern Area' (draining to the River Dove) measures 1.40ha and the 'Southern Area' (draining to Bulling Dike) measures 2.40ha.

Ordnance Survey Mapping

3.2.4 Ordnance survey (OS) mapping shows the River Dove conveys flow east along the northern boundary of the Site. Bulling Dike conveys flow south-east along the south-western boundary of the Site (Figure 3.11). Drawing 002 shows two fishing lakes located approximately 600m, and 750m north-west of the Site. Both lakes are natural and not impounded.

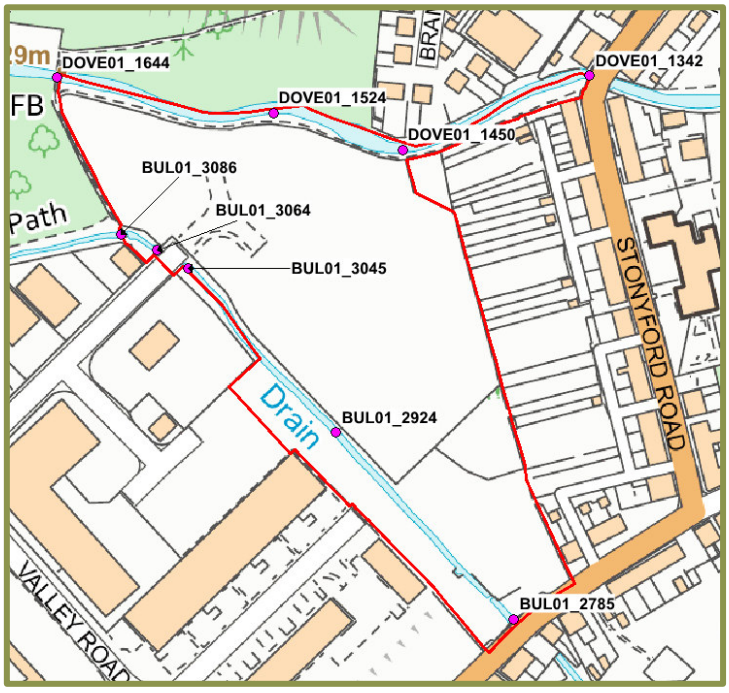
Figure 3.11: Site Watercourses



Watercourse Levels

3.2.5 Enzygo Ltd completed a hydraulic modelling exercise for the River Dove and Bulling Dike which commenced in 2016 and resulted in an update to the Environment Agency Flood Map for Planning in July 2018 (Appendix 5). Watercourse bed and bank levels at the Site have been taken from cross-sections within the Enzygo Ltd hydraulic model of the River Dove and Bulling Dike. Four locations have been identified along the River Dove and five locations along Bulling Dike (Figure 3.12). The bed and bank elevations for each cross-section are included in Table 3.2.

Figure 3.12: Model cross-section locations



3.2.6 The River Dove has a bed level of 24.86m AOD at the footbridge in the north-western corner of the Site falling to 24.02m AOD immediately upstream of the Stonyford Road bridge on the north-eastern boundary of the Site (Table 3.2). Left bank levels are 28.37m AOD at the footbridge, 25.42 to 25.83m AOD along the middle of the northern boundary, and 28.42m AOD at Stonyford Road. Right bank levels are 28.01m AOD at the footbridge, 26.12 to 26.67m AOD along the middle of the northern boundary, and 26.71m AOD at Stonyford Road. The bed gradient for the River Dove at the Site is approximately 1:360.

3.2.7 Bulling Dike has a bed level of 23.99m AOD at the footbridge on the western boundary of the Site falling to 23.39m AOD within the central south-western part of the Site before rising slightly to 23.46m AOD at the Station Road culvert on the south-eastern boundary of the Site. Left bank levels are 25.70m AOD on the western boundary, between 25.36 and 25.82 m AOD within the central south-western part of the Site and 25.46m AOD on the south-eastern boundary. Right bank levels are 23.99m AOD on the western boundary, between 25.08 and 25.78 within the central south-western part of Site, and 25.15 on the south-eastern boundary. The bed gradient for Bulling Dike at the Site is approximately 1:570.

Table 3.2: Watercourse Bed and Bank Levels

Point	Level (m AOD)		
	Left Bank	Bed	Right Bank
DOVE01_1644	28.37	24.86	28.01
DOVE01_1524	25.42	24.20	26.67
DOVE01_1450	25.83	24.03	26.12
DOVE01_1342	28.42	24.02	26.71
BUL01_3086	25.70	23.99	25.96
BUL01_3064	25.82	23.88	25.70
BUL01_3045	25.52	23.81	25.78
BUL01_2924	25.36	23.39	25.08
BUL01_2785	25.49	23.46	25.15

Structures

3.2.8 There are three in-channel structures present on the River Dove at, adjacent to, or upstream of the Site; a new bridge located approximately 400m upstream of the Site at Netherwood Academy (Grid Ref. 439991 403853), a footbridge located on the north-western boundary of the Site and Stonyford Road bridge located on the eastern boundary (Figure 3.13). The new bridge was built in 2012 as part of the Academy and replaced a dilapidated Pitt Bridge. The new bridge is a free-spanning type with a soffit level of 29.81m AOD (3.33m above bed level). The footbridge has a soffit level of 26.66m AOD (1.8m above bed level). Stonyford Road bridge has a single arch opening with a springing level of 24.94m AOD and a soffit level of 26.59m AOD. All levels taken from the Enzygo Ltd hydraulic model.

Figure 3.13: River Dove Structures

Top Left: *New Bridge.* ***Top Right:*** *River Dove footbridge.* ***Bottom:*** *Stonyford Road Bridge.*

3.2.9 There are three in-channel structures present on Bulling Dike at, or adjacent to, the Site; a footbridge located on the western boundary of the Site, Valley Road bridge at the secondary access location, and the Station Road culvert on the south-eastern boundary of the Site (Figure 3.14). The footbridge has two arch openings; the left opening has a left springing level of 24.07m AOD, a right springing level of 23.95m AOD and a soffit level of 24.70m AOD, the right opening has a left springing level of 24.19m AOD, a right springing level of 24.45m AOD and a soffit level of 24.70m AOD. The Valley Road bridge has a single rectangular opening with a soffit of 26.10m AOD (2.3m above bed level). The Station Road culvert has a single rectangular opening with an upstream soffit of 24.76m AOD (1.3m above bed level), a downstream soffit of 24.67m AOD (1.21m above bed level) a is 31m long. All levels taken from the Enzygo Ltd hydraulic model.

Figure 3.14: Bulling Dike Structures (continues over page)

Top Left: *Bulling Dike footbridge.* ***Top Right:*** *Valley Road Bridge.* ***Bottom:*** *Station Road Culvert.*

Site Walkover Observations

River Dove

3.2.10 The River Dove was observed to flow unobstructed along the northern boundary of the Site at the time of visit (Figure 3.15). Wooded vegetation was observed on the northern bank of the River Dove and scrub on the southern bank with a footpath running along it.

Figure 3.15: River Dove

Left: *View upstream of the Site.* ***Right:*** *View downstream of the Site.*

Bulling Dike

3.2.11 Bulling Dike was observed to be overgrown with vegetation at the time of visit (Figure 3.16). The reeds and algae in the central reach within the Site are indicators of low velocity flow within the watercourse.

Figure 3.16: Bulling Dike

Left: *View upstream from the south-west corner of the Site.* ***Right:*** *View downstream from the south-west corner of the Site.*

Drainage Cut

3.2.12 During the Site walkover, a drainage cut, with north to south orientation, was observed to cross the centre of the Site (Figure 3.17). The cut was not conveying flow and was vegetated with rough grass at the time of visit (Figure 3.18).

Figure 3.17: Drainage Cut Location

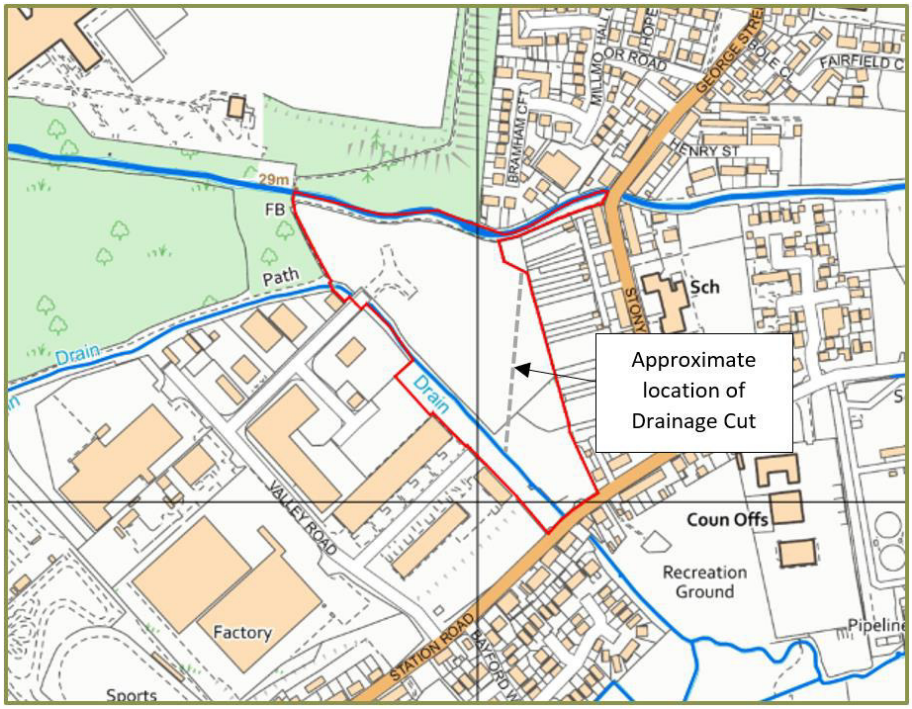


Figure 3.18: Drainage Cut

Left: *View north along Drainage Cut.* ***Right:*** *View south along Drainage Cut.*

3.3 Sewerage Assets

3.3.1 Yorkshire Water asset plans show there are two public surface water sewers out falling to Bulling Dike in the south-west corner of the Site; the more northerly is a Ø675mm diameter while the more southerly is a Ø225mm diameter. The sewers serve Station Road and the industrial units on Valley Road.

3.3.2 There is a Ø600mm diameter public surface water sewer serving the Bramham Croft residential area north of the Site and which outfalls to the River Dove via the left bank immediately north of the Site.

3.3.3 A Ø600mm diameter public combined sewer runs south-east within the south-western boundary of the Site. The sewer then follows Station Road north-east to a Sewage Treatment Works located south of Ings Road approximately 250m east of the Site.

3.4 Designated Sites

3.4.1 The DEFRA Magic Map (England and Wales)[17] shows the Site lies within Denaby Ings (Site of Special Scientific Interest [SSSI]) Impact Risk Zone – to assess planning applications for likely impacts on SSSIs/SACs/SPAs & Ramsar Sites.

3.4.2 The Site and wider area are located within a Surface Water Nitrate Vulnerable Zone (NVZ).

3.4.3 Development of the Site would include SuDS to manage surface water runoff. The use of SuDS would improve the water quality of surface water runoff, thereby providing mitigation measures from the proposed development and would offer a betterment to existing conditions.

3.4.4 As such, the proposed development would not pose a significant hydrological impact on the above designated site status or NVZ.

[17] http://www.natureonthemap.naturalengland.org.uk/MagicMap.aspx

4.0 Flood Risk Assessment

4.1 Potential Sources of Flooding

4.1.1 A summary of the potential sources of flooding and the potential risk posed by each source at the Site is presented in Table 4.1. Each source of flooding and level of risk is then assessed in further detail.

Table 4.1: Potential Risk Posed by Flooding Sources

Flooding Source	Potential Flood Risk at Application Site (Yes/No)	Potential Source	Data Sources
Fluvial	Yes	River Dove and Bulling Dike	Environment Agency flood mapping (Drawings 005 and 008), JBA mapping (Drawing 004.2), SFRA mapping (Appendix 3)
Tidal	No	None identified	Environment Agency flood mapping (Drawing 005) and Site location (Drawing 001)
Groundwater	Yes	Aquifers	BGS mapping (Drawing 003) and Geosmart Groundwater (Drawing 006)
Surface Water	Yes	Poor permeability, impermeable surfaces	Environment Agency online flood mapping, SFRA mapping (Appendix 3), JBA mapping (Drawing 004.1), Environment Agency Complex mapping (Drawing 009.1-009.4)
Sewer	Yes	Public sewers	Yorkshire Water Asset plans (Appendix 4), topographic survey (Appendix 2)
Infrastructure Failure	Yes	Reservoir failure	Environment Agency online flood mapping, OS mapping, Environment Agency consultation (Appendix 5)

4.2 Flood History

4.2.1 The SFRA historic flood mapping (Appendix 3) shows the Site flooded in March 1947 and June 2007.

4.2.2 The Environment Agency Historic Flood Events (Drawing 008) shows that there have been two historical flooding events within the Site boundary. In March 1947, the north-west of the Site was inundated, with a small area in the west of the Site also affected. In June 2007, most of the Site was flooded, with only the centre shown to be free from flooding.

4.3 Flood Defences

4.3.1 SFRA mapping (Appendix 3) and Environment Agency online flood mapping shows that the Site does not benefit from flood defences. Defences on the River Dove are present approximately 350m downstream of the Site.

4.4 Flood Warning Service

4.4.1 Online River Levels UK mapping[18] shows the Site is located within two flood warning areas; the River Dove from Aldham Bridge to Low Valley including Wombwell Ings Caravan Site (Figure 4.1); and the River Dearne Catchment (Figure 4.2).

Figure 4.1: River Dove Flood Warning Area

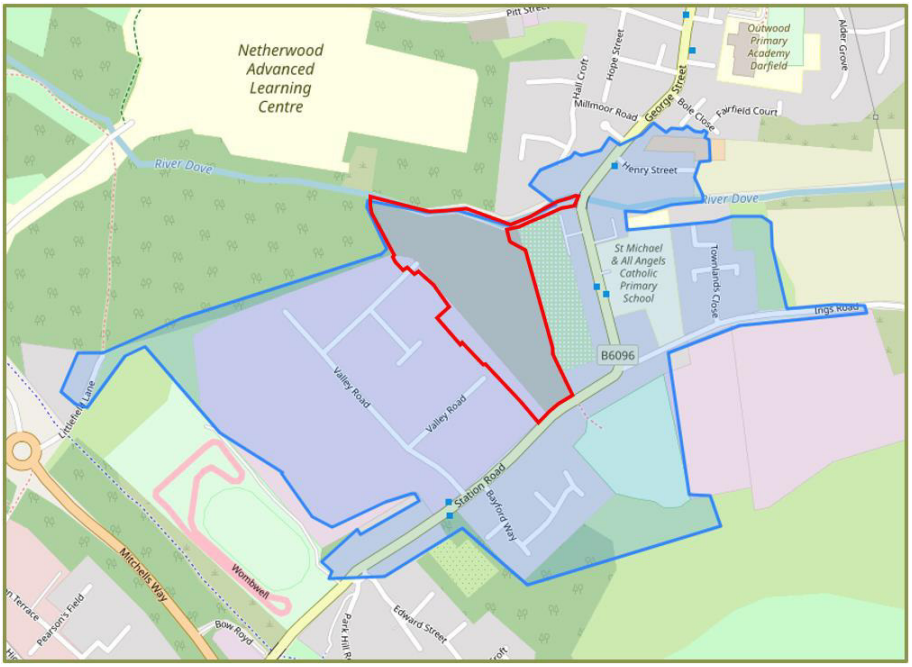
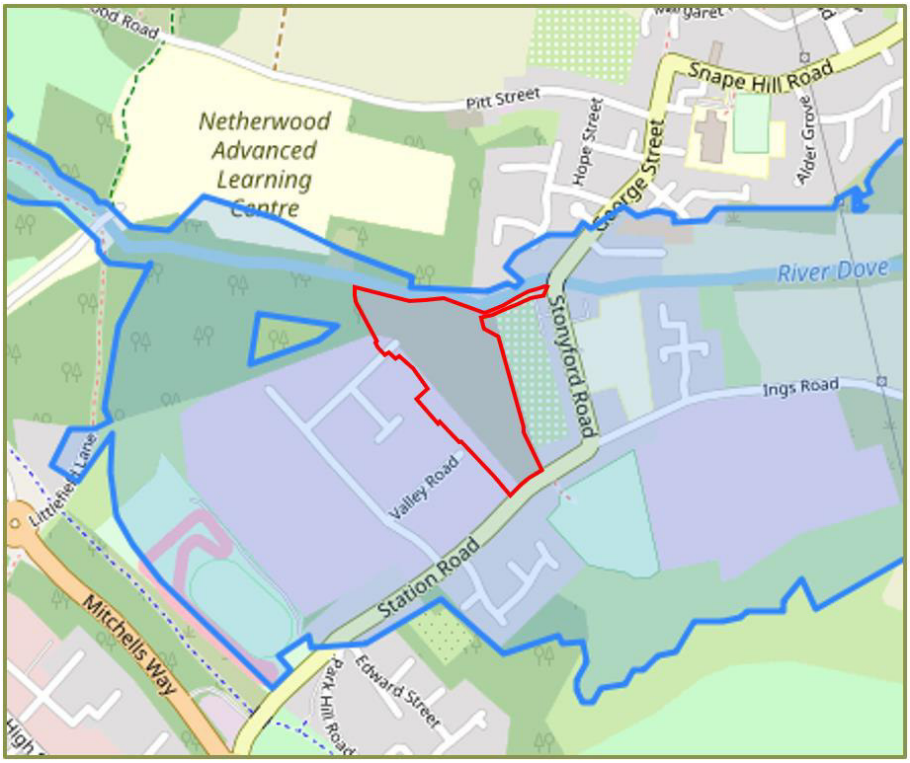


Figure 4.2: River Dearne Flood Warning Area (continues overleaf)

[18] https://riverlevels.uk/flood-map



Top: *Whole Flood Warning Area.* ***Bottom****: Flood Warning Area zoomed to Site level.*

4.5 Fluvial Flooding

Environment Agency Flood Mapping

4.5.1 The Environment Agency Flood Zones are the current best information on the extent of the extremes of flooding from rivers or the sea that would occur without the presence of flood defences, since these can be breached, overtopped and may not be in existence for the lifetime of a development.

4.5.2 The Environment Agency Flood Zones (Drawing 005) shows most of the Site is in Flood Zone 2; between the 1 in 1000-year and 1 in 100-year probability of fluvial (river) flooding (0.1% - 1% Annual Exceedance Probability [AEP]), at 'medium' risk. This risk is associated with the River Dove. The south-western part of the Site and areas in the central-western extent of the Site are located within Flood Zone 1; which is land located outside the extent of the 1 in 1000-year (<0.1% AEP) risk of fluvial flooding, at 'low' risk.

4.5.3 The proposed vehicular Site access via Station Road on the south-eastern boundary and potential emergency vehicular access via Valley Road on the south-western boundary are both located within Flood Zone 2.

SFRA Mapping

4.5.4 SFRA mapping (Appendix 3) shows the Site is within Flood Zone 2. The mapping is small scale and should be used with caution for site-specific assessments.

JBA Mapping

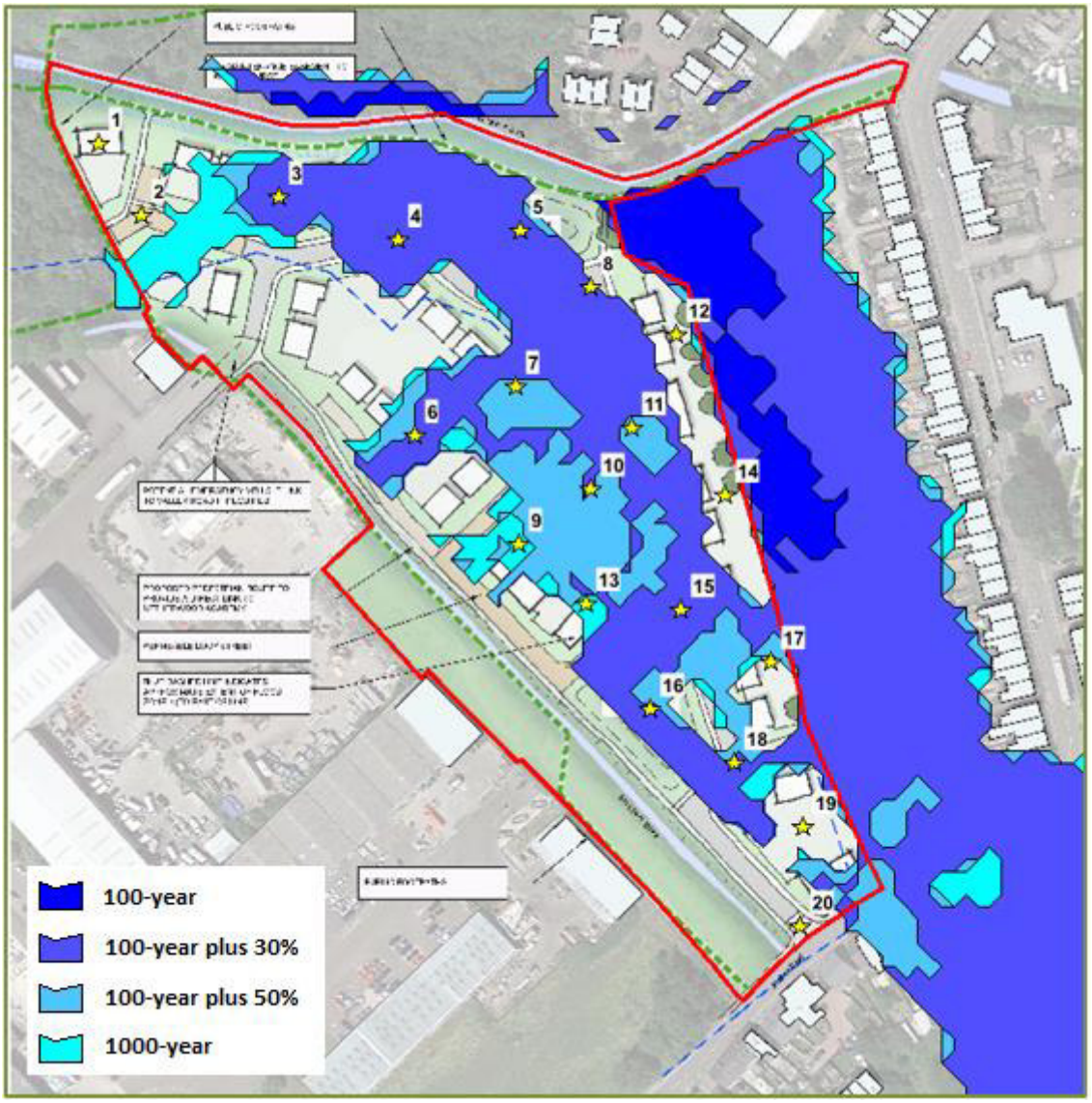
4.5.5 The JBA Flooding from Rivers mapping (Drawing 004.2) shows that most of the Site is located within Flood Zone 3b (functional floodplain); within the mapped extent of flooding from the River Dove and Bulling Dike during a 1 in 20-year event (5% AEP), at 'high' risk. Areas in the central-north and central-south are at a lower risk of fluvial flooding. The eastern boundary, south-east and south-west corners of the Site are not shown to be at risk of fluvial flooding.

Hydraulic Modelling Exercise

4.5.6 The results from the Enzygo Ltd 1D2D linked Flood Modeller model built for the River Dove and Bulling Dike which resulted in a successful flood map challenge (Appendix 5) have been assessed here.

4.5.7 The results show that the Site floods during the 1 in 100-year plus 30% climate change, 1 in 100-year plus 50% climate change, and 1 in 1000-year events (Figure 4.3).

Figure 4.3: Enzygo Modelled Results Nodes - Site (continues overleaf)



4.5.8 Areas within the north-western corner of the Site, within and immediately outside the south-western boundary, and along Station Road to the south of the Site are shown to be free from flooding. The designation of these areas as Flood Zone 2 on the Environment Agency Flood Zone Map (Drawing 005) is based on historical flood outlines from June 2007 and March 1947. Both flood events occurred prior to the replacement of the dilapidated Pitt Bridge on the River Dove upstream of the Site with a new access bridge built for Netherwood Academy in 2012 (Grid Ref. 439991 403853). Prior to its replacement, Pitt Bridge acted as a restriction to flow and during higher flow events water spilled from the right bank immediately upstream of the structure. Once out of bank, water would flow overland south towards Littlefield Lane before joining Bulling Dike where it was then conveyed towards the Site and Wombwell causing flooding. The results of the Enzygo Ltd hydraulic modelling exercise for the River Dove and Bulling Dike which show these areas to be free from fluvial flooding (Figure 4.3) and the Historic Flood Events Map (Drawing 008) confirm the influence of the bridge replacement.

4.5.9 Figure 4.3 shows node point locations in the Site. Maximum flood depth, level, velocity, and hazard are provided in Table 4.2 for the 1 in 100-year plus 50% climate change and 1 in 1000-year events. The Upper End climate change allowance is commonly used to guide flood mitigation measures for residential development such as setting finished floor levels. Figure 4.4 shows the Defra hazard to people classification.

4.5.10 The results show that during the 1 in 100-year plus 50% climate change event flooding within the Site originates along the right bank of the River Dove and then flows south, overland across the Site. The north-west corner, south-western, and eastern boundaries of the Site remain free of flooding. Across the Site, flood depths reach a maximum of 0.50m, maximum velocity is 0.55m/s, and maximum flood hazard is 1.45 (Danger for most - including the general public).

4.5.11 During the 1 in 1000-year event, flooding extends further west and south-west across the Site. The same flood mechanisms as in the 1 in 100-year plus 50% climate change event are shown. Across the Site, flood depths reach a maximum of 0.55m, maximum velocity is 0.61m/s, and maximum flood hazard is 1.49 (Danger for most - including the general public).

Table 4.2: Enzygo Modelled Results (maximums - Site)

Node ID	100-year plus 50% climate change				1000-year			
	Depth (m)	Level (mAOD)	Velocity (m/s)	Hazard Category[19]	Depth (m)	Level (mAOD)	Velocity (m/s)	Hazard Category[22]
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.37	26.67	0.12	1.23	0.42	26.72	0.13	1.26
4	0.50	26.67	0.18	1.34	0.55	26.72	0.24	1.41
5	0.37	26.64	0.11	1.23	0.41	26.68	0.12	1.25
6	0.12	26.34	0.54	1.12	0.15	26.37	0.61	1.16
7	0.10	26.60	0.11	1.06	0.11	26.61	0.27	1.09
8	0.43	26.63	0.55	1.45	0.47	26.67	0.56	1.49
9	0.00	0.00	0.00	0.00	0.02	26.63	0.06	1.01
10	0.08	26.62	0.05	1.04	0.10	26.64	0.12	1.06
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.03	26.63	0.08	1.01
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[19] http://randd.defra.gov.uk/Document.aspx?Document=FD2321_7400_PR.pdf

Node ID	100-year plus 50% climate change				1000-year			
	Depth (m)	Level (mAOD)	Velocity (m/s)	Hazard Category[19]	Depth (m)	Level (mAOD)	Velocity (m/s)	Hazard Category[22]
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.02	26.02	0.39	1.02	0.02	26.02	0.58	1.02
17	0.01	26.24	0.05	1.01	0.02	26.24	0.08	1.01
18	0.38	25.97	0.46	1.36	0.41	26.00	0.46	1.39
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 4.4: DEFRA Hazard to People Classification

This table is recommended for development planning and control use.

Table 4 – Hazard to People Classification using Hazard Rating *(HR= d x (v + 0.5) + DF)* for (Source Table 13.1 of FD2320/TR2 - Extended version)

HR	Depth of flooding - d (m)												
	DF = 0.5				DF = 1								
Velocity v (m/s)	0.05	0.10	0.20	0.25	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
0.0	0.03 + 0.5 = 0.53	0.05 + 0.5 = 0.55	0.10 + 0.5 = 0.60	0.13 + 0.5 = 0.63	0.15 + 1.0 = 1.15	0.20 + 1.0 = 1.20	0.25 + 1.0 = 1.25	0.30 + 1.0 = 1.30	0.40 + 1.0 = 1.40	0.50 + 1.0 = 1.50	0.75 + 1.0 = 1.75	1.00 + 1.0 = 2.00	1.25 + 1.0 = 2.25
0.1	0.03 + 0.5 = 0.53	0.06 + 0.5 = 0.56	0.12 + 0.5 = 0.62	0.15 + 0.5 = 0.65	0.18 + 1.0 = 1.18	0.24 + 1.0 = 1.24	0.30 + 1.0 = 1.30	0.36 + 1.0 = 1.36	0.48 + 1.0 = 1.48	0.60 + 1.0 = 1.60	0.90 + 1.0 = 1.90	1.20 + 1.0 = 2.20	1.50 + 1.0 = 2.50
0.3	0.04 + 0.5 = 0.54	0.08 + 0.5 = 0.58	0.15 + 0.5 = 0.65	0.19 + 0.5 = 0.69	0.23 + 1.0 = 1.23	0.30 + 1.0 = 1.30	0.38 + 1.0 = 1.38	0.45 + 1.0 = 1.45	0.60 + 1.0 = 1.60	0.75 + 1.0 = 1.75	1.13 + 1.0 = 2.13	1.50 + 1.0 = 2.50	1.88 + 1.0 = 2.88
0.5	0.05 + 0.5 = 0.55	0.10 + 0.5 = 0.60	0.20 + 0.5 = 0.70	0.25 + 0.5 = 0.75	0.30 + 1.0 = 1.30	0.40 + 1.0 = 1.40	0.50 + 1.0 = 1.50	0.60 + 1.0 = 1.60	0.80 + 1.0 = 1.80	1.00 + 1.0 = 2.00	1.50 + 1.0 = 2.50	2.00 + 1.0 = 3.00	2.50 + 1.0 = 3.50
1.0	0.08 + 0.5 = 0.58	0.15 + 0.5 = 0.65	0.30 + 0.5 = 0.80	0.38 + 0.5 = 0.88	0.45 + 1.0 = 1.45	0.60 + 1.0 = 1.60	0.75 + 1.0 = 1.75	0.90 + 1.0 = 1.90	1.20 + 1.0 = 2.20	1.50 + 1.0 = 2.50	2.25 + 1.0 = 3.25	3.00 + 1.0 = 4.00	3.75 + 1.0 = 4.75
1.5	0.10 + 0.5 = 0.60	0.20 + 0.5 = 0.70	0.40 + 0.5 = 0.90	0.50 + 0.5 = 1.00	0.60 + 1.0 = 1.60	0.80 + 1.0 = 1.80	1.00 + 1.0 = 2.00	1.20 + 1.0 = 2.20	1.60 + 1.0 = 2.60	2.00 + 1.0 = 3.00	3.00 + 1.0 = 4.00	4.00 + 1.0 = 5.00	5.00 + 1.0 = 6.00
2.0	0.13 + 0.5 = 0.63	0.25 + 0.5 = 0.75	0.50 + 0.5 = 1.00	0.63 + 0.5 = 1.13	0.75 + 1.0 = 1.75	1.00 + 1.0 = 2.00	1.25 + 1.0 = 2.25	1.50 + 1.0 = 2.50	2.00 + 1.0 = 3.00	2.50	4.75	6.00	7.25
2.5	0.15 + 0.5 = 0.65	0.38 + 0.5 = 0.80	0.60 + 0.5 = 1.10	0.75 + 0.5 = 1.25	0.90 + 1.0 = 1.90	1.20 + 1.0 = 2.20	1.50 + 1.0 = 2.50	1.80 + 1.0 = 2.80	3.40	4.00	5.50	7.00	8.50
3.0	0.18 + 0.5 = 0.68	0.35 + 0.5 = 0.85	0.70 + 0.5 = 1.20	0.88 + 0.5 = 1.38	1.05 + 1.0 = 2.05	1.40 + 1.0 = 2.40	1.75 + 1.0 = 2.75	3.10	3.80	4.50	6.25	8.00	9.75
3.5	0.20 + 0.5 = 0.70	0.40 + 0.5 = 0.90	0.80 + 0.5 = 1.30	1.00 + 0.5 = 1.50	1.20 + 1.0 = 2.20	1.60 + 1.0 = 2.60	3.00	3.40	4.20	5.00	7.00	9.00	11.00
4.0	0.23 + 0.5 = 0.73	0.45 + 0.5 = 0.95	0.90 + 0.5 = 1.40	1.13 + 0.5 = 1.63	1.35 + 1.0 = 2.35	1.80 + 1.0 = 2.80	3.25	3.70	4.60	5.50	7.75	10.00	12.25
4.5	0.25 + 0.5 = 0.75	0.50 + 0.5 = 1.00	1.00 + 0.5 = 1.50	1.25 + 0.5 = 1.75	1.50 + 1.0 = 2.50	2.00 + 1.0 = 3.00	3.50	4.00	5.00	6.00	8.50	11.00	13.50
5.0	0.28 + 0.5 = 0.78	0.60 + 0.5 = 1.10	1.10 + 0.5 = 1.60	1.38 + 0.5 = 1.88	1.65 + 1.0 = 2.65	2.20 + 1.0 = 3.20	3.75	4.30	5.40	6.50	9.25	12.00	14.75

Flood Hazard Rating (HR)	Colour Code	Hazard to People Classification
Less than 0.75		Very low hazard - Caution
0.75 to 1.25		Danger for some – includes children, the elderly and the infirm
1.25 to 2.0		Danger for most – includes the general public
More than 2.0		Danger for all – includes the emergency services

4.5.12 Figure 4.5 shows node point locations along the proposed access/egress routes. Maximum flood depth, level, velocity, and hazard for the 1 in 100-year plus 30% climate change and 1 in 1000-year events are provided in Table 4.5. The Higher Central climate change allowance is commonly used to assess whether safe access/egress can be attained for residential development.

Figure 4.5: Enzygo modelled results nodes - access/egress

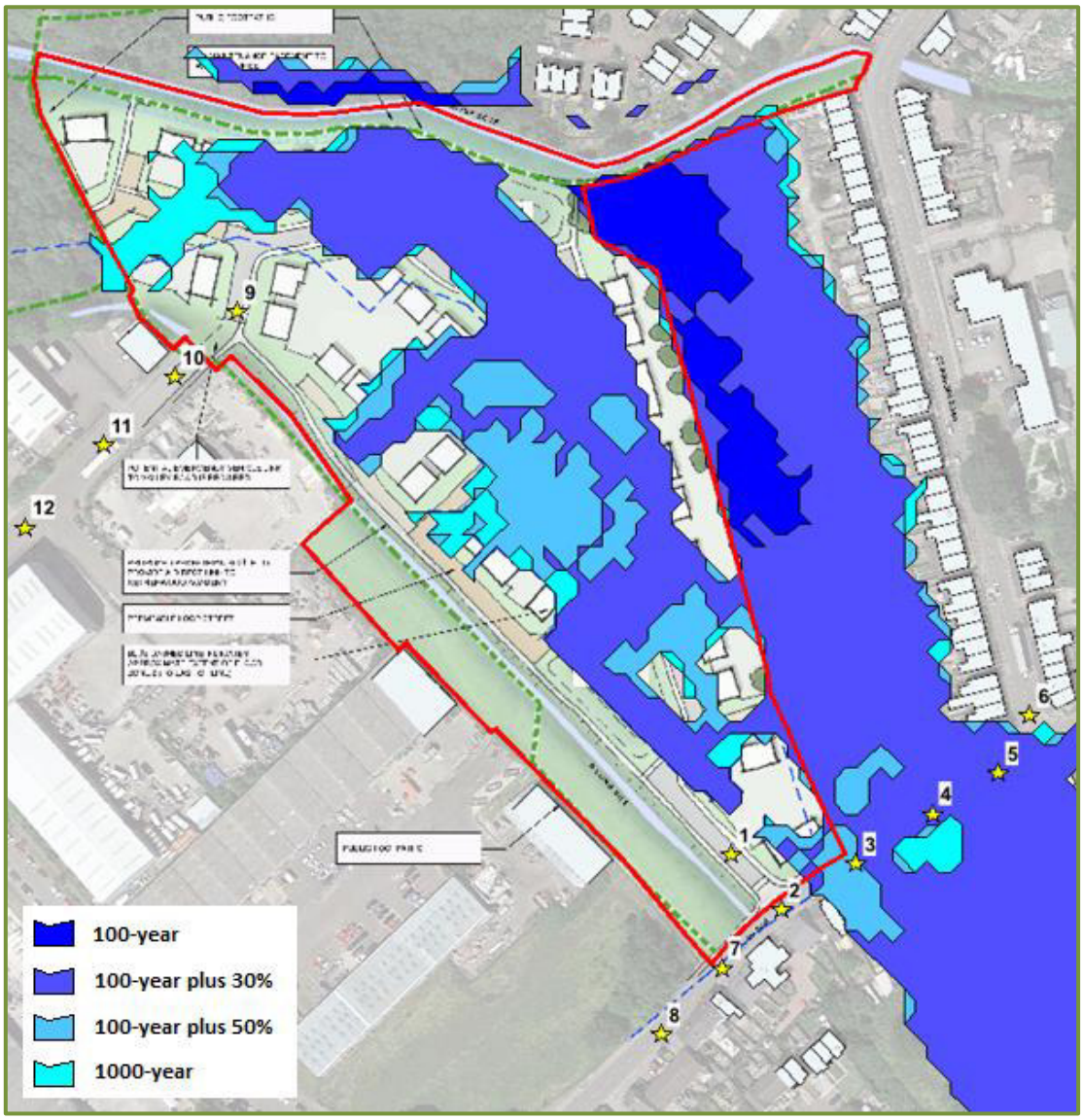


Table 4.5: Enzygo modelled results (maximums) - access/egress

Node ID	100-year plus 30% climate change				1000-year			
	Depth (m)	Level (mAOD)	Velocity (m/s)	Hazard Category[20]	Depth (m)	Level (mAOD)	Velocity (m/s)	Hazard Category[22]
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.01	25.70	0.06	1.01	0.03	25.72	0.22	1.02
4	0.09	25.86	0.28	1.07	0.12	25.89	0.34	1.10
5	0.11	25.89	0.36	1.10	0.15	25.93	0.37	1.13
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[20] http://randd.defra.gov.uk/Document.aspx?Document=FD2321_7400_PR.pdf

Node ID	100-year plus 30% climate change				1000-year			
	Depth (m)	Level (mAOD)	Velocity (m/s)	Hazard Category[20]	Depth (m)	Level (mAOD)	Velocity (m/s)	Hazard Category[22]
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.5.13 During the 1 in 100-year plus 30% climate change event along the proposed access/egress route, via the south-eastern boundary and then north-west along Station Road, flood depths reach a maximum of 0.11m, maximum velocity is 0.36m/s, and maximum flood hazard is 1.10 (Danger for some - including children, the elderly, and the infirm). During the 1 in 1000-year event, flood depths reach a maximum of 0.15m, maximum velocity is 0.37m/s, and maximum flood hazard is 1.13 (Danger for some).

4.5.14 Access/egress south-west from the Site along Station Road and via Valley Road would be free from fluvial flooding.

Third Party Flood Risk

4.5.15 Development of the Site would likely result in the displacement of flood water from Flood Zone 2 when the lifetime of the development is considered (i.e. based on the 1 in 100-year plus climate change allowance events) by the proposed residential properties and internal roads on the basis of the flood model results unless mitigated for through floodplain compensation on a level-for-level basis, so that the impact on flood risk to third parties upstream and downstream of the Site would be negligible.

4.5.16 An initial assessment of the volume of displacement during the 1 in 100-year plus 50% climate change event caused by the proposed building units shows that at least 1,400m^3 of compensatory storage will be required. Storage could be provided in the northern part of the Site adjacent to the River Dove or within land to be acquired by the applicant offsite. It is recommended that a more detailed assessment is completed at the detailed design stage when proposed levels within the Site are set.

Summary Flood Risk

4.5.17 The JBA and SFRA mapping does not account for the flood modelling carried out by Enzygo Ltd during 2016 and 2017, which resulted in a Flood Map Challenge and update to the Environment Agency Flood Map for Planning. The Environment Agency Mapping shows historic flood outlines from 2007 and 1947, which inform Flood Zone 2. Enzygo Ltd modelling has shown that due to the replacement of the dilapidated Pitt Bridge, the flood route as shown in the historical outlines can no longer occur. The Enzygo Ltd modelling results are therefore taken in preference.

4.5.18 The risk of fluvial flooding is assessed as moderate for the eastern, southern, and central areas of the Site, with the north-western corner, the south-western part of the Site and small areas towards the centre at low risk. When the lifetime of the development is considered (i.e. against the 1 in 100-year plus 50% climate change flood risk), the risk of fluvial flooding is assessed as high.

4.5.19 Mitigation measures against fluvial flooding are discussed in Section 5.

4.6 Tidal Flooding

4.6.1 The Site is not located close to tidally affected flooding sources (Drawing 001) and so the flood risk from this source is assessed as negligible.

4.7 Groundwater Flooding

Introduction

4.7.1 Groundwater flooding occurs when subsurface water emerges either at surface or in made ground or in subsurface structures such as basements and services ducts. It occurs as diffuse seepage, emergence from new point source springs or an increase in flow from existing springs. It results from aquifer recharge from infiltrating rainfall, from sinking streams entering aquifers from adjacent non-aquifers, or from high river levels or tides driving water through near surface deposits. It tends to occur with a delay following rainfall and can last for several weeks or months. Groundwater flooding or shallow water tables also prevent or reduce infiltration and so can worsen surface water flooding.

BGS Groundwater Flooding Susceptibility Map

4.7.2 The BGS Groundwater Flooding Susceptibility Map (Drawing 003) shows that most of the Site is within the mapped extent of susceptibility to groundwater flooding, with potential for flooding to occur at surface. The south-eastern corner and eastern boundary of the Site are not shown to be at risk of groundwater flooding. The higher risk of groundwater flooding is likely to be linked to the Alluvium superficial deposits (clay, silt, sand and gravel), which have high permeability. The bedrock underlying most of the Site is Pennine Middle Coal Measures Formation (mudstone, siltstone and sandstone), which has a lower permeability than the alluvium.

Geosmart 1 in 100-year Groundwater Flood Risk Map

4.7.3 The Geosmart 1 in 100-year groundwater flood risk map (Drawing 006) shows that the entire Site is at negligible risk of groundwater flooding and falls within Risk Class 4 (Table 4.2). This data source is of a higher resolution and accuracy level than the BGS mapping and is therefore taken in preference.

4.7.4 Mapped classes combine understanding of likelihood, model and data uncertainty, and possible severity. Likelihood is ranked according to whether we expect groundwater flooding at a site due to extreme elevated groundwater levels with an annual probability of occurrence greater than 1%, considering model and data uncertainty. Severity relates to expectations of the amount of property damage or other harm that groundwater flooding at that location might cause (Table 4.2).

Table 4.2: Groundwater flood risk classification

Risk Class	Probability of Groundwater Flooding	Effect
4: Negligible	Annual probability less than 1%.	Negligible unless unusually sensitive use.
3: Low	Annual probability greater than 1%.	Remote possibility of damage to property or harm to sensitive receptors Flooding likely to be limited

Risk Class	Probability of Groundwater Flooding	Effect
		to seepages and waterlogged ground, damage to basements and subsurface infrastructure, and should pose no significant risk to life. Surface water flooding may be worsened.
2: Moderate	Annual probability greater than 1%.	Significant possibility of damage to property or harm to other sensitive receptors at or near this location. flooding is likely to be in the form of shallow pools or streams. Surface water flooding and failure of drainage systems may be worsened when groundwater levels are high.
1: High	Annual probability greater than 1%.	Groundwater flooding will occur which could lead to damage to property or harm to other sensitive receptors at or near this location. Flooding may result in damage to property, road or rail closures and, in exceptional cases, may pose a risk to life. Surface water flooding and failure of drainage systems may be worsened when groundwater levels are high.

Flood Risk

4.7.5 The risk of groundwater flooding is assessed as negligible.

4.8 Surface Water Flooding

Introduction

4.8.1 Surface water flooding occurs following rainfall on ground where infiltration rates are less than the rainfall precipitation rate. This can occur when either:

- Soils or ground materials are naturally of low permeability or have been compacted (infiltration excess runoff);
- Soils or ground materials are saturated from previous rainfall either directly or from upslope (saturation excess runoff and return flow) or from high groundwater levels.

SFRA Mapping

4.8.2 SFRA mapping (Appendix 3) shows no risk of surface water flooding in the majority of the Site. There is however a surface water flow pathway along the course of Bulling Dike with depths of up to 1.00-1.50m and three areas of surface water ponding within the centre of the Site at depths of 0.15-0.50m. The mapping is small scale and should be used with caution for site-specific assessments.

JBA Surface Water Flood Map

4.8.3 The JBA Surface Water Flood Map (Drawing 004.1) shows that the south-western boundary of the Site, an area associated with Bulling Dike, and the northern boundary, an area associated

with the River Dove, are at risk of surface water flooding. This risk for the south-western boundary is predominantly associated with the 1 in 1000-year event. However, close to the north-west corner of the Site the flood risk is associated with the 1 in 75-year and 200-year events.

4.8.4 Both areas are associated with fluvial flooding and are therefore superseded by the Enzygo Ltd modelling (Section 4.5).

4.8.5 The JBA mapping also identifies four areas of surface water ponding in the central northern part of the Site with risk between the 1 in 200-year and 1000-year events.

Environment Agency Complex Surface Water Flood Mapping

4.8.6 The Environment Agency Complex Surface Water Flood Mapping (Drawings 009.1 to 009.4) shows that there is a surface water flow pathway associated with the route of Bulling Dike along the south-western boundary and within the south western extent of the Site. The flood depth is between 0.00 and >1.20m during the extreme 1000-year event. The flood velocity is up to >2.00m/s. The flood hazard is between 'low' (0.50-0.75) and 'extreme' (>2.00).

4.8.7 The Bulling Dike surface water flow pathway is shown to flow through the potential emergency vehicular access off Valley Road. At this point, the flood depth is >1.20m during the extreme 1000-year event. The flood velocity is up to >2.00m/s. The flood hazard is between 'low' (0.50-0.75) and 'extreme' (>2.00). The Bulling Dike surface water flow pathway is also shown to affect the proposed vehicular access via Station Road. At this point, the flood depth is >1.20m during the extreme 1000-year event. The flood velocity is up to 2.00m/s. The flood hazard is between 'low' (0.50-0.75) and 'significant' (>1.25-2.00). In both cases, the risk is associated with Bulling Dike and does not consider the conveyance capacity of the Valley Road bridge and Station Road culvert. The Enzygo Ltd hydraulic modelling has shown the fluvial risk from Bulling Dike would be low. Despite this, the two access locations would be at risk of flooding from the River Dove. This risk is assessed in Section 4.5.

4.8.8 A second flow pathway associated with the River Dove is shown along the northern boundary of the Site. The flood depth is between 0.00 and 1.20m during the extreme 1000-year event. The flood velocity is up to 2.00m/s. The flood hazard is between 'low' (0.50-0.75) and 'extreme' (>2.00).

4.8.9 Both surface water flow pathways are associated with fluvial flooding and are therefore superseded by the Enzygo Ltd modelling (Section 4.5).

4.8.10 The mapping also shows three areas of surface water ponding within the central northern area of the Site. The larger and most northerly of the ponds has a flood depth between 0.15 and 0.60m and flood velocity is up to 0.50m/s during the extreme 1000-year event. The flood hazard is between 'low' (0.50-0.75) and 'moderate' (0.75-1.25). The two smaller ponds have a flood depth between 0.15 and 0.30m and flood velocity is up to >0.50m/s during the extreme 1000-year event. The flood hazard is between 'low' (0.50-0.75) and 'moderate' (0.75-1.25).

Flood Risk

4.8.11 The risk of surface water flooding for most of the Site is assessed as negligible. Bulling Dike and the River Dove are associated with fluvial flooding which is assessed in Section 4.5. There are three areas of low risk ponding within the central northern part of the Site.

4.8.12 Mitigation measures against surface water flooding are discussed in Section 5.

4.9 Sewer Flooding

Introduction

4.9.1 Sewer flooding occurs when urban drainage networks become overwhelmed after heavy or prolonged rainfall due to restrictions or blockage in the sewer network or if the volume of water draining into the system exceeds the sewer design capacity.

4.9.2 New sewers are built to the guidelines within Sewers for Adoption[21] and have a design standard to the 1 in 30-year flood event. Older sewers were not designed to any standard. Modern sewer systems will only surcharge during rainstorm events with a return period greater than 30-years (e.g. 100-years).

Sewer Assets

4.9.3 There is a public combined sewer within the south-western extent of the Site and two public surface water sewers out falling to Bulling Dike. Based on the location of these assets, any floodwater from the surcharging or failure of these assets would follow the topography to the south west towards Bulling Dike and away from the development.

Flood Risk

4.9.4 The risk of flooding from sewers is assessed as negligible for most of the Site and low for the area in the south-western extent of the Site downslope of the combined sewer.

4.10 Flooding from Infrastructure Failure

Lakes

4.10.1 OS Mapping (Drawing 002) shows two fishing lakes located 600m and 750m north-west of the Site. These are not impounded, and any overflow caused by excessive rainfall would follow the fluvial flood outlines described in Section 4.5. The risk of flooding from lakes is assessed as negligible.

Reservoir

4.10.2 The Environment Agency online flood mapping shows the Site is located outside the extent of flooding sourced from reservoirs. The risk of flooding from reservoirs is assessed as negligible.

Highway Drainage

4.10.3 The topographic survey (Appendix 2) shows highway drainage along Station Road to the south-east of the Site and along Valley Road to the south-west of the Site. The elevation of the Site on the south-eastern boundary is approximately 150mm above the elevation of Station Road with levels along the road falling south-west away from the Site. The elevations along Valley Road also fall south-west away from the Site. Should the highway drainage assets surcharge in either location, flood water would shed south-west along the roads and away from the Site.

4.10.4 The risk of flooding from Highway drains is assessed as negligible.

[21] WRC (2012) Sewers for Adoption 7th Edition.

5.0 Flood Risk Mitigation Measures

5.1 Introduction

5.1.1 The following sources of flooding were identified:

- Fluvial flooding from the River Dove;
- Surface water flooding, associated with the River Dove and Bulling Dike, and ponding within the central northern part of the Site; and
- Sewer flooding.

5.2 Mitigation Measures

Fluvial Flooding from Bulling Dike and the River Dove

- Set the finished floor levels of all buildings above the 1 in 100-year (plus 50% climate change) flood level (26.67mAOD) and freeboard allowance.
- Retain external levels as close to existing as feasible.
- Provide level-for-level compensatory flood storage within Flood Zone 2 when the lifetime of the development is considered based on the volume of floodwater displaced by the proposed development during the 1 in 100-year plus 50% climate change event. An initial assessment of the volume of displacement during this event caused by the proposed building units shows that at least 1,400m^3 of compensatory storage will be required. It is recommended that a more detailed assessment is completed at the detailed design stage when proposed levels within the Site are set.
- Provide a 9m easement free from development along either side of Bulling Dike, as per IDB correspondence and an 8m easement free from development along the right bank of the River Dove. These easements would provide access for inspection and maintenance purposes, including vehicle access.
- Production of a Flood Evacuation Management Plan (FEMP) for the proposed development.
- Utilise flood resilient construction.
- Adoption of a surface water management strategy.
- Undertake maintenance activities to keep Bulling Dike clear from debris and overgrown vegetation to maintain the conveyance of the channel.

Surface Water Flooding

- Adoption of a surface water management strategy.
- Set finished floor levels as per above.

Sewer Flooding

- Provide a 4m easement free from development along either side of the combined sewer. This easement would provide access for inspection and maintenance purposes.

5.3 Summary of Flood Risk

5.3.1 Table 5.1 summarises the probability and level of risk, both with and without mitigation measures.

Table 5.1: Probability and consequences of all sources of flooding

Flooding Source	Potential Source	Probability	Consequence & Impact Without Mitigation	Consequence & Impact with Mitigation
Fluvial	Bulling Dike and River Dove	Low to High across the Site	Low to High across the Site	Low
Tidal	None	Negligible	Negligible	Negligible
Groundwater	Aquifers	Negligible	Negligible	Negligible
Surface Water	Poor Permeability, impermeable surfaces	Negligible to Low across the Site	Negligible to Low across the Site	Negligible
Sewer	Public sewers	Low	Low	Negligible
Infrastructure Failure	Reservoir Failure	Negligible	Negligible	Negligible

Key: *Green - Negligible, Yellow - Low, Orange - Medium and Red - High; based on consequence and impact with mitigation from each flooding source.*

5.4 Flood Guidance and Sequential Test

5.4.1 The proposal is for a residential development. Table 2 of PPG ID: 7 (not included in this report) classifies the proposed use as 'more vulnerable'.

5.4.2 The Environment Agency Flood Zones and acceptable development types are listed in Table 5.2. All development types (including more vulnerable uses) are acceptable in Flood Zones 1 and 2 (low to medium risk). Subject to the above mitigation measures, the Sequential and Exception Tests would need to be passed as indicated in Table 5.3.

Table 5.2: Environment Agency Flood Zones and Appropriate Land Use

Flood Zone	Probability	Explanation	Appropriate Land use
Zone 1	Low	Less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).	All development types generally acceptable.
Zone 2	Medium	Between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% 0.1%) in any year.	Most development type are generally acceptable.

Flood Zone	Probability	Explanation	Appropriate Land use
Zone 3a	High	A 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.	Some development types not acceptable.
Zone 3b	'Functional Floodplain'	Land where water must flow or be stored in times of flood. SFRAs should identify this zone (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 at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).	Some development types not acceptable.

Note: *The Flood Zones are 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, because these can be breached, overtopped and may not be in existence for the lifetime of the development. The identified risk of fluvial flooding is highlighted green.*

Table 5.3: Vulnerability and Flood Zone 'Compatibility' as identified in Table 3 of PPG ID: 7

Flood Risk Vulnerability classification (see Table 1 of PPG ID: 7)	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	Yes	Yes	Yes	Yes	Yes
Zone 2	Yes	Yes	Exception test required	Yes	Yes
Zone 3a	Exception test required	Yes	No	Exception test required	Yes
Zone 3b 'Functional Floodplain'	Exception test required	Yes	No	No	No

Key: *Yes: Development is appropriate, No: Development should not be permitted.*
The identified risk of fluvial flooding is highlighted green.

6.0 Site Drainage

6.1 Surface Water Drainage

6.1.1 Consideration of flood issues is not confined to the floodplain. This is recognised in the NPPF and associated guidance where all proposed development of 1ha or more in Flood Zone 1 and so outside the floodplain nevertheless requires an FRA. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in a catchment, particularly flooding downstream; and replacing permeable vegetated areas with low permeability roofs, roads and other paved areas will increase the speed, volume and peak flow of surface water runoff.

6.1.2 A surface water management strategy for the development is proposed to manage and reduce the flood risk posed by surface water runoff from the Site. The developer will be required to ensure that any scheme for surface water should build in sufficient capacity for the entire Site.

6.1.3 The surface water drainage arrangements for any development Site should be such that the volume and peak flow rates of surface water leaving a developed Site are no greater than the rates prior to the proposed development, unless specific off-Site arrangements are made and result in the same net effect.

6.1.4 An assessment of the surface water runoff rates was undertaken to determine the surface water options and attenuation requirements for the Site.

6.2 Existing Drainage System

6.2.1 The Site comprises of a demolished industrial unit which included parking areas and internal roads. The remnants of these areas of hardstanding are still present along with a number of spoil heaps and vegetation.

6.2.2 The Soilscapes online soils map viewer shows that the Site is underlain by loamy and clayey floodplain soils with naturally high groundwater. The Geology of Britain online map viewer shows that superficial deposits beneath the Site are Alluvium (clay, silt, sand and gravel). The bedrock beneath most of the Site is Pennine Middle Coal Measures Formation (mudstone, siltstone and sandstone). The bedrock beneath the north-east of the Site is Ackton Rock (sandstone). Made Ground is also present across the Site. The soils and geology are indicative of low infiltration potential.

6.2.3 The detailed topographic survey shows the Site generally falls in a south easterly direction from 27.08 metres Above Ordnance Datum (m AOD) (located in the north westerly corner) to 24.82m AOD (located along the south-western boundary). The fall of 2.26m over 305.15m gives a gradient of 1:135. The northern end of the Site also falls north towards the River Dove and the south-western part of the Site falls south-west towards Bulling Dike.

6.2.4 The River Dove conveys flow east along the northern boundary of the Site and Bulling Dike conveys flow south-east along the south-western boundary of the Site.

6.2.5 The current drainage arrangement within the Site is predominantly by overland flow, following the topography towards the River Dove in the northern part of the Site or Bulling Dike in the southern and western parts of the Site. A small amount of infiltration to bedrock, and throughflow to watercourse is also likely.

6.3 Proposed Development

6.3.1 The proposal is for a residential development.

6.3.2 A figure of 55% impermeable area (inclusive of urban creep) was applied to the (2.72ha) developable area. The existing and proposed impermeable areas are shown in Table 6.1 using information provided within the site layout (Appendix 1). For the purposes of this assessment, the existing impermeable area is taken as zero as brownfield rates will not be sought and the Site will be treated as greenfield.

Table 6.1: Impermeable Area

Area	Existing Buildings and Hardstanding	Proposed Buildings and Hardstanding	Difference
Area (ha)	0.00	1.50	+1.50
Percentage of Total Site Area (%)	0.00	39.47	+39.47

6.3.3 The proposed development will increase the impermeable surfaces and therefore increase the amount of runoff.

6.4 Greenfield Runoff Rates

6.4.1 An assessment of greenfield runoff rates was undertaken to determine the attenuation requirements for the proposed development.

6.4.2 The runoff rates were calculated using the HR Wallingford greenfield runoff estimation software tool using the current 'industry best practice' guidelines as outlined in the Interim Code of Practice for SuDS[22], and the Environment Agency Report SC030219 – Rainfall runoff management for developments.

6.4.3 The following parameters were used in the runoff calculations:

- Developable Area: North = 1.02ha, South = 1.70ha (Drawing 011)
- Average Annual Rainfall (SAAR): 615 mm/year;
- Soil: 0.47;
- Impermeable Areas: 0 (0.00ha)
- Region No.: 3

6.4.4 The soil type assigned was 2 giving an SPR value of 0.3, indicating very permeable to moderately permeable soils (Figure 6.1). Based on the loamy and clayey floodplain soils, Alluvium (clay, silt, sand and gravel) superficial deposits, sandstone and mudstone bedrock, and presence of made ground, the soils type was changed to type 4 and the SPR value to 0.47. These values are carried forward within the greenfield runoff calculations.

[22] Office of the Deputy Prime Minister, National SuDS Working Group, July 2004, Interim Code of Practice for sustainable drainage systems.

Figure 6.1: Soil Index (Sourced from Microdrainage)

Soil Index	General Description	Soil Type
0.150	i) Well drained permeable sandy or loamy soils and shallower analogues over highly permeable limestone, chalk, sandstone or related drifts. ii) Earthy peat soil drained by dikes and pumps. iii) Less permeable soils in valleys.	1
0.300	i) Very permeable soils with shallow ground-water. ii) Permeable soils over rock or frangipani, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils. iii) Moderately permeable soils, some with slowly permeable subsoils.	2
0.400	i) Relatively impermeable soils in boulder and sedimentary clays and in alluvium, especially in eastern England. ii) Permeable soils with shallow ground-water in low lying areas. iii) Mixed areas of permeable and impermeable soils in approximately equal proportions.	3
0.450	i) Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.	4
0.500	Soils of the wet upland i) With peaty or humose surface horizons and impermeable layers at shallow depth. ii) Deep raw peat associated with gentle upland slopes or basin sites. iii) Bare rock cliffs and screes. iv) Shallow, permeable rocky soil on steep slopes.	5

6.4.5 Table 6.2 shows the calculated greenfield runoff rates. Extracts from Microdrainage calculations are included in Appendix 9.

Table 6.2: Greenfield Runoff Rates

Annual Probability (Return Period, years)	Greenfield Runoff (l/s)	
	Northern Developable Area (1.02ha)	Southern Developable Area (1.70ha)
QBAR	4.23	7.05
100% (1)	3.64	6.07
3.33% (30)	7.41	12.34
1% (100)	8.80	14.67
1% + Climate Change	12.32	20.54

Note: *40% added to the data to account for long-term climate change as stated in 'Flood Risk Assessment: Climate Change Allowance'. The 1-year, 30-year and 100-year annual probability events are of importance to the Water Companies and the Environment Agency when looking at sewage discharge and flood risk.*

6.5 Sustainable Drainage Options (SuDS)

Feasibility of SuDS

6.5.1 Soakaway testing was not undertaken at the Site due to the presence of Made Ground and the risk that surface water disposal via infiltration methods could potentially mobilise contaminants. The use of deep borehole soakaways would also be unfeasible due to shallow groundwater which a review of borehole records at the Site shows is present at depths of between 3.25 and 4.95m bgl.

6.5.2 The loamy and clayey soils at the Site are indicative of low infiltration potential. Assuming no infiltration potential is a conservative approach, requiring larger attenuation volumes within the proposed below ground storage.

Choice of SuDS Options

6.5.3 Sustainable water management measures should be used to control the surface water runoff from the proposed development Site, thereby managing the flood risk to the Site and surrounding areas from surface water runoff. These measures will also improve the quality of water discharged from the Site.

6.5.4 Current guidance promotes sustainable water management using SuDS. Options applicable to this Site are identified in Table 6.3.

Table 6.3: SuDS Options

Green roofs	Infiltration basins
Water butts	Detention basins
Permeable paving	Oversized pipes
Rainwater harvesting	Brown roofs
Filter strips	Swales
Wetland Areas	Cellular Storage

Note: *SuDS appropriate to the development are highlighted green.*

6.5.5 A hierarchy of SuDS techniques is identified[23]:

1. **Prevention** – the use of good Site design and housekeeping measures on individual Sites to prevent runoff and pollution (e.g. minimise areas of hard standing).
2. **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting).
3. **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole Site).
4. **Regional Control** – management of runoff from several Sites, typically in a detention pond or wetland.

6.5.6 Using SuDS as opposed to conventional drainage systems provides several benefits by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed Sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open spaces and wildlife habitat; and

[23] CIRIA (2004) Report C609, Sustainable Drainage Systems – Hydraulic, Structural and Water Quality advice.

- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

SuDS Maintenance

6.5.7 The low to high risk of fluvial flooding means the potential to use green SuDS is greatly reduced as flooding issues mean the drainage network needs to be assessed with flood reliance in mind.

6.5.8 While permeable paving for the parking areas may be ideal to meet SuDS guidance it would be an issue during fluvial flooding as the permeable sub-base would be compromised, thus reducing any capacity in the system.

6.5.9 A more traditional sealed pipe system would be more appropriate as it would allow for a network that can be controlled even during times of high fluvial levels. An oversized pipe storage system is proposed to provide the attenuation needed to meet the drainage requirements and reduce flood risk from the existing site, in line with SuDS principles.

6.5.10 Maintenance of the SuDS features would be in line with the SuDS Manual (CIRIA C753, 2015), as detailed in Figure 6.2. The maintenance would be undertaken by a private maintenance company.

6.5.11 It is standard for SuDS features within a new development to be maintained by a private maintenance company, unless the council adopt them. If the maintenance company goes into administration, the Site will be contracted to a new maintenance company. Residents will pay a surcharge to the maintenance company and a number of them would be appointed to its board. This will ensure maintenance throughout the lifetime of the development.

6.5.12 Details of other SuDS features, and maintenance would be considered further at detailed design, when a detailed layout has been produced. The level of detailed provided within this FRA should be sufficient at outline stage to demonstrate that SuDS would be deliverable.

Figure 6.2: Attenuation Storage Tank Operation and Maintenance Requirements (Table 21.3 of the SuDS Manual)

TABLE 21.3 Operation and maintenance requirements for attenuation storage tanks

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

6.6 Surface Water Management Strategy

Hierarchy of Discharge

6.6.1 In accordance with requirement H3 of the Building Regulations 2000[24] rainwater runoff must discharge to one of the following, listed in order of priority:

1. **An adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable:** The use of infiltration-based SuDS is not feasible due to the presence of Made Ground beneath the Site.
2. **A watercourse; or where that is not reasonably practicable:** Bulling Dike runs along the south-west boundary of the Site and the River Dove borders the north of the Site.
3. **A sewer:** There is a combined Ø600mm public sewer along the south-western boundary of the Site and two sewers in the south-west of the Site; the more northerly Ø675mm and southerly Ø225mm.

6.6.2 The potential route to discharge from the existing Site will be by outfall to Bulling Dike. Since Bulling Dike is an IDB Drain, any proposed discharge of surface water to it will require the IDB's consent and should be based on a maximum rate of 5 l/s for small sites (as this Site is defined) (Appendix 7).

Drainage Design

6.6.3 Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

6.6.4 Landscaped areas should be incorporated into the layout where possible, and the associated gardens of each unit will allow a proportion of the rainfall to infiltrate into the soil substrate.

6.6.5 Surface water will be directed to the onsite underground oversized pipe system, positioned to achieve a pumped connection to Bulling Dike.

6.6.6 An indicative drainage layout is in Drawing 010.

Flood Risk Considerations

6.6.7 Table 6.4 shows the calculated greenfield runoff rates for the developable area and the betterment with outfall restricted to 5l/s. Extracts from the calculations are included in Appendix 9.

Table 6.4: Greenfield Runoff Rates - Betterment

Annual Probability (Return Period, years)	Greenfield Runoff (l/s)	Restricted Rate (l/s)	Betterment (with outfall limited to 5l/s)	
			(l/s)	(%)
QBAR	11.3	5.0	6.3	55.8
100% (1)	9.7	5.0	4.7	48.5
3.33% (30)	19.8	5.0	14.8	74.8
1% (100)	23.5	5.0	18.5	78.7

[24] Office of the Deputy Prime Minister, The Building Regulations 2000.

Annual Probability (Return Period, years)	Greenfield Runoff (l/s)	Restricted Rate (l/s)	Betterment (with outfall limited to 5l/s)	
			(l/s)	(%)
1% + Climate Change	32.9	5.0	29.7	90.3

6.6.8 Table 6.4 shows that restricting discharge to 5l/s would offer a significant betterment on existing conditions across all return periods. As such, an outfall to Bulling Dike would not increase flood risk downstream from the Site.

Attenuation Requirements

6.6.9 Attenuation storage is required to reduce the post-application surface water runoff from the Site to watercourse to the calculated greenfield runoff rates, up to and including the 100-year (+40%CC) rainfall event, assuming no infiltration losses.

6.6.10 The following input parameters were assumed in the calculations:

- Impermeable Areas: North = 0.56ha (14.74%), South = 0.94ha (24.74%);
- Cv (proportion of rainfall forming surface water runoff): 75% summer, 84% winter;
- Infiltration losses: 0.00m/hour;
- With outfall: restricted to 5l/s.

6.6.11 The attenuation volume for the 100-year event (plus climate change) is 1,318m^3.

6.6.12 Drainage calculations are included in Appendix 9. The calculated runoff rates and attenuation volumes will be reviewed at detailed design stage.

6.7 Exceedance Routes

6.7.1 The underground oversized pipe system will be designed with a capacity up to a 1 in 100-year (plus 40% climate change) event, with a +300mm freeboard allowance, based on the 5.0l/s restricted discharge rate. This provides a betterment (reduction) in runoff when compared to existing undeveloped conditions, where runoff is uncontrolled across all return periods.

6.7.2 A storm event in excess of this design standard would be extreme and would cause the underground oversized pipe system and manholes to surcharge (with no sudden deluge) and then shed overland following the topography (north-east within the northern part of the Site and south-west within the southern part of the Site) as per existing conditions (Drawing 011).

6.7.3 Finished floor levels of new dwellings will be set above external levels, which will mitigate the residual risk of overtopping.

6.8 Foul Drainage

6.8.1 The Site is not currently served by a foul drainage network.

6.8.2 It is proposed that foul flow is discharged to the Ø600mm public combined sewer within Station Road to the south of the Site. Subject to confirmation of invert levels, the topography of the Site may allow for a gravity-fed connection. An indicative drainage layout is included as Drawing 010.

6.8.3 In accordance with Sewers for Adoption (7th Edition), peak foul water discharge from a residential development is 4,000 litres per property per day. Using this method, peak foul

flows are estimated to be 2.08l/s from the 45-unit residential development. The calculated foul flow rate will be reviewed at detailed design stage.

6.8.4 All foul sewerage should be designed in accordance with Building Regulations Part H. In areas where sewers are to be adopted by Yorkshire Water, sewerage should be designed in accordance with Sewers for Adoption (7th Edition) and supplemented with additional standards provided by Yorkshire Water. An application to enter into a Section 104 agreement for sewer adoption must be made in writing to Yorkshire Water prior to any works commencing on Site. A connection point should be agreed with Yorkshire Water.

7.0 Summary and Conclusions

7.1 Introduction

7.1.1 A site-specific Flood Risk Assessment (FRA) has been undertaken for the proposed residential development, located on a 3.80ha Site on land off Station Road, Wombwell.

7.2 Flood Risk

7.2.1 The risk of fluvial flooding from the River Dove is medium for most of the Site, with the north-western corner, the south-western part of the Site and small areas towards the centre at low risk.

7.2.2 The risk of surface water flooding for most of the Site is assessed as negligible. Bulling Dike and the River Dove are associated with high risk surface water flow pathways and there are three areas of low risk ponding within the central northern part of the Site.

7.2.3 The risk of sewer flooding is low.

7.2.4 The risk of flooding from all other sources is negligible.

7.3 Mitigation Measures

7.3.1 Fluvial and surface water flood risk can be mitigated to a negligible level through the following approach:

- Set the finished floor levels of all buildings above the 1 in 100-year (plus 50% climate change) flood level (26.67mAOD) and freeboard allowance.
- Retain external levels as close to existing as feasible.
- Provide level-for-level compensatory flood storage within Flood Zone 2 when the lifetime of the development is considered.
- Provide a 9m easement free from development along either side of Bulling Dike, as per IDB correspondence and an 8m easement free from development along the right bank of the River Dove. These easements would provide access for inspection and maintenance purposes, including vehicle access.
- Production of a Flood Evacuation Management Plan (FEMP) for the proposed development.
- Utilise flood resilient construction.
- Adoption of a surface water management strategy.
- Undertake maintenance activities to keep Bulling Dike clear from debris and overgrown vegetation to maintain the conveyance of the channel.

7.4 Flood Guidance

7.4.1 The proposed residential use is classified as ‘more vulnerable’.

7.4.2 All development is acceptable within Flood Zone 1 and 2. As such, the Sequential Test will be passed, and the Exception Test would not be required.

7.5 Site Drainage

Surface Water

7.5.1 The proposed development will increase the impermeable surfaces and therefore increase the amount of runoff without mitigation.

7.5.2 Surface water runoff from the Site will be restricted to 5l/s which offers a significant betterment when compared to existing undeveloped conditions where runoff is uncontrolled across all return periods.

7.5.3 A SuDS drainage scheme is proposed to manage excess runoff from the development, comprising an underground oversized pipe system designed to maintain runoff below pre-development rates, with an outfall to Bulling Dike.

Foul Water

7.5.4 It is proposed that foul flows will discharge to the public combined sewer within Station Road to the south of the Site. Foul flows have been calculated at 2.08l/s.

7.6 Conclusion

7.6.1 This FRA demonstrates that the proposed development could be operated with minimal risk from flooding, and would not increase flood risk elsewhere, subject to the implementation of a floodplain compensation scheme.

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DRAWINGS

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Samuel House, 5 Fox Valley Way, Stocksbridge, Sheffield, S36 2AA

CLIENT: Hartwood Estates

SCALE: 1:20,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

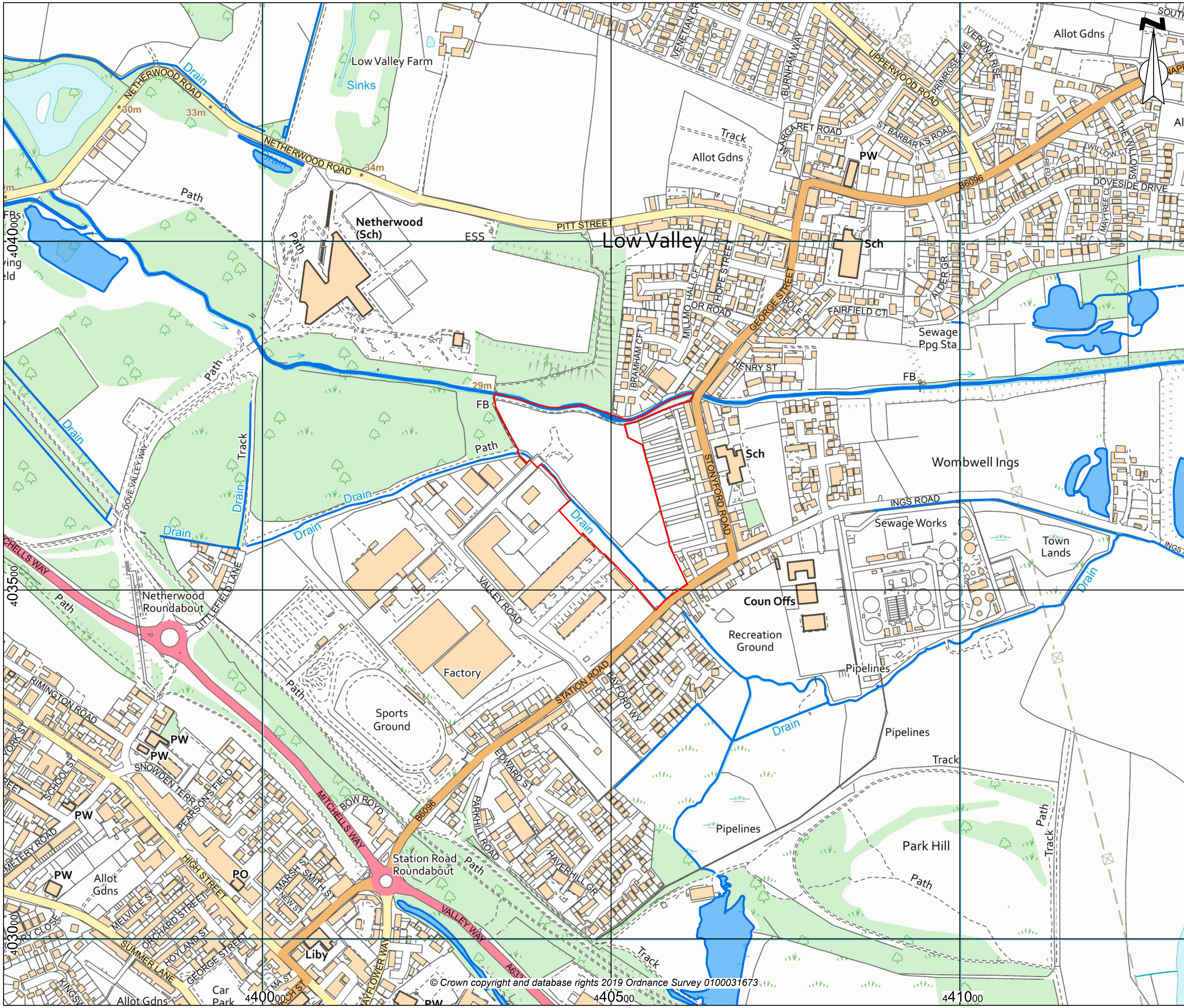
CHECKED: MG

DATE: May 2019

PROJECT: Wombwell Outline Planning Application

TITLE: Site Location Plan

DRAWING NO: CRM.1122.005.HY.D.001



Key

Site Boundary

Surface Water Features

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CLIENT:
Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

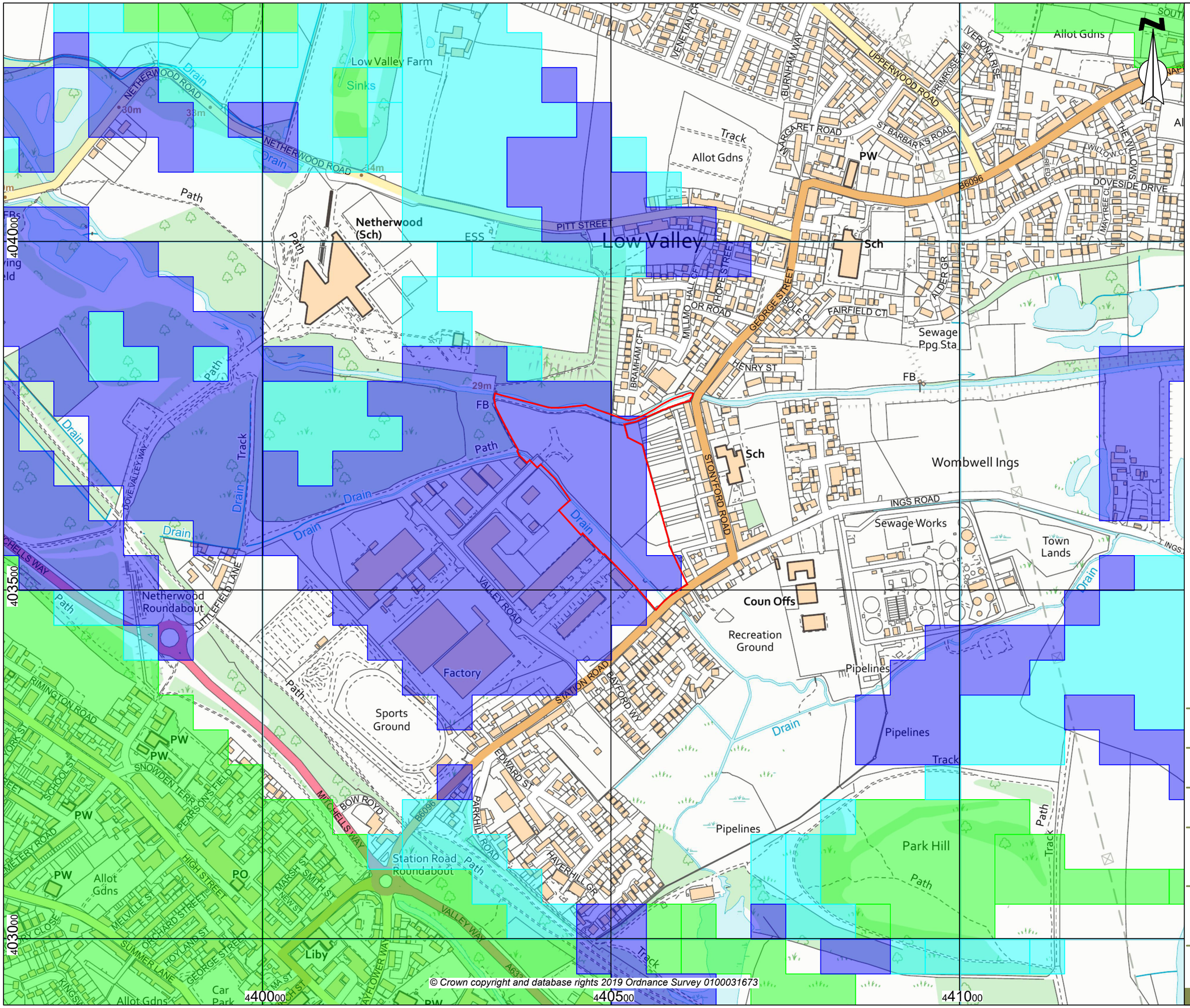
CHECKED: MG

DATE: May 2019

PROJECT:
Wombwell Outline Planning Application

TITLE:
Surface Water Features

DRAWING NO:
SHF.1122.005.HY.D.002



Key

- Site Boundary
- Potential for Groundwater Flooding to Occur at Surface
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Limited Potential for Groundwater Flooding to Occur

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CLIENT: Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

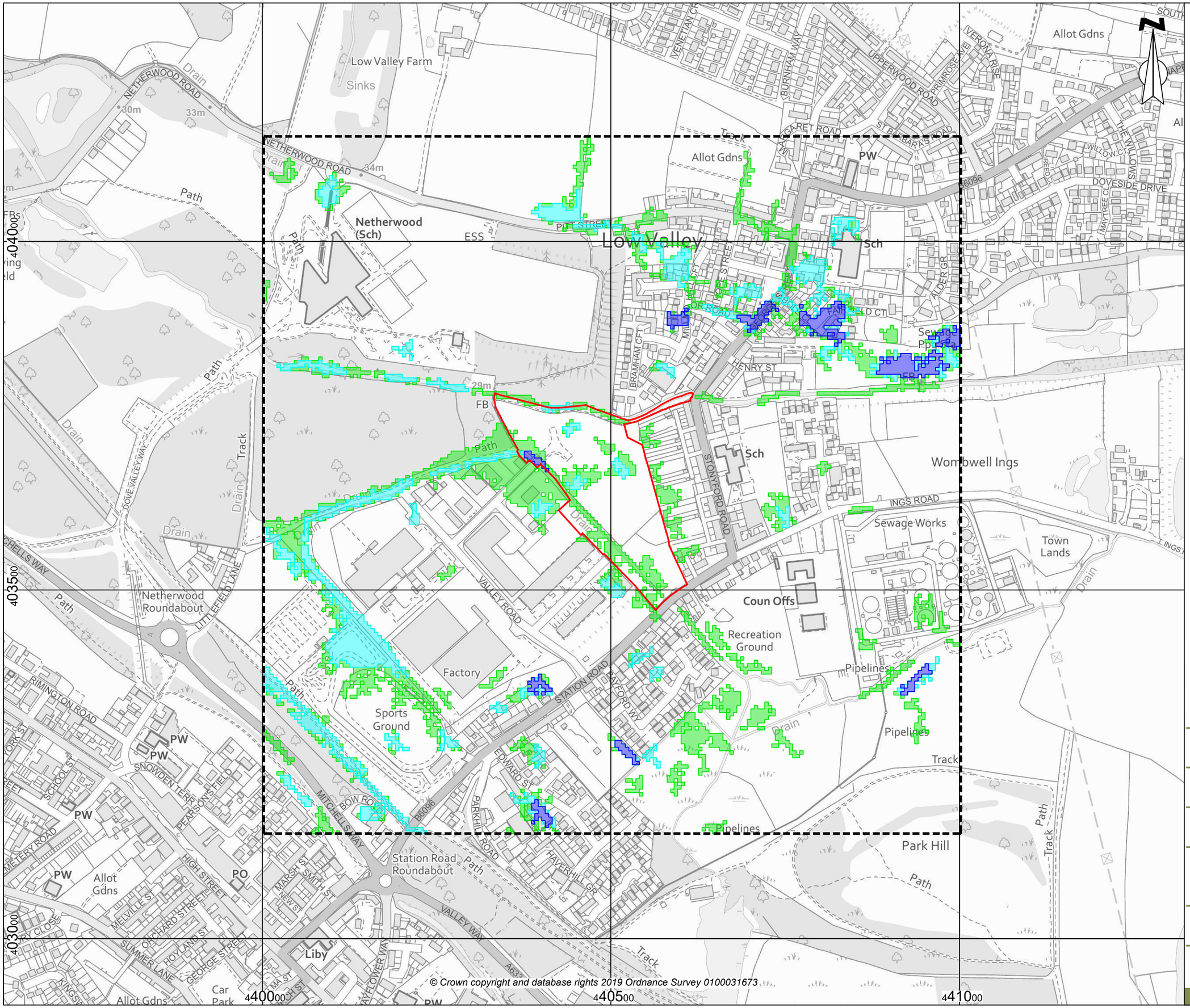
CHECKED: MG

DATE: May 2019

PROJECT: Wombwell Outline Planning Application

TITLE: BGS Groundwater Flooding Susceptibility

DRAWING NO: CRM.1122.005.HY.D.003



Key

- Site Boundary
- Search Extent
- 1 in 75 Year Surface Water Flooding
- 1 in 200 Year Surface Water Flooding
- 1 in 1000 Year Surface Water Flooding

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CLIENT: Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

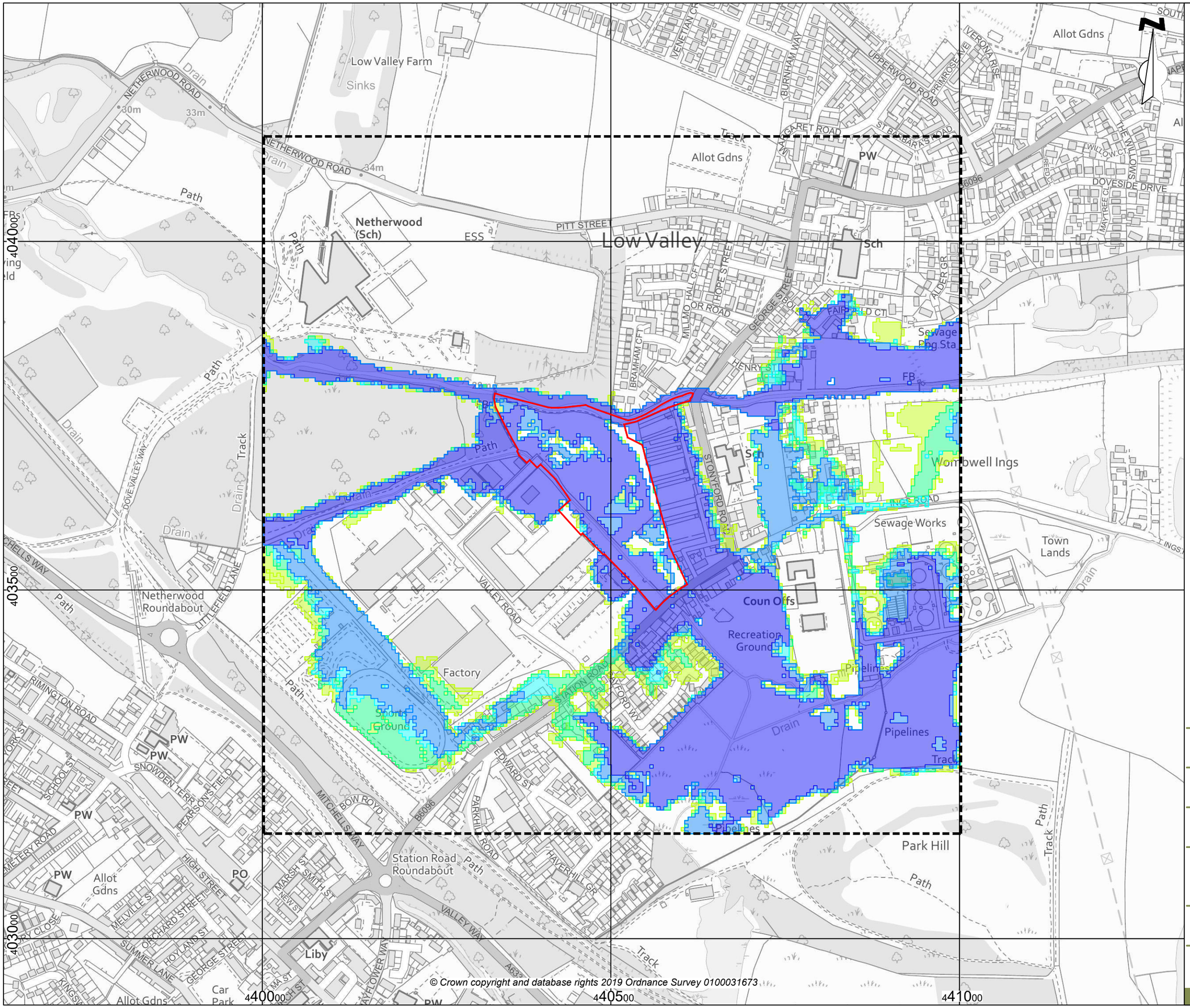
CHECKED: MG

DATE: May 2019

PROJECT: Wombwell Outine Planning Application

TITLE: JBA Surface Water Flooding

DRAWING NO: SHF.1122.005.HY.D.004.1



Key

- Site Boundary
- Search Extent
- 1 in 20 Year Flooding from Rivers
- 1 in 75 Year Flooding from Rivers
- 1 in 100 Year Flooding from Rivers
- 1 in 200 Year Flooding from Rivers
- 1 in 1000 Year Flooding from Rivers

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CLIENT: Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

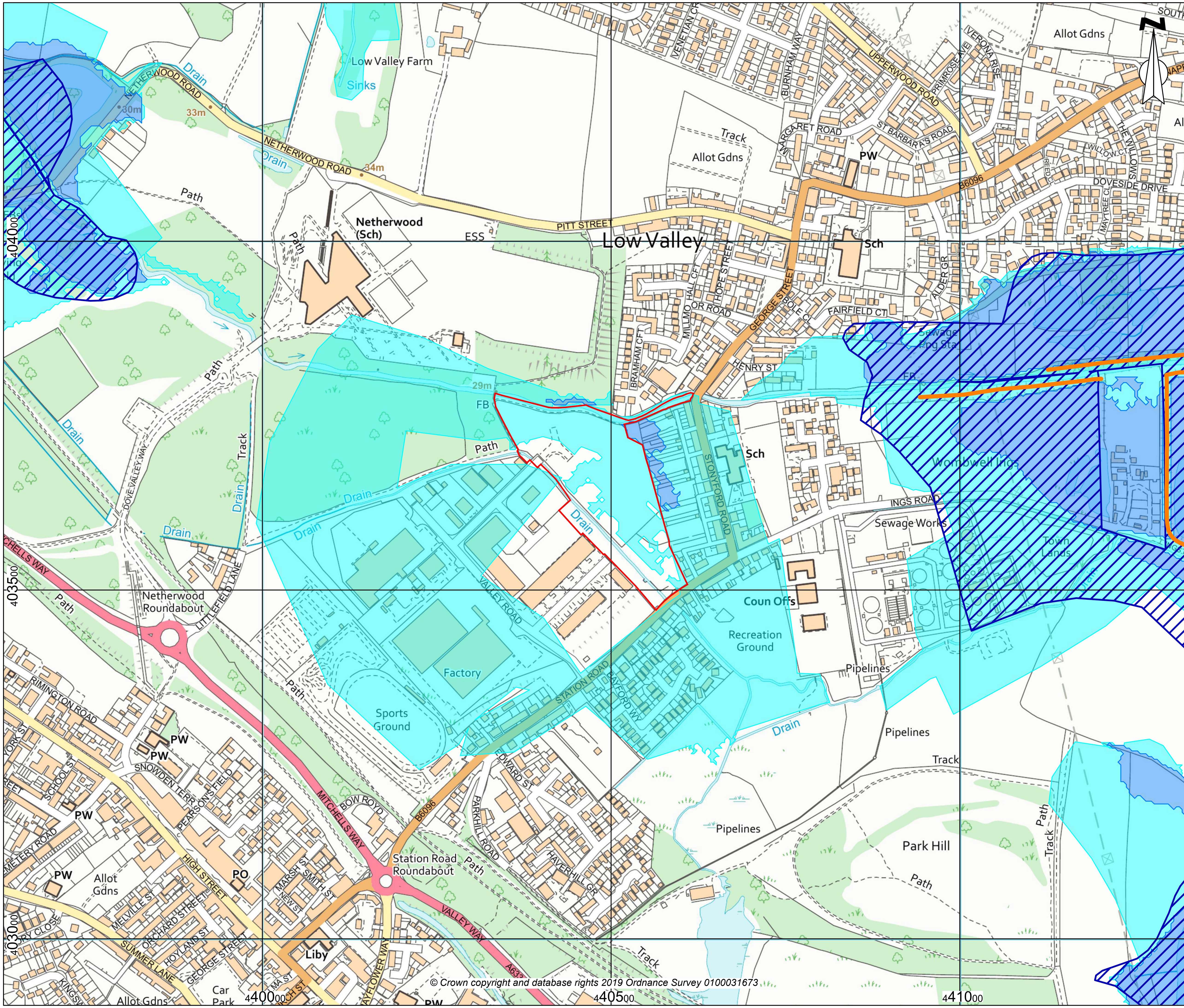
CHECKED: MG

DATE: May 2019

PROJECT: Wombwell Outline Planning Application

TITLE: JBA Flooding from Rivers

DRAWING NO: SHF.1122.005.HY.D.004.2



Key

- Site Boundary
- Flood Defences
- Flood Water Storage Areas
- Flood Zone 3
- Flood Zone 2
- Flood Zone 1

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CLIENT:
Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

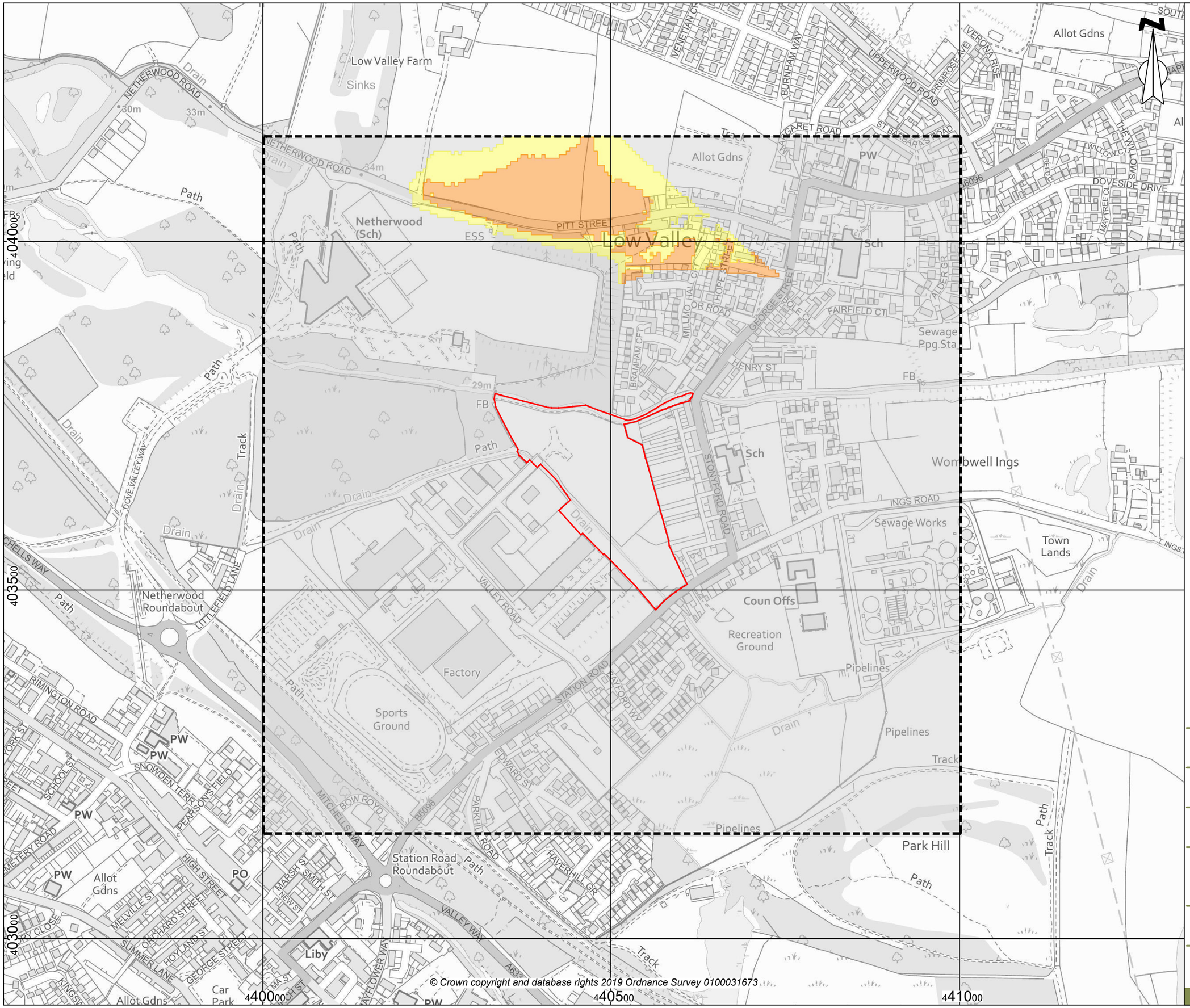
CHECKED: MG

DATE: May 2019

PROJECT:
Wombwell Outline Planning Application

TITLE:
Environment Agency Flood Zones

DRAWING NO:
CRM.1122.005.HY.D.005



Key

- Site Boundary
- Search Extent
- Class 1 - High Risk
- Class 2 - Moderate Risk
- Class 3 - Low Risk
- Class 4 - Negligible Risk

Notes:

GEOSMART GROUNDWATER FLOOD RISK MAP GW5
Version 2.2© - www.geosmartinfo.co.uk

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CLIENT: Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

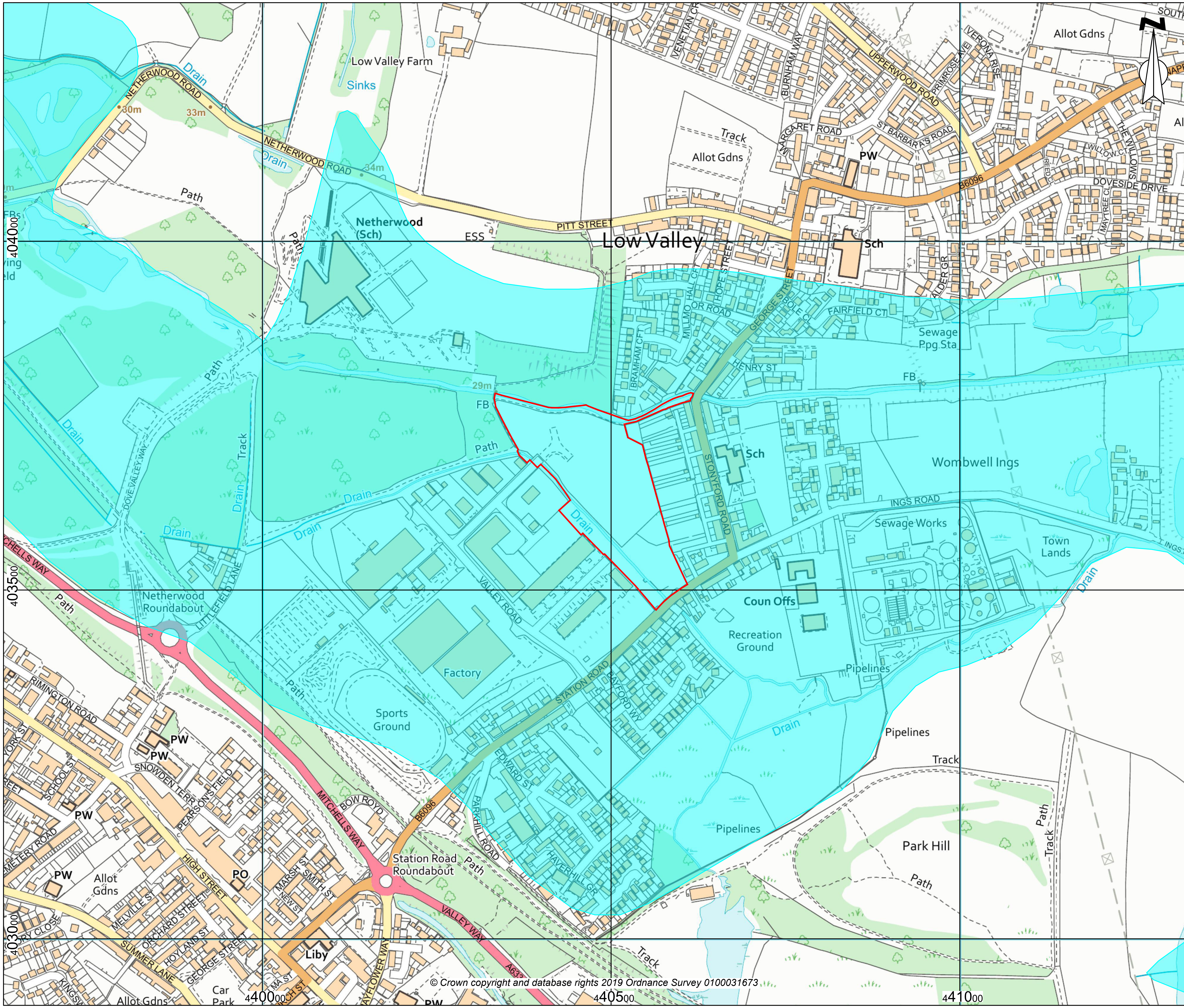
CHECKED: MG

DATE: May 2019

PROJECT: Wombwell Outline Planning Application

TITLE: Groundwater Flood Risk Map

DRAWING NO: CRM.1122.005.HY.D.006



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Key

- Site Boundary
- Geological Indicators of Flooding *from Inland Flooding*

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CLIENT:
Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

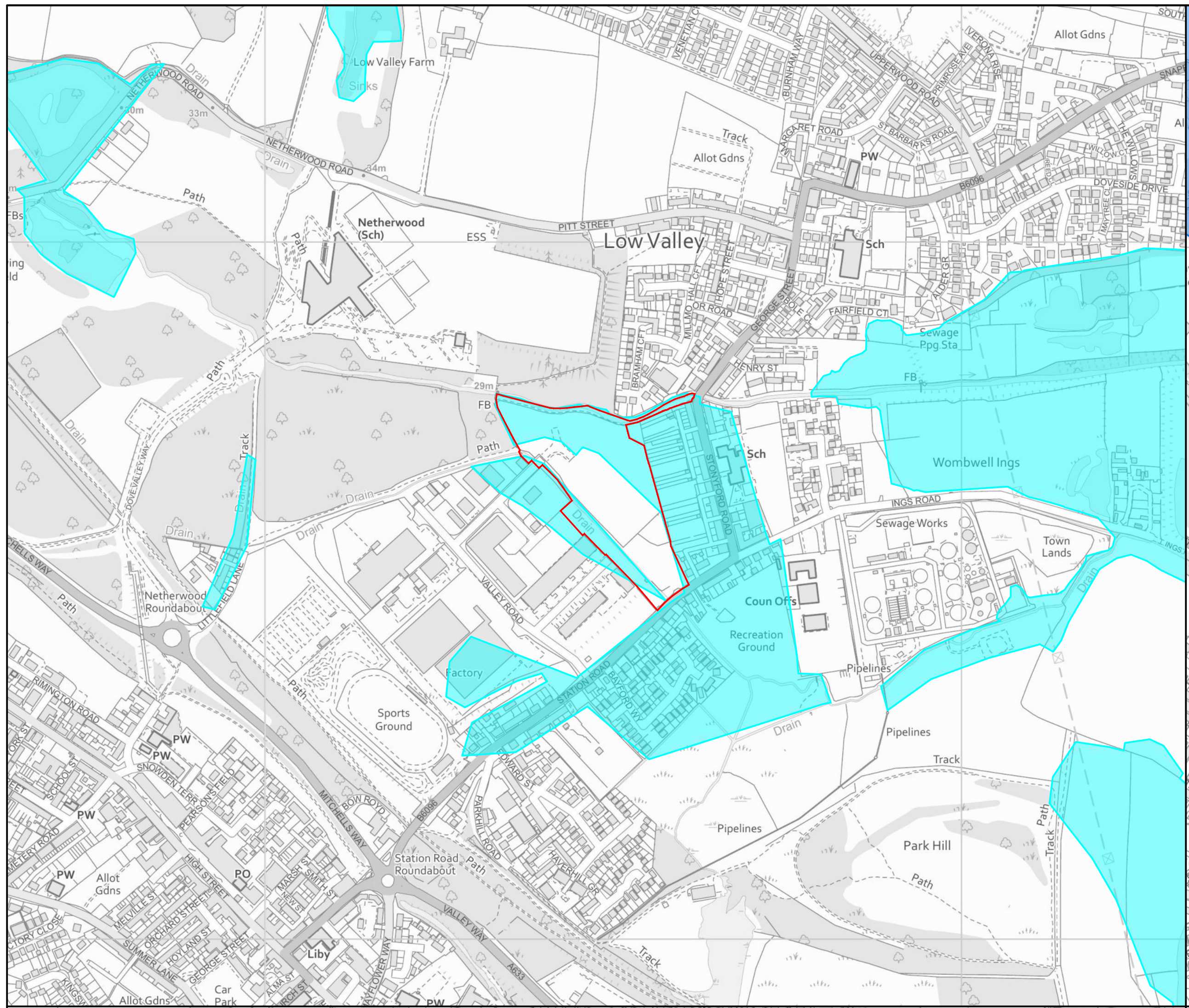
CHECKED: MG

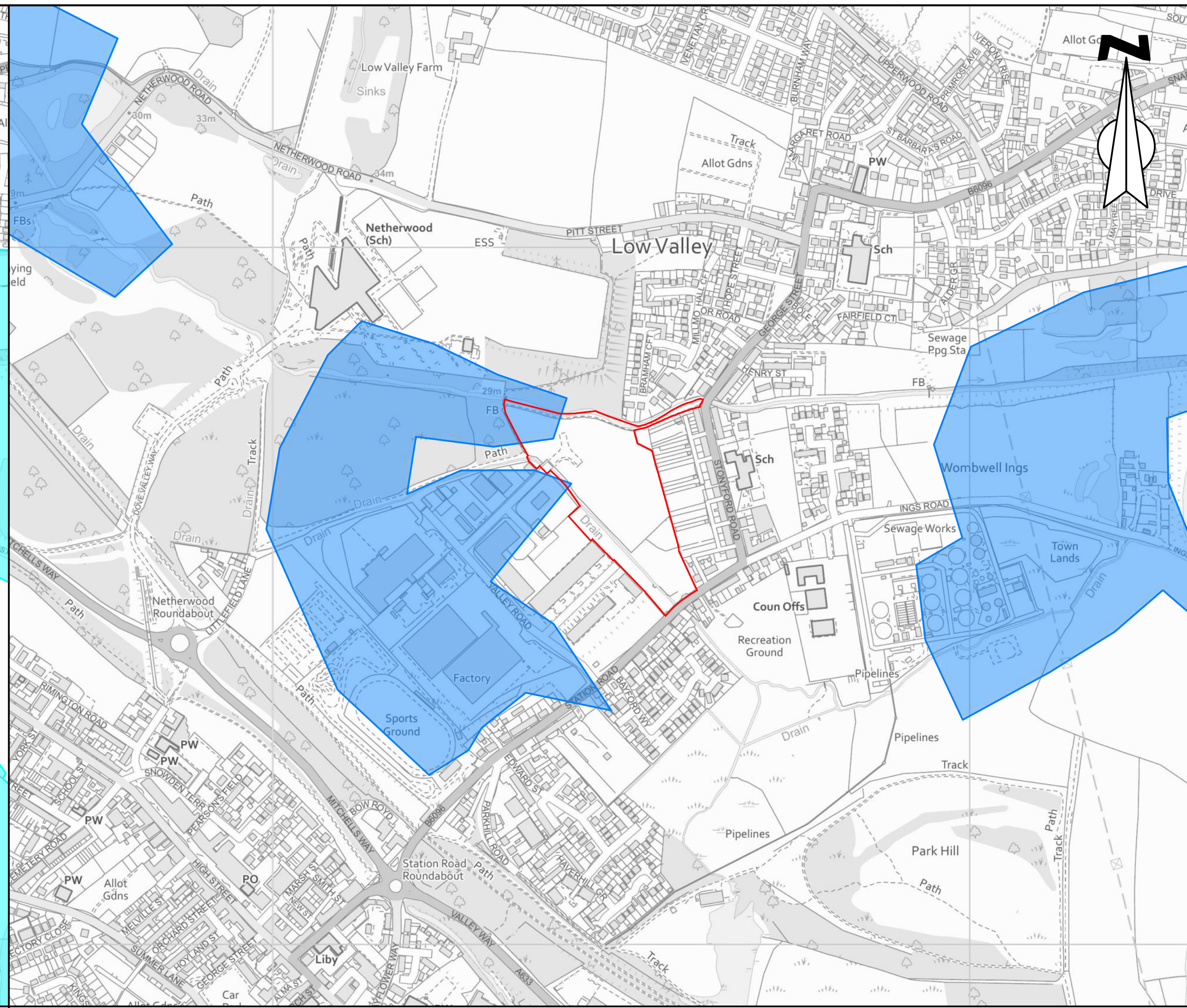
DATE: May 2019

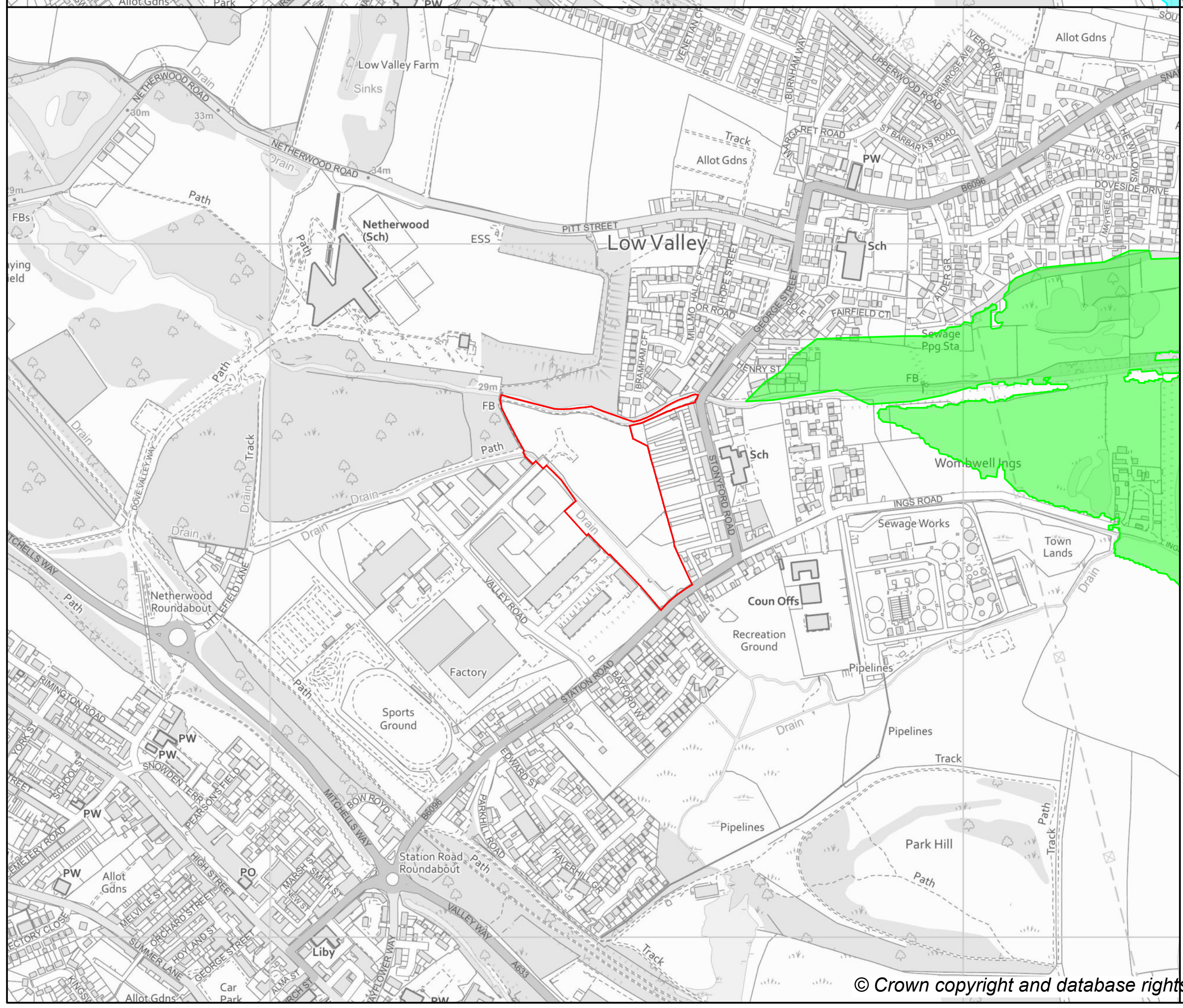
PROJECT:
Wombwell Outline Planning Application

TITLE:
Geological Indicators of Flooding
(based on geological deposits)

DRAWING NO:
SHF.1122.005.HY.D.007







Key

Site Boundary

Historic Flood Zone
(Date of flood 25/06/2007 - 26/06/2007)

Historic Flood Zone
(Date of flood 19/03/1947 - 22/03/1947)

Historic Flood Zone
(Date of flood 06/11/2000 - 04/12/2000)

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CLIENT:
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SCALE: 1:10,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

CHECKED: MG

DATE: May 2019

PROJECT:
Wombwell Outline Planning Application

TITLE:
Historic Flood Events

DRAWING NO:
CRM.1122.005.HY.D.008

Key

- Site Boundary
- Search Extent
- 30 Year Extent
- 100 Year Extent
- 1000 Year Extent
- Flow Direction

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CLIENT: Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

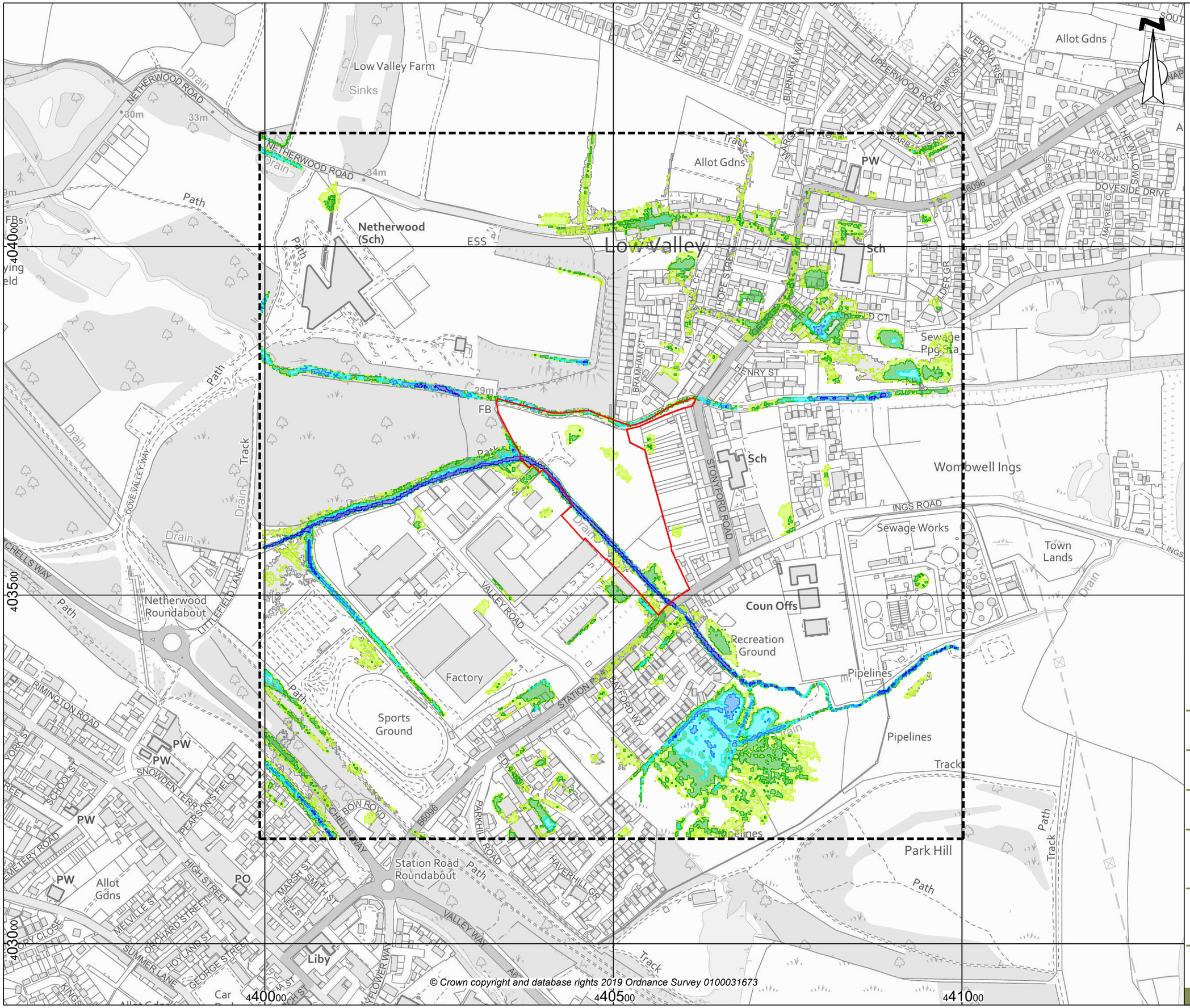
CHECKED: MG

DATE: May 2019

PROJECT: Wombwell Outline Planning Application

TITLE: Environment Agency Surface Water Flow Paths

DRAWING NO: CRM.1122.005.HY.D.009.1



Key

- Site Boundary
- Search Extent
- Depth greater than 1.20 (m)
- Depth 0.90 - 1.20 (m)
- Depth 0.60 - 0.90 (m)
- Depth 0.30 - 0.60 (m)
- Depth 0.15 - 0.30 (m)
- Depth 0.0 - 0.15 (m)

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CLIENT: Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

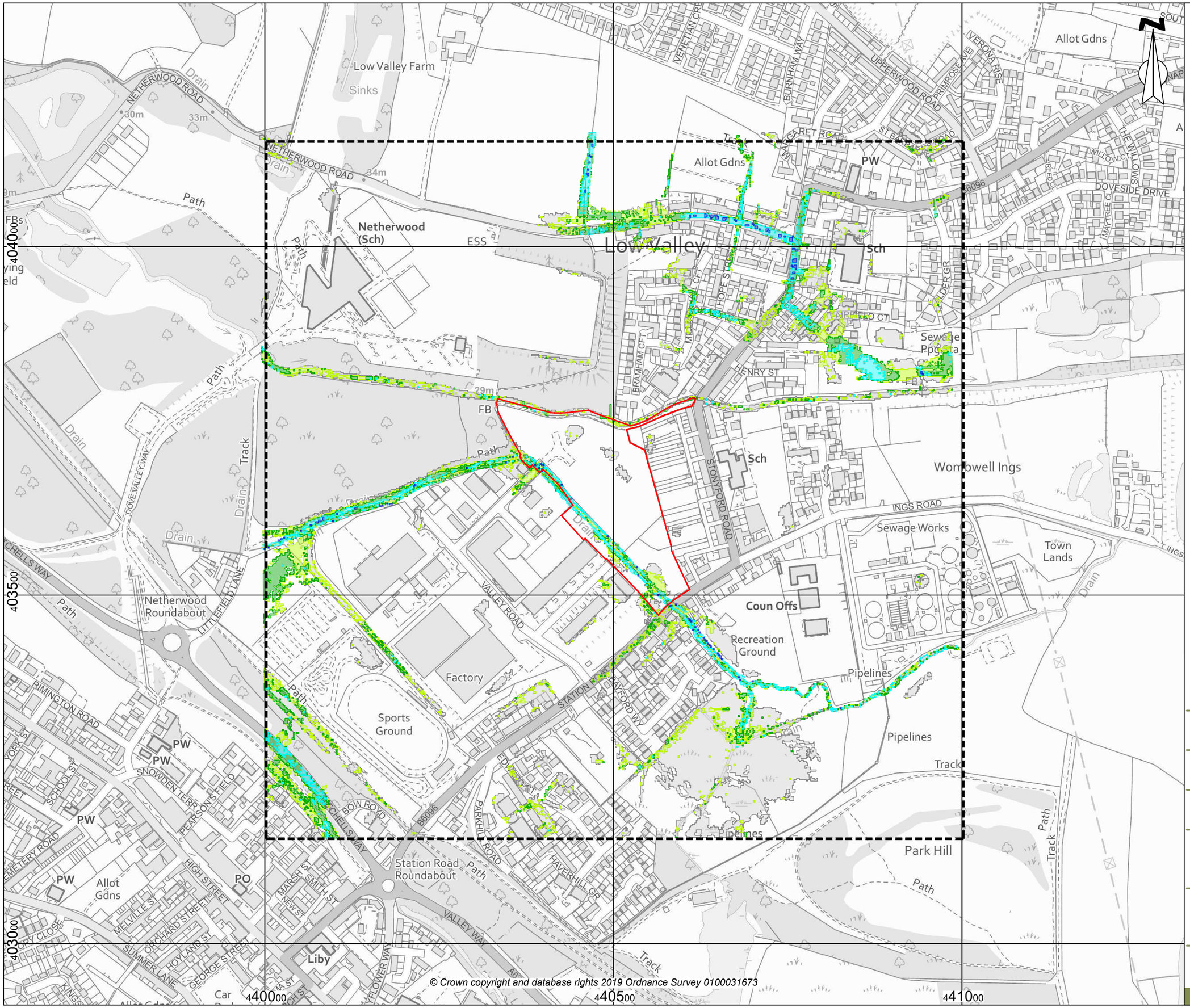
CHECKED: MG

DATE: May 2019

PROJECT: Wombwell Outline Planning Application

TITLE: Environment Agency 1 in 1000 Year Surface Water Depth

DRAWING NO: CRM.1122.005.HY.D.009.2



Key

- Site Boundary
- Search Extent
- Velocity 2.00 or greater (m/s)
- Velocity 1.00 - 2.00 (m/s)
- Velocity 0.50 - 1.00 (m/s)
- Velocity 0.25 - 0.50 (m/s)
- Velocity 0.00 - 0.25 (m/s)

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CLIENT: Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

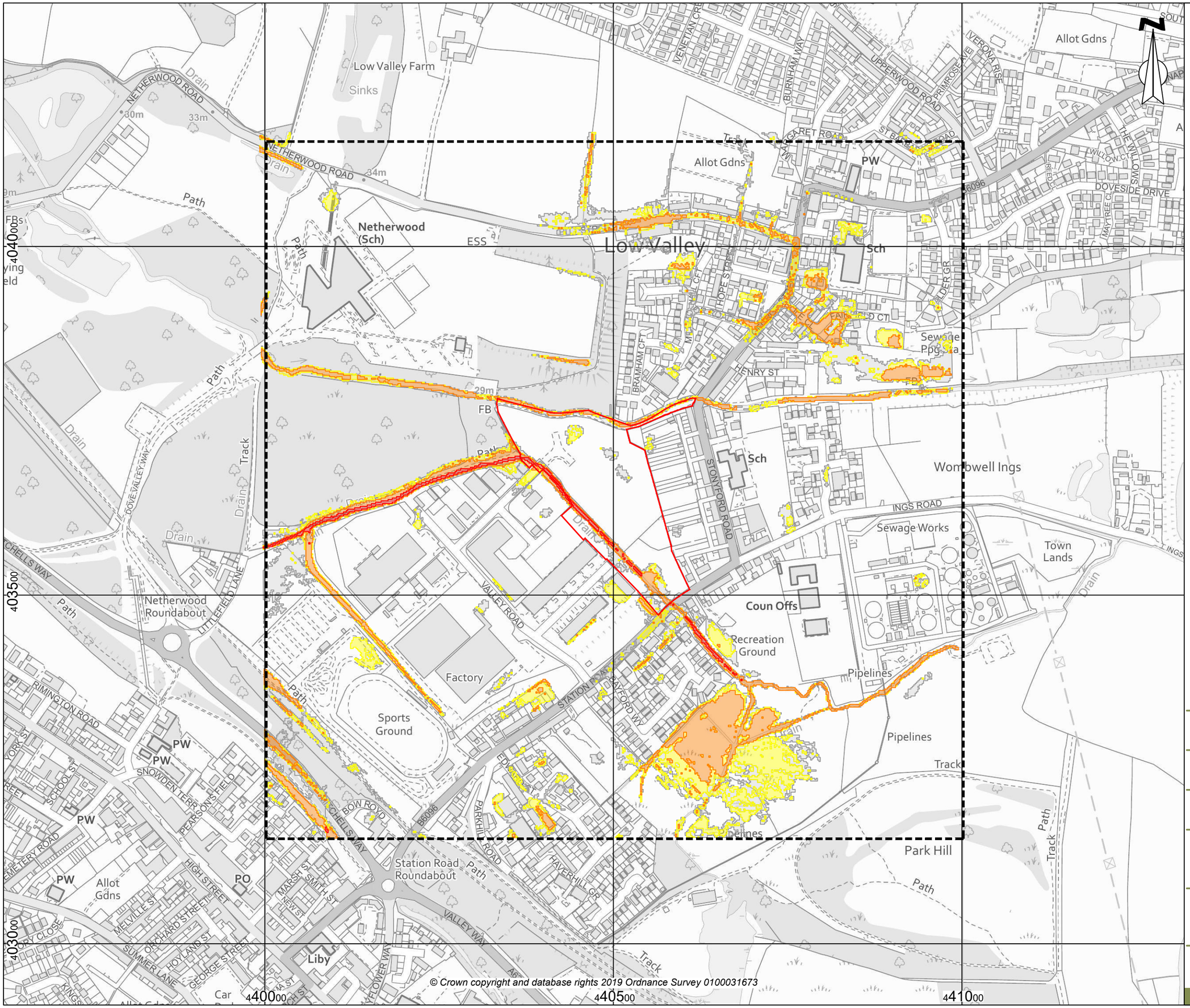
CHECKED: MG

DATE: May 2019

PROJECT: Wombell Outline Planning Application

TITLE: Environment Agency 1 in 1000 Year Surface Water Velocity

DRAWING NO: CRM.1122.005.HY.D.008.3



Key

- Site Boundary
- Search Extent
- Extreme Hazard (> 2.0)
- Significant Hazard (1.25 - 2.00)
- Moderate Hazard (0.75 - 1.25)
- Low Hazard (0.50 - 0.75)

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CLIENT: Hartwood Estates

SCALE: 1:5,000@A3

PROJECT REF: CRM.1122.005

DRAWN: CH

CHECKED: MG

DATE: May 2019

PROJECT: Wombell Outline Planning Application

TITLE: Environment Agency Surface Water 1000 Year Hazard Rating

DRAWING NO: CRM.1122.005.HY.D.009.4

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29m

FB

Path

BRAM

ENR

Sch

STONYFORD ROAD

Attenuation crate to be confirmed by manufacturer design and layout.

660m2 (+3m) UNDERGROUND SW ATTENUATION

Southern Attenuation Crate Tank:
Developable Area: 2.72ha
Impermeable Area: 1.496ha
GL - 26.800
Top of Tank - 25.800
Bottom of Tank - 23.800

5l/s Discharge to Bulling Dyke:
Storage Volume Required - 1318m3

Outfall from attenuation crate to be pumped into the Bulling Dyke
Outfall:
BL - 23.39
IL - 24.96

BILLING DIKE

VALLEY ROA

Foul to discharge to existing public sewer, subject to agreement by Water Authority. Levels of existing sewer to be confirmed

Cou

NOTES

1. DO NOT SCALE.
2. This drawing is to be read in conjunction with all other relevant drawings.
3. Should there be any conflict between the details indicated on this drawing and those indicated on other drawings, the Engineer should be informed PRIOR to construction on site.
4. Until Technical Approval has been obtained from the relevant Authority, it should be understood that all drawings issued are Preliminary and Not for Construction. Should the Contractor commence site work prior to Approval being given, it is entirely at his own risk.
5. All dimensions are in metres U.N.O.
6. All levels in metres.
7. All pipe sizes in mm unless noted otherwise
8. All cover levels are indicative only and should be confirmed by architect / landscape architect
9. Positions of FWDP and RWP to be confirmed by client / architect
10. Abandoned buried pipework to be grouted or removed
11. Linear drainage channels, pumping stations, attenuation tanks and any other specialist equipment to manufacturers design and specification
12. Cover levels indicative, subject to architects and landscape plan
13. Contractor to confirm no live connections before abandoning pipes
14. Grease traps assumed to be internal to kitchens etc.
15. For design of above ground facilities / pipework refer to M&E Engineer
16. Internal manholes to be double sealed.

Key

- Site Boundary 3.80ha
- 100 Year+50% Climate change
- Indicative Foul Drainage
- Indicative Surface Water Drainage
- Existing Foul Sewer
- Existing Combined Sewer

REV:	DATE:	DETAIL:	DES:	CHK:	APP:
P06	28.08.19	New development framework added.	CH	IH	IH
P05	23.07.19	Indicative drainage networks added. Existing sewers added.	CH	MGg	IH
P04	16.07.19	Updated DFP recieved. Drainage strategy changed to suit.	CH	MGg	IH
P03	20.06.19	Attenuation crate designed to suit a discharge of 5l/s	CH	MGg	IH
P02	14.05.19	Development framework plan updated. Ponds redesigned to suit.	CH	MGg	IH
P01	03.05.19	Initial issue	CH	MGg	IH

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CLIENT: Hartwood Estates

PROJECT: Wombwell Outline Planning Application

DRAWING TITLE: Indicative Drainage Strategy

DRAWN:	DESIGNED:	CHECKED:	APPROVED:
CH	CH	IH	IH

DATE:	SCALE @ A1:
03/05/2019	NTS

PROJECT NO.:	DRAWING NO.:
CRM.1122.005	010

DRAWING STATUS:	ISSUE:
PRELIMINARY	P05

NOTES

1. DO NOT SCALE.
2. This drawing is to be read in conjunction with all other relevant drawings.
3. Should there be any conflict between the details indicated on this drawing and those indicated on other drawings, the Engineer should be informed PRIOR to construction on site.
4. Until Technical Approval has been obtained from the relevant Authority, it should be understood that all drawings issued are Preliminary and Not for Construction. Should the Contractor commence site work prior to Approval being given, it is entirely at his own risk.
5. All dimensions are in metres U.N.O.
6. All levels in metres.
7. All pipe sizes in mm unless noted otherwise
8. All cover levels are indicative only and should be confirmed by architect / landscape architect
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11. Linear drainage channels, pumping stations, attenuation tanks and any other specialist equipment to manufacturers design and specification
12. Cover levels indicative, subject to architects and landscape plan
13. Contractor to confirm no live connections before abandoning pipes
14. Grease traps assumed to be internal to kitchens etc.
15. For design of above ground facilities / pipework refer to M&E Engineer
16. Internal manholes to be double sealed.

Key

- Site Boundary 3.80ha
- Flow Path Arrow
- Contours
- Northern Area 1.40ha
- Southern Area 2.40ha

REV.	DATE:	DETAIL:	DES:	CHK:	APP:
P01	21.05.19	Initial issue	CH	IH	IH

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CLIENT: Hartwood Estates

PROJECT: Wombwell Outline Planning Application

DRAWING TITLE: Catchment Areas Drawing

DRAWN:	DESIGNED:	CHECKED:	APPROVED:
CH	CH	IH	IH

DATE:	SCALE @ A1:
21/05/2019	NTS

PROJECT NO.:	DRAWING NO.:
CRM.1122.005	11

DRAWING STATUS:	ISSUE:
PRELIMINARY	P01

APPENDICES

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Appendix 1 – Site Layout

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DEVELOPMENT AREAS:

RESIDENTIAL DEVELOPMENT AREA	= 2.77 HECTARES (111 UNITS @40 DPH)
PUBLIC OPEN SPACE & DRAINAGE	= 1.07 HECTARES (28%)
GROSS AREA	= 3.84 HECTARES

REV	DATE	DESCRIPTION	BY	CHECK
C	27.08.19	LAYOUT AMENDED TO INCORPORATE NO DEVELOPMENT WITHIN 5M OF BILLING DIKE	LB	
B	05.07.19	ATTENUATION SHOWN AS 660M2 UNDERGROUND STORAGE WITH 3M EASEMENT	LB	
A	10.05.19	2 ATTENUATION BASINS SHOWN AS PER ENGINEERS COMMENTS	LB	

NORTH

1:1000 SCALE

10m 100m

jrp ARCHITECTURE | PLANNING | LANDSCAPE

CLIENT:
HARTWOOD ESTATES

PROJECT:
STATION ROAD
WOMBWELL

DRAWING:
ILLUSTRATIVE MASTERPLAN

DRAWING NUMBER:
P08 4141 SK102

SCALE @ A2:
1:1000

DATE:
APRIL 2019

SK102 / ILLUSTRATIVE MASTERPLAN

14 MARINER COURT / CALDER PARK / WAKEFIELD / WF4 3FL
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Appendix 2 – Topographic Survey

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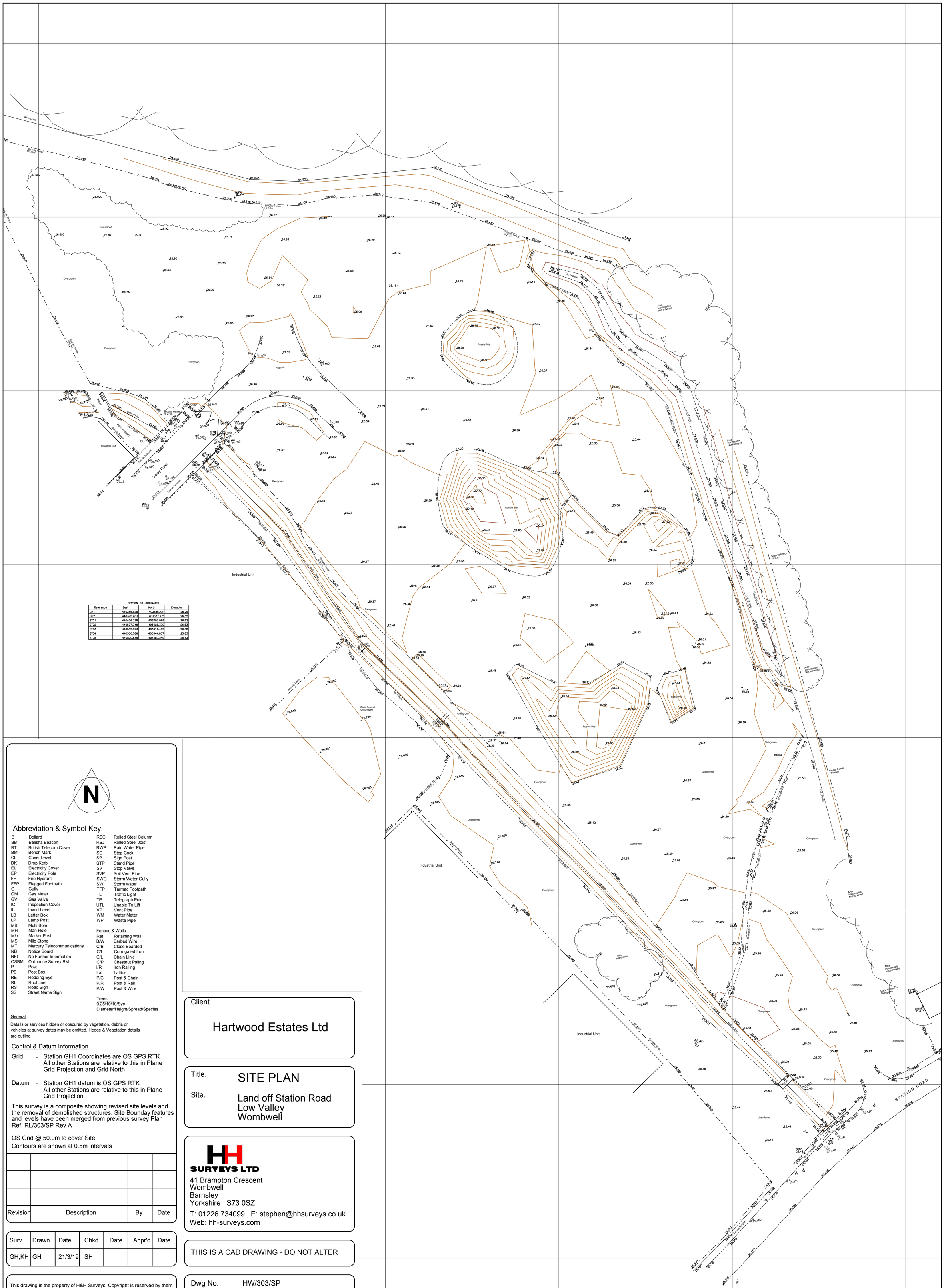

STATION CO-ORDINATES

Reference	East	North	Elevation
GH1	440386.525	403686.721	26.29
GH2	440395.463	403677.971	26.32
ST01	440426.328	403703.969	26.92
ST02	440507.748	403626.379	26.53
ST03	440552.823	403614.462	26.38
ST04	440550.786	403544.857	25.83
ST05	440570.849	403480.249	25.43

N

Abbreviation & Symbol Key.

B	Bollard
BB	Belisha Beacon
BT	British Telecom Cover
BM	Bench Mark
CL	Cover Level
DK	Drop Kerb
EL	Electricity Cover
EP	Electricity Pole
FH	Fire Hydrant
FFP	Flagged Footpath
G	Gully
GM	Gas Meter
GV	Gas Valve
IC	Inspection Cover
IL	Invert Level
LB	Letter Box
LP	Lamp Post
MB	Multi Bole
MH	Man Hole
Mkr	Marker Post
MS	Mile Stone
MT	Mercury Telecommunications
NB	Notice Board
NFI	No Further Information
OSBM	Ordnance Survey BM
P	Post
PB	Post Box
RE	Rodding Eye
RL	RootLine
RS	Road Sign
SS	Street Name Sign

RSC	Rolled Steel Column
RSJ	Rolled Steel Joist
RWP	Rain Water Pipe
SC	Stop Cock
SP	Sign Post
STP	Stand Pipe
SV	Stop Valve
SVP	Soil Vent Pipe
SWG	Storm Water Gully
SW	Storm water
TFP	Tarmac Footpath
TL	Traffic Light
TP	Telegraph Pole
UTL	Unable To Lift
VP	Vent Pipe
WM	Water Meter
WP	Waste Pipe

Fences & Walls

Ret	Retaining Wall
B/W	Barbed Wire
C/B	Close Boarded
C/I	Corrugated Iron
C/L	Chain Link
C/P	Chestnut Paling
I/R	Iron Railing
Lat	Lattice
P/C	Post & Chain
P/R	Post & Rail
P/W	Post & Wire

Trees
0.25/10/10/Syc
Diameter/Height/Spread/Species

General

Details or services hidden or obscured by vegetation, debris or vehicles at survey dates may be omitted. Hedge & Vegetation details are outline

Control & Datum Information

Grid - Station GH1 Coordinates are OS GPS RTK
All other Stations are relative to this in Plane Grid Projection and Grid North

Datum - Station GH1 datum is OS GPS RTK
All other Stations are relative to this in Plane Grid Projection

This survey is a composite showing revised site levels and the removal of demolished structures. Site Bounday features and levels have been merged from previous survey Plan Ref. RL/303/SP Rev A

OS Grid @ 50.0m to cover Site
Contours are shown at 0.5m intervals

Revision	Description	By	Date

Surv.	Drawn	Date	Chkd	Date	Appr'd	Date
GH,KH	GH	21/3/19	SH			

Client.

Hartwood Estates Ltd

Title. SITE PLAN

Site. Land off Station Road
Low Valley
Wombwell

HH SURVEYS LTD
41 Brampton Crescent
Wombwell
Barnsley
Yorkshire S73 0SZ
T: 01226 734099 , E: stephen@hhsurveys.co.uk
Web: hh-surveys.com

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Dwg No. HW/303/SP

Sheet No.

SCALE	1/500	REV.	

Do not print

Appendix 3 – SFRA Mapping Extracts

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North

HUDDERSFIELD

RIVER DEARNE

Sough Dike

RIVER DOVE

RIVER DON

Knoll Beck

PENISTONE

THURLSTONE MOORS

LANGSETT MOORS

HARDEN MOOR

MIDHOPE MOORS

STOCKSBRIDGE

HOWARTH MOORS

UPPER COMMONS

BROOMHEAD MOOR

HOWDEN MOORS

BRADFIELD MOORS

BIRCHINLEE PASTURE

BOWSTED PASTURE

DERWENT MOORS

EDALE MOOR

HOLMFIRTH

ROYSTON

HEMSWORTH

WORSBROUGH

HOYLAND

THURNSCOE

MEXBOROUGH

SWINTON

CONISBROUGH

RAWMARSH

ROTHERHAM

SHEFFIELD

1:126,172

LEGEND

- Barnsley MBC Boundary
- Main River

Historical Flood Extents

- June 2007
- Autumn 2000
- January 1982
- March 1947

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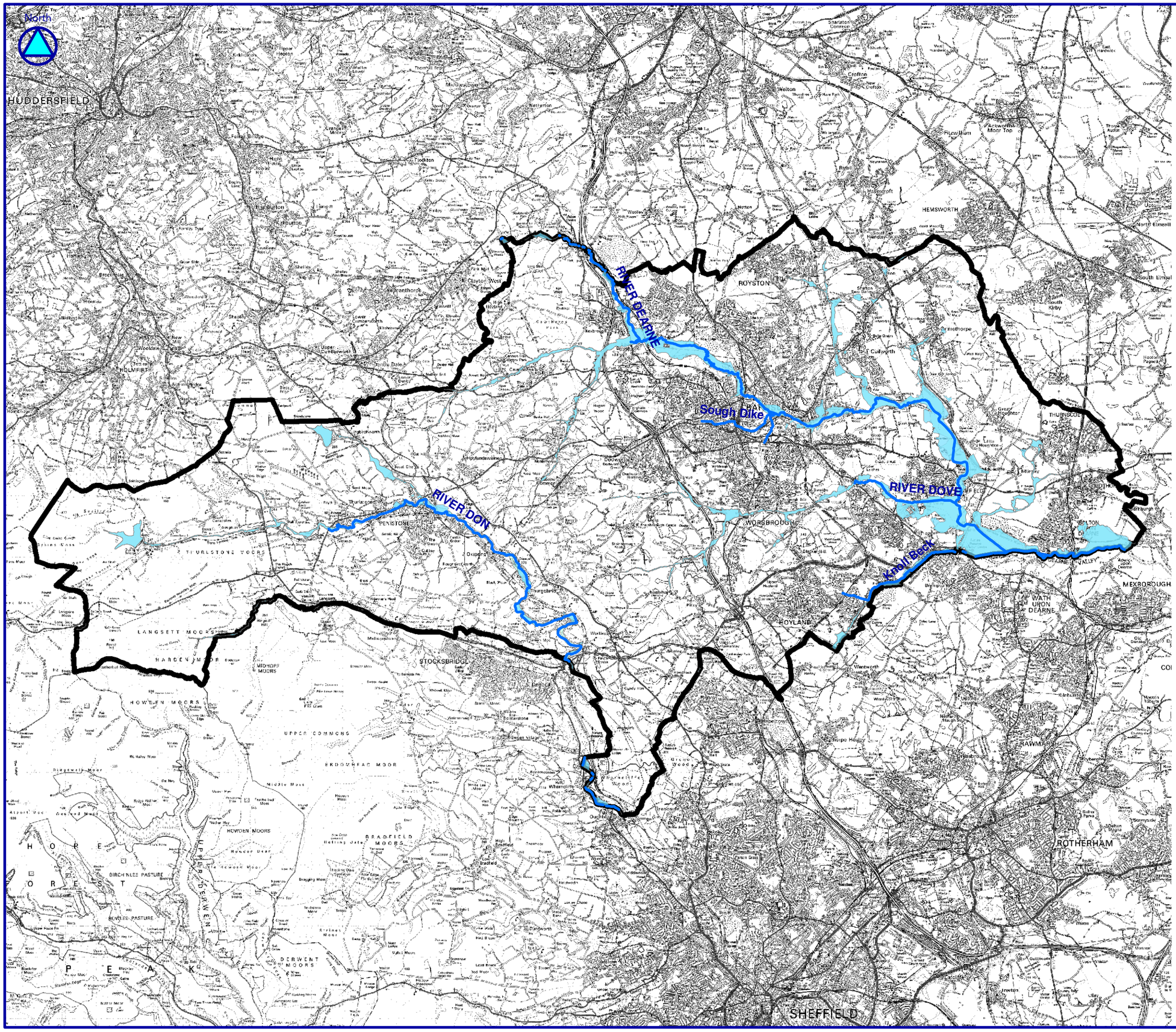
MAP 2

HISTORICAL FLOOD EVENTS



LEGEND

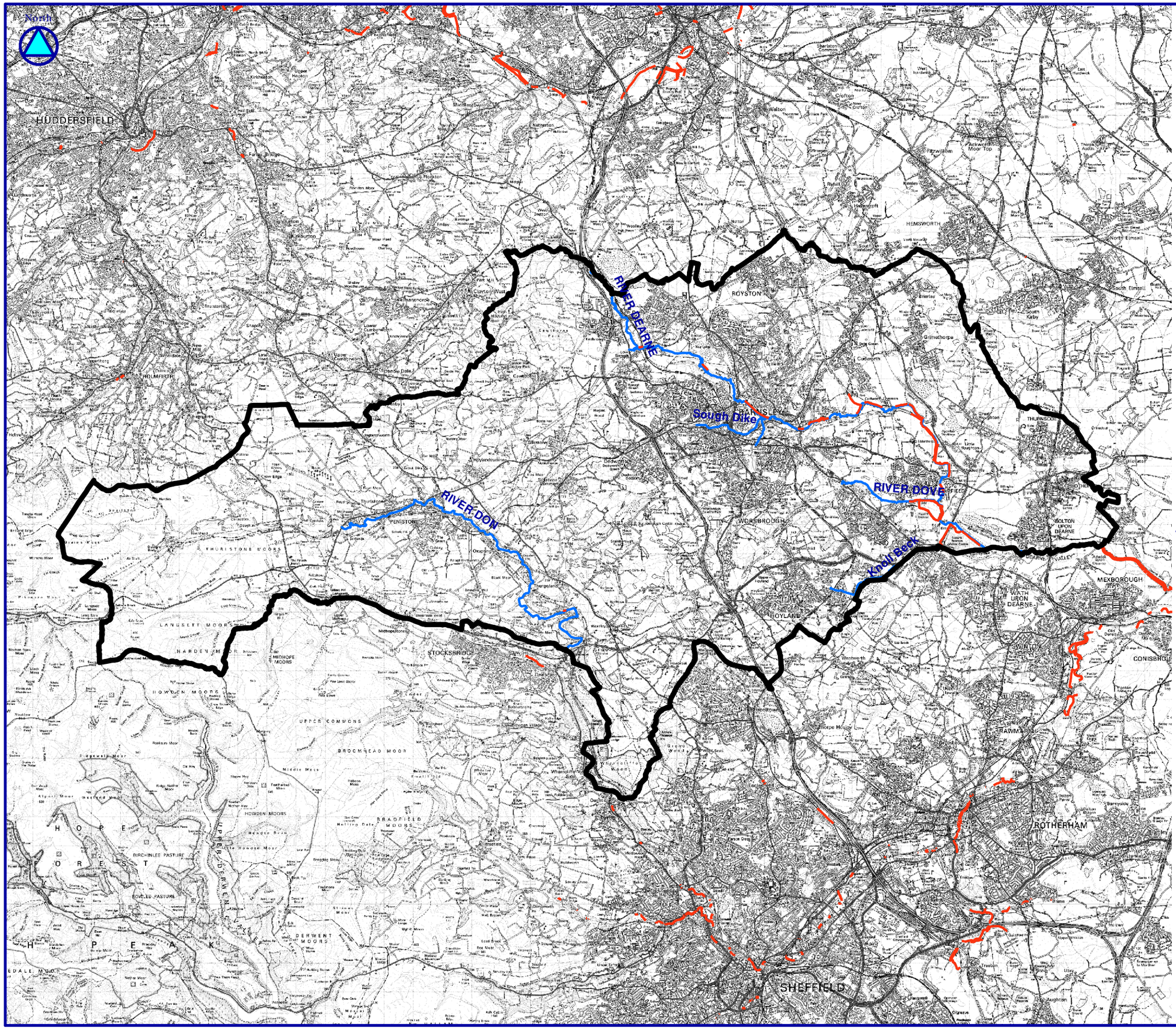
1:120,000

- Main River
- Flood Zone 2
- Barnsley MBC Boundary

JBA CONSULTING

MAP 4

FLOOD ZONE 2



1:126,172

LEGEND

Barnsley MBC Boundary

Main River

Existing Flood Defences

Flood Defence

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MAP 5

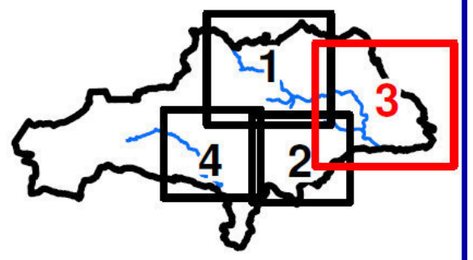
EXISTING DEFENCES

North

SAF26 NE1/12 HS39 HS41 HS37 SAF28 HS35 SAF35 ES21 HS27 HS26 ES11 HS20 HS23 HS21 DE1/13 SAF19 HS15 HS47 HS49 HS51 SAF25 WW4/3 SAF5 SAF4 SAF33 SAF1 SAF36 SAF38 SAF24

Upper Cudworth
Grimethorpe Hall
Brierley Manor
Grimethorpe
Belle Green
Cudworth
Burntwood Hall
Country Park
Howell Wood
Broad Lane Fm
Hooton Pagnell Wood
West Haigh Wood
Houghton Lodge
Howell Ho
Frickley Hall
Wink Ho
Hargate Hill
New Park Spring
Clayton
Cudworth Common
Little Park Cemy
Great Houghton
Barnsley Boundary Walk
THURNSCOE
Horse-Carr Wood
Tyers Hall Fm
Crook House Fm
Opencast Workings
Sandhill
Bilham House Fm
Stotfold
Wood Laithes Fm
Edderthorpe
Little Houghton
Ardsley
Cranford Hall
Low Laithes
Middlecliffe
Billingley
Millhouses
Billingley Green
GOLDTHORPE
Bella Wood
Snape Hill
RIVER DEARNE
RIVER DOVE
Low Valley
Wombwell
Nature Reserve
Broomhill
Nature Reserve Visitor Centre
Barnsley Boundary Walk
Trans-Pennine Trail
BOLTON UPON DEARNE
Barnburgh
DEARNE VALLEY
Adwick upon Dearne
Hemingfield
Brampton en le Morthen
MEXBORO

KEYPLAN



LEGEND

1:32,596

- Barnsley MBC Boundary
- Defence
- Main River
- Possible route of restored canal
- Flood Zone 3
- Flood Zone 2

Proposed Development Sites

- Employment Sites
- Housing Sites
- UDP Sites
- Safeguarded Land

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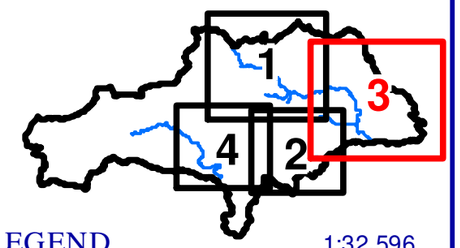
MAP A - 3

PROPOSED DEVELOPMENT SITES AND FLOOD ZONES

North

KEYPLAN



LEGEND 1:32,596

Barnsley MBC Boundary

Urban Areas

Main River

Surface Water Flooding

Flood Depth (m)

0.15 - 0.3

0.3 - 0.5

0.5 - 1

1 - 1.5

1 - 2

> 2

Note:
Please see Section 5.8 of the SFRA for further details.

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MAP C - 3

PLUVIAL FLOODING CAUSED BY 100YEAR RAINSTORM

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Appendix 4 – Yorkshire Asset Plans

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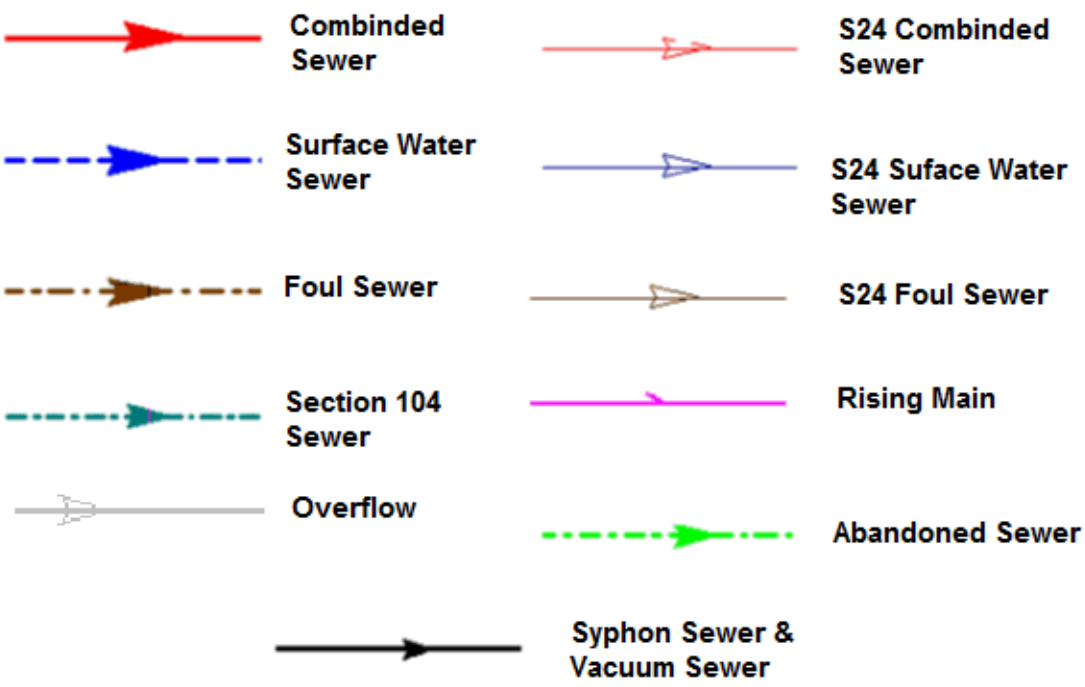
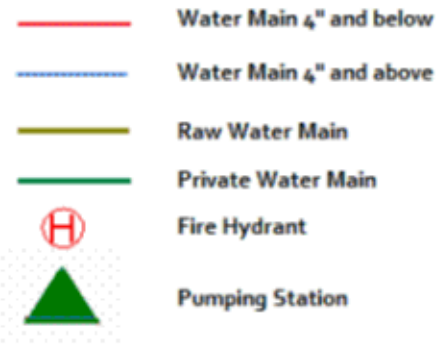
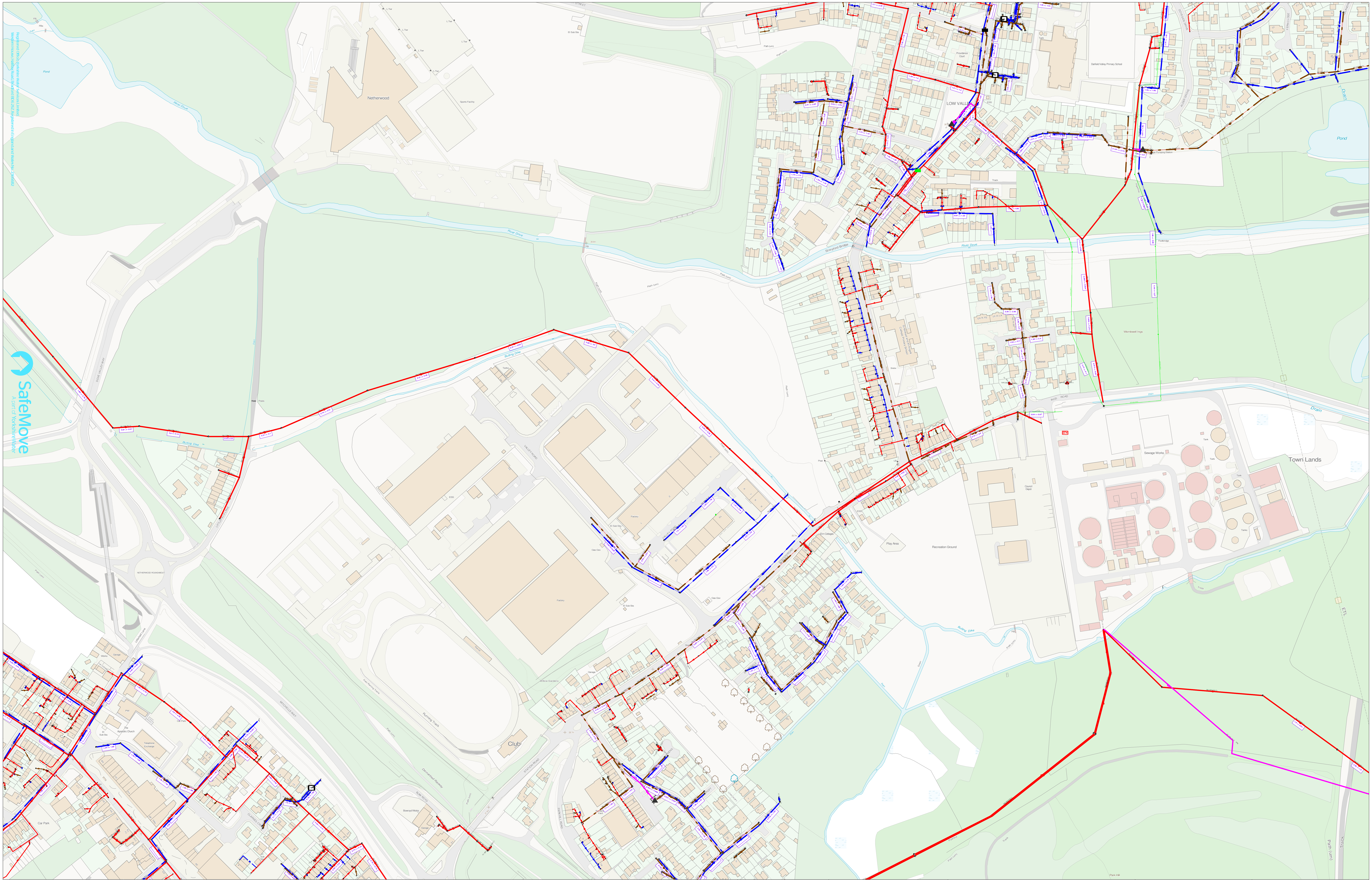
Property Indentfier

Sewer Legend



Water Legend





440009 : 403296	Map Name : SE3903SE

Yorkshire Water,
PO Box 500,
Halifax Road,
Bradford BD6 2LZ
Contact Name :
Search Advisor L MULLOCK
Contact Tel : 75 4506

Title

Notes

Partial Key

Foul Sewer = F
Combined Sewer = C
Surface Water Sewer = SW
Trade Sewer = TD
Partially Separate = PS

This plan is furnished as a general guide only and no warranty as to its correctness is given or implied. This plan must not be relied upon in the event of excavations or other works made in the vicinity of public sewers. No house or property connections are shown.

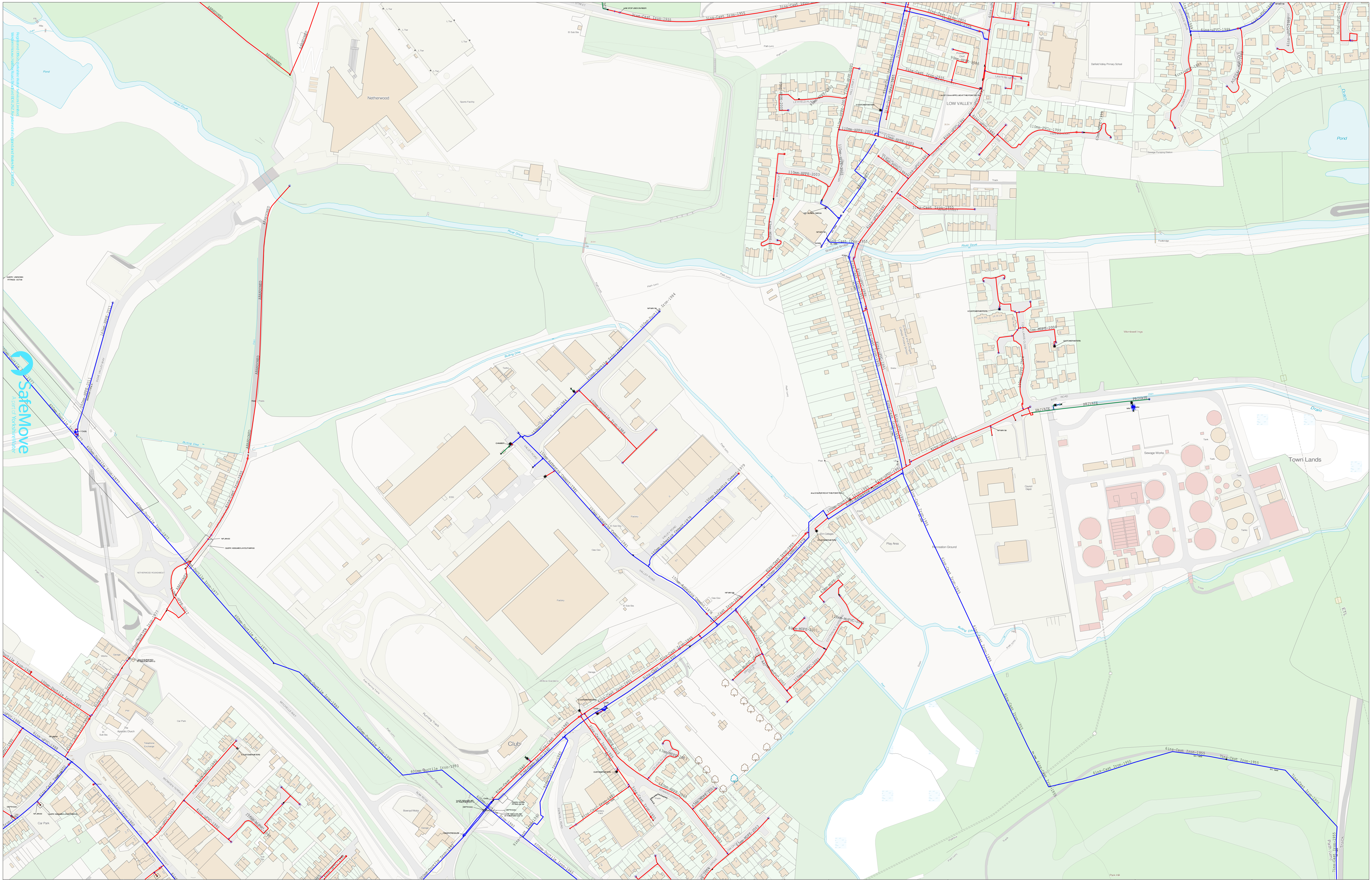
Date Req : 14/02/2019, 09:49:02

Date Gen : 14/02/2019, 09:49:09

Source : Sewer Network Enquiry

UPN: Undefined

Originator: L MULLOCK, Safe-Move, 75 4506



440009 : 403296	Map Name : SE3903SE	Title	Partial Key	The position and depths of apparatus shown on this plan are approximate only. The exact positions and depths should be obtained by excavation trial holes.
YorkshireWater	Yorkshire Water, PO Box 500, Halifax Road, Bradford BD6 2LZ	Notes	Water mains up to 4" in diameter	
	Contact Name :		Water mains over 4" in diameter	
	Search Advisor L MULLOCK		Raw water mains	
	Contact Tel : 75 4506		Private water mains	Scale : 1:2500
			Drg No :	Maris No :
			Date Req : 14/02/2019, 09:49:39	Date Gen : 14/02/2019, 09:49:45
			Source : Water Network Enquiry	

UPN: Undefined Originator: L MULLOCK, Safe-Move, 75 4506

Appendix 5 – Environment Agency

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creating a better place

Environment Agency

Ian Hopkinson
Enzygo Ltd,
Samuel House
First Floor
5 Fox Valley Way
Stocksbridge
Sheffield
S36 2AA

Date: 5th Jan 2018

Dear Mr Hopkinson,

Flood Map for Planning, Low Valley development

The Environment Agency would like to confirm that we have accepted the outputs from the provided Low Valley model to update our Flood Map for Planning for the development area.

We are providing you a draft copy of the revised Flood Map for Planning. Please note that Flood Zone 2 also includes the outlines of historic flood event extents in the area.

We confirm that we have now updated our internal systems with the provided extents for the development site and the amended Flood Map for Planning will be published on or around Wednesday the 31st of January 2018.

Best regards,

Aneta Plonczynska
FCRM Officer - Partnerships and Strategic Overview Yorkshire

Tel: 020 847 46874
Email: Aneta.Plonczynska@environment-agency.gov.uk

Environment Agency, Lateral, 8 City Walk, Leeds, LS11 9AT

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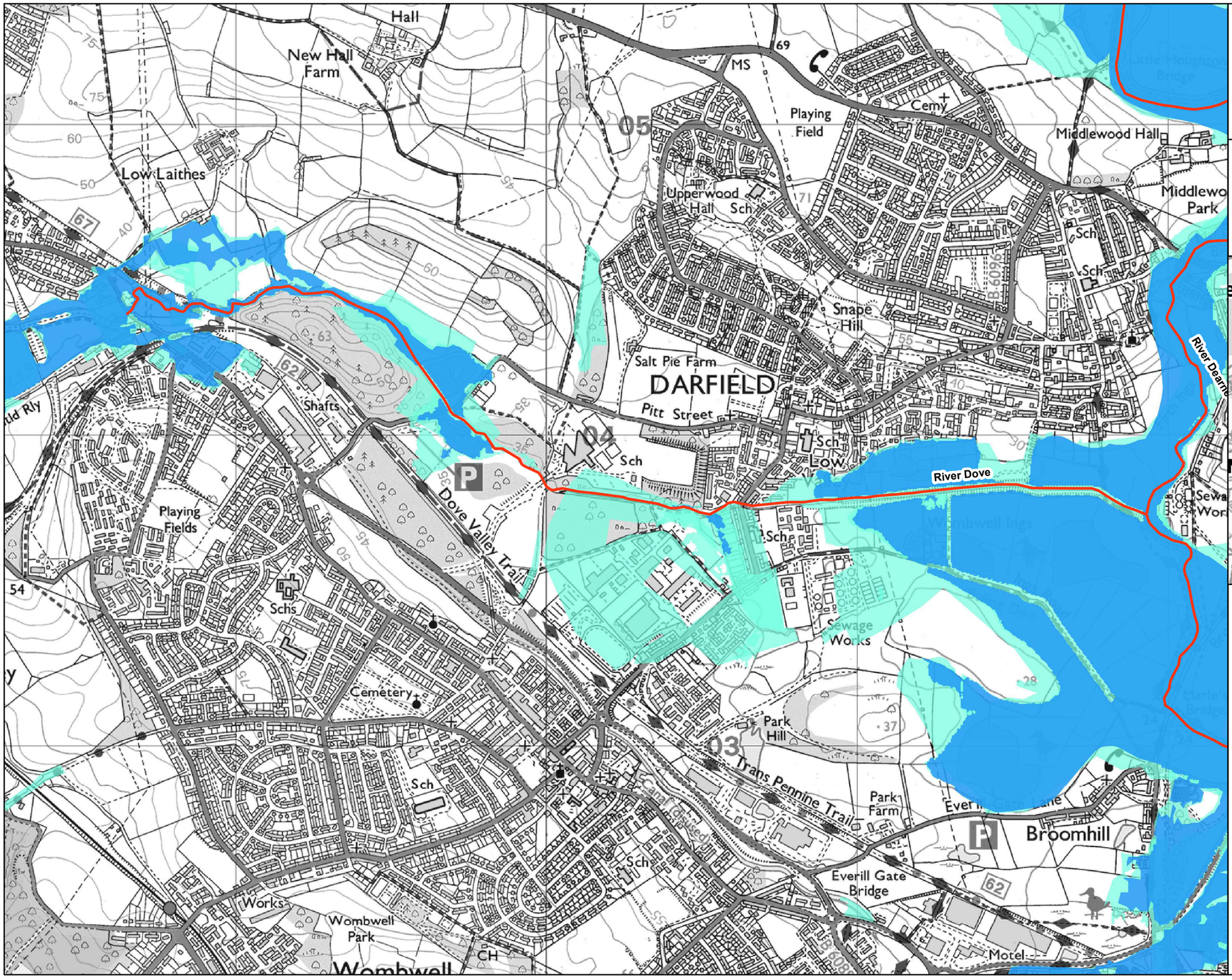
Draft Flood Map for Planning for Low Valley

Date Created: 19/06/18



www.environment-agency.gov.uk

Scale: 1:12,500

N W E S

when reproduced @ A3

LEGEND

- Main River
- Draft Flood Zone 3
- Draft Flood Zone 2

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

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Appendix 6 – Barnsley Metropolitan Borough Council

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Ian Hopkinson

From: Charlotte Whitham
Sent: 16 May 2019 11:42
To: Ian Hopkinson
Subject: FW: CRM.1122.005 - Station Road, Wombwell- LLFA Consultation

---

From: HighwayDrainage <HighwayDrainage@barnsley.gov.uk>
Sent: 16 May 2019 11:39
To: Charlotte Whitham <Charlotte.whitham@enzygo.com>
Subject: FW: CRM.1122.005 - Station Road, Wombwell- LLFA Consultation

Hello Charlotte

I seem to remember Enzygo had more information about this site than we hold. A lot of work including including river modelling, flooding history was carried out for planning application 2005/2017. If you need anymore the best point of contact will be the EA for the River Dove and Danvm IDB who control Bulling Dyke.

Thanks

From: Park , Amber
Sent: 16 May 2019 11:18
To: HighwayDrainage
Subject: FW: CRM.1122.005 - Station Road, Wombwell- LLFA Consultation

Hi

We have had a call this morning in regards to this, I spoke to Kim who said you would be able to help.

Could you please Ian back on 0114 321 5151

Thank you

From: DevelopmentControl & DevelopmentManagement
Sent: 13 May 2019 14:54
To: HighwayDrainage
Subject: FW: CRM.1122.005 - Station Road, Wombwell- LLFA Consultation

Hi

Is this something you can help with as it's not planning.

Thanks

From: Charlotte Whitham [mailto:Charlotte.whitham@enzygo.com]
Sent: 13 May 2019 14:41
To: DevelopmentControl & DevelopmentManagement
Cc: Ian Hopkinson
Subject: RE: CRM.1122.005 - Station Road, Wombwell- LLFA Consultation

To whom it may concern,

Please can you let me know if you have an update on the response to my below email?

Thank you,
Charlotte Whitham

From: Charlotte Whitham
Sent: 21 January 2019 09:54
To: developmentmanagement@barnsley.gov.uk
Cc: Ian Hopkinson <ian.hopkinson@enzygo.com>
Subject: CRM.1122.005 - Station Road, Wombwell- LLFA Consultation

Our Reference: CRM.1122.005 - Station Road, Wombwell
Location: Station Road, Wombwell, S73 0BJ

To whom it may concern,

Enzygo have been commissioned to prepare a Flood Risk Assessment (FRA) in accordance with National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) for an application for development on land north of Station Road, Wombwell. The site is located at grid ref: 440492, 403647 and a site location has been attached.

Based on a review of the Environment Agency and Ordnance Survey mapping the River Dove (a main river) conveys flows east along the northern boundary of the Site. Bulling Dike (an ordinary watercourse) conveys flow south-east along the south-western boundary of the Site.

From our initial investigation, the Environment Agency flood map (see below) shows most of the Site is in Flood Zone 2; between the 1 in 1000-year and 1 in 100-year probability of fluvial (river) flooding (0.1% - 1% Annual Exceedance Probability [AEP]), at 'medium' risk. The south-eastern parts of the Site, furthest from the River Dove, are within Flood Zone 1; which is land located outside the extent of the 1 in 1000-year (<0.1% AEP) risk of fluvial flooding, at 'low' risk. Vehicular Site access is indicatively via Station Road along the southern boundary, located within Zones 1 and 2. Pedestrian access is planned along the south-western boundary of the Site, crossing Bulling Dike but within Flood Zone 1.

The development will be classed as 'more vulnerable' (residential) and the Site is at low to medium risk of fluvial flooding.

As part of completing an FRA it is standard to contact the Lead Local Flood Authority to determine the points outlined below. I was hoping someone may have records of flooding for the local area pertaining to the site plus other information of value to my enquires. Please note that we are also consulting the Environment Agency with regards to this proposed development and have also reviewed the local SFRA:

- Can you confirm the flood zone within the site?
- Do you have any records of historic flooding events on this site, either from fluvial sources and other sources (i.e. surface water, sewers, groundwater, reservoir etc.)? If you are aware of historical flooding at the site, can you please provide us with details of these historical flood events where it is available, including flood levels, estimated return periods, photographs, and other such data as may be relevant to our study?
- Do you have any information on drainage within the site and in the local area, including any known drainage problems on site and in the local area?
- The proposal is for a development of a brownfield Site, please could you indicate the maximum allowable discharge rate, and any requirements for betterment when discharging to watercourse as well as all other relevant drainage requirements.
- Please can you also indicate to us whether you are aware of any relevant environmentally sensitive receptors (such as aquatic wildlife in receiving watercourses, etc.) in the area around the site that we should be aware of when preparing this Flood Risk Assessment?
- As required by the Building Regulations, we will need to consider discharge of surface water from the site to soakaway / infiltration as a first option. We would be grateful if you could provide us with any information that you have that may assist in our assessment of this option, such as details of sensitive aquifers in the area, known contamination issues, etc.
- Do you have any information of any surface water flooding within the Site or its immediate vicinity?
- Do you have any information on highway drainage, including asset plans and drainage capacity?

Many thanks,

Charlotte Whitham
Assistant Hydrologist

Enzygo Ltd,
Samuel House
First Floor
5 Fox Valley Way
Stocksbridge
Sheffield
S36 2AA

Offices in Bristol, Sheffield and Manchester

Planning and EIA, Waste & Environmental Permitting, Noise and Vibration, Flood Risk and Hydrology, Hydrogeology, Landscape and Visual Impact, Arboriculture, SI and Geo-environmental, Ecology, Traffic and Transport

Office: +44 (0) 114 321 5151
Email: charlotte.whitham@enzygo.com
Web: www.enzygo.com

Registered Office: Stag House, The Chipping, Wotton under Edge, GL12 7AD
Registered in England & Wales registered number: 06525159 VAT number: 283 2596 77

Please consider the environment before printing this email

Appendix 7 – Danvm Drainage Commissioners Internal Drainage Board Consultation

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Ian Hopkinson

From: Charlotte Whitham
Sent: 21 January 2019 13:25
To: Ian Hopkinson
Subject: FW: Station Road, Wombwell- IDB consultation
Attachments: Wombwell- 21 January 2019.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Saved in folder

From: Shire Group Planning <planning@shiregroup-idbs.gov.uk>
Sent: 21 January 2019 12:35
To: Charlotte Whitham <Charlotte.whitham@enzygo.com>
Subject: RE: Station Road, Wombwell- IDB consultation

Dear Charlotte

I attach our standard guidelines for discharge into a nearby watercourse. Please note our advice for when working near the River to contact the Environment Agency for any relevant conditions they may have.

To discharge into a nearby watercourse within the IDB district you will need to apply for consent to the Board, a form can be found on our website www.shiregroup-idbs.gov.uk.

I will contact the Board Engineer & Environmental Officer for any further advice we can give you on this location.

Kind Regards
Naomi Wright
(on behalf of the Shire Group of IDB's)
Tel: 01302 337798

Shire Group of IDBs

From: Charlotte Whitham <Charlotte.whitham@enzygo.com>
Sent: 21 January 2019 10:39
To: Information (ShireGroup) <info@shiregroup-idbs.gov.uk>; Shire Group Planning <planning@shiregroup-idbs.gov.uk>
Cc: Ian Hopkinson <ian.hopkinson@enzygo.com>
Subject: Station Road, Wombwell- IDB consultation

To whom it may concern,

Enzygo Ltd are preparing a Flood Risk Assessment (FRA) and drainage assessment for a proposed residential development located on an (approximate) 3-hectare Site located on land to the north of Station Road, Wombwell, S73 0BJ (NGR: 440492, 403647). A location plan has been attached.

In accordance with requirement H3 of the Building Regulations 2010, surface water must discharge to one of the following, listed in order of priority

i. Soakaway or infiltration system

ii. Watercourse

iii. Sewer

An initial review of the available borehole records at the Site shows that Made Ground is present to depths of up to 2.5m Below Existing Ground Level (begl) with groundwater at levels shown at 3.25 to 4.95mbegl. Due to the presence of Made Ground soakaway/infiltration methods for disposal of surface water would potentially mobilise contaminants and would therefore be unsuitable. The use of deep borehole soakaways would also be unfeasible due to shallow groundwater. Therefore, to discharge to a watercourse is the next suitable option for this Site.

The River Dove (a main river) conveys flows east along the northern boundary of the Site. Bulling Dike (an ordinary watercourse) conveys flow south-east along the south-western boundary of the Site. We believe these watercourses are in an area under the authority of the local IDB.

We are planning on discharging surface water to watercourse and ask what discharge rate would accept? We also ask what consents are required to allow us to discharge to watercourse.

In addition to this, do you have any of the following information at the Site?:

- Can you confirm the flood zone within the site?
- Do you have any records of historic flooding events on this site, either from fluvial sources and other sources (i.e. surface water, sewers, groundwater, reservoir etc.)? If you are aware of historical flooding at the site, can you please provide us with details of these historical flood events where it is available, including flood levels, estimated return periods, photographs, and other such data as may be relevant to our study?
- Do you have any information on drainage within the site and in the local area, including any known drainage problems on site and in the local area?
- The proposal is for a development of a brownfield Site, please could you indicate the maximum allowable discharge rate, and any requirements for betterment when discharging to watercourse as well as all other relevant drainage requirements
- Please can you also indicate to us whether you are aware of any relevant environmentally sensitive receptors (such as aquatic wildlife in receiving watercourses, etc.) in the area around the site that we should be aware of when preparing this Flood Risk Assessment?
- As required by the Building Regulations, we will need to consider discharge of surface water from the site to soakaway / infiltration as a first option. We would be grateful if you could provide us with any information that you have that may assist in our assessment of this option, such as details of sensitive aquifers in the area, known contamination issues, etc.
- Do you have any information of any surface water flooding within the Site or its immediate vicinity?
- Do you have any information on highway drainage, including asset plans and drainage capacity?

Kind regards,

Charlotte Whitham
Assistant Hydrologist

enzygo

Enzygo Ltd,
Samuel House
First Floor
5 Fox Valley Way
Stocksbridge
Sheffield
S36 2AA

Offices in Bristol, Sheffield and Manchester

Planning and EIA, Waste & Environmental Permitting, Noise and Vibration, Flood Risk and Hydrology, Hydrogeology, Landscape and Visual Impact, Arboriculture, SI and Geo-environmental, Ecology, Traffic and Transport

Office: +44 (0) 114 321 5151
Email: charlotte.whitham@enzygo.com
Web: www.enzygo.com

Registered Office: Stag House, The Chipping, Wotton under Edge, GL12 7AD
Registered in England & Wales registered number: 06525159 VAT number: 283 2596 77

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Certificate GB2004416

Association of Geotechnical &
Geoenvironmental Specialists


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JBA Consulting, , , , . Telephone:

WEM Framework Suppliers 2013-2019 and the Shire Group of IDBs is a member of the JBA group of companies.

PRE-APPLICATION PLANNING CONSULTATION

Enquiry Date:	21 January 2019
Contact:	Charlotte Whitham (Enzygo Ltd)
Proposal	Residential Development
Address	Land North of Station Road, Wombwell, Barnsley
Date of Reply	21 January 2019
Engineer to the Board/Officer	Paul Jones (Shire Group of IDB's)
On behalf of	Danvm Drainage Commissioners

Shire Group of IDBs

Epsom House
Chase Park Redhouse Interchange
Doncaster
South Yorkshire
DN6 7FE

The IDB as a Consultee give the following standard comments/recommendations:

If the surface water were to be disposed of via a soakaway system, the IDB would have no objection in principle but would advise that the ground conditions in this area may not be suitable for soakaway drainage. It is therefore essential that percolation tests are undertaken to establish if the ground conditions are suitable for soakaway drainage throughout the year.

If surface water is to be directed to a mains sewer system the IDB would again have no objection in principle, providing that the Water Authority are satisfied that the existing system will accept this additional flow.

If the surface water is to be discharged to any watercourse within the Drainage District, Consent from the IDB would be required in addition to Planning Permission, and would be restricted to 1.4 litres per second per hectare or greenfield runoff.

If there is an existing connection which is being altered, then the discharge is likely to be consented at the existing discharge rate.

If this is a new connection, then the likely discharge rate acceptable would be 1.4 l/s/ha. or 5 l/s for small sites.

No obstructions within 9 metres of the edge of a watercourse are permitted without Consent from the IDB.

If surface water or works are planned adjacent to a Main River within the Drainage District, then the Environment Agency should be contacted for any relevant Permits

Advice/recommendations:

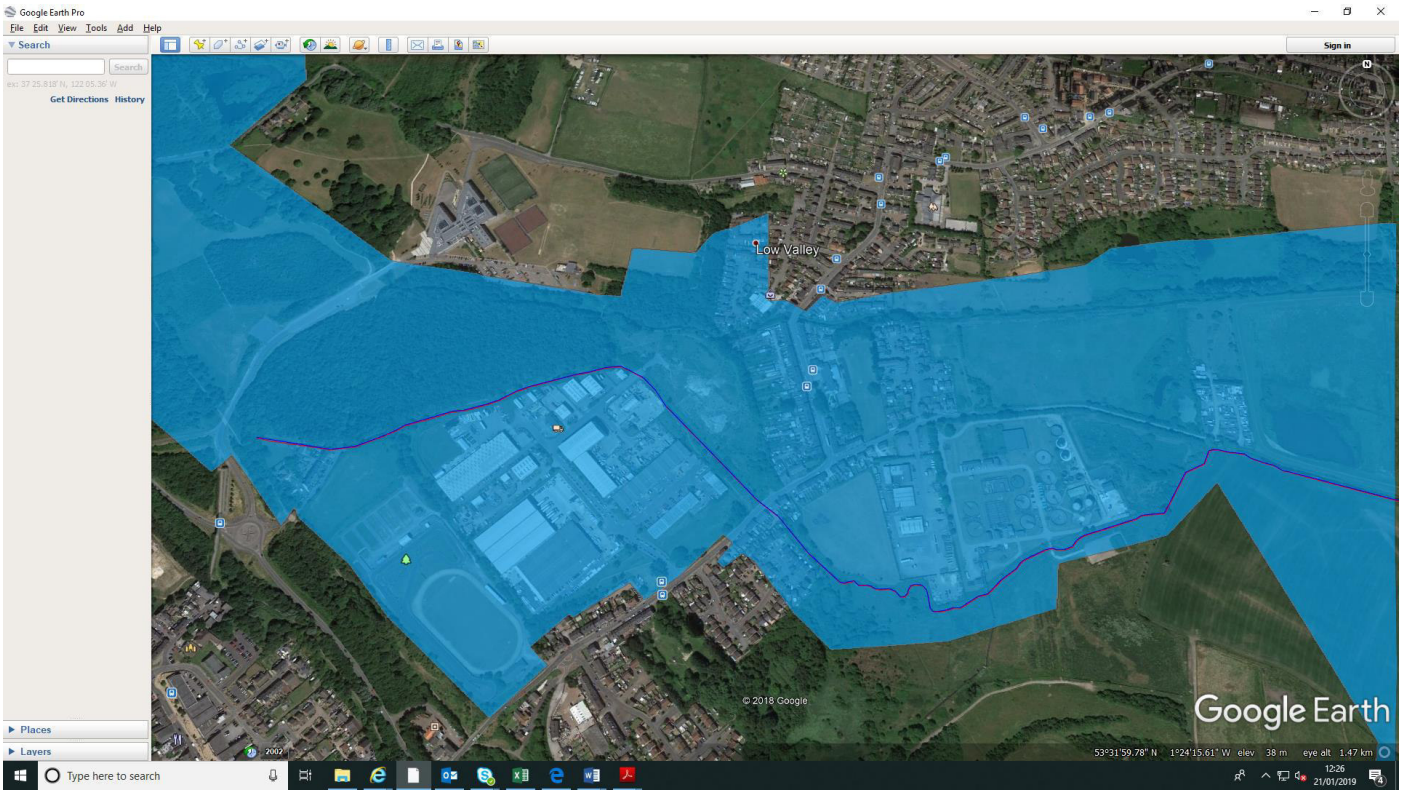
SHOULD Consent be required from the IDB as described above then we would advise that this should be made a CONDITION of any Planning DECISION.

ANY surface water discharge into ANY watercourses in, on, under or near the site requires CONSENT from the Drainage Board.

For further guidance, pre-application advice & consent form visit:
www.shiregroup-idbs.gov.uk, and select "Danvm DC"

For direct enquiries e-mail: planning@shiregroup-idbs.gov.uk

IDB Location Plan of Proposed site



NB: IDB drain in blue is called “Bulling Dyke”

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Appendix 8 – Borehole Logs

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SE 40 SW / 67 E

FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 5

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 1 OF 2

BORING METHOD/SIZE(MM) Shell and Auger - 150mm/Rotary coring - 98mm

BORING			SAMPLES		STRATA				TESTING	
DATE	CASING (M)	WATER (M)	DEPTH (M)	TYPE	KEY	DEPTH (M)	LEVEL (M)	DESCRIPTION	'N' RQD	%
17/10/77						0.00	27.18			
			0.10	U4		0.10	27.08	TOPSOIL		
			0.55					MADE GROUND		8.3
				SPT				Well compacted dark grey mudstone with red and black shale, and coal fragments	23	9.7
			1.00							
			1.30	U4						12
	1.70		1.75			1.75	25.43			
				SPT				MADE GROUND		
		26/10 a.m. ▽	2.20					Well compacted dark grey-black - brown mudstone with black shale, coal and sandstone fragments	19	13
			2.40-2.80	B						24
			2.80			2.90	24.28			
				SPT				MADE GROUND	7	34
	3.20	3/11 a.m. ▽	3.25			3.30	23.88	Black ash, coal and shale		
		26/10 a.m. ▽	3.60					Medium brown very sandy, very gravelly CLAY		20
		water struck		U4						
			4.05			4.00	23.18			
								Medium dense medium brown fine to coarse grained clayey SAND and GRAVEL		
	4.70		4.90							
17/10/77				SPT					2	
25/10/77			5.35							
			6.00							
	6.20			SPT					11	16
			6.45							
			7.45							
	7.70			SPT					8	13
			7.90							
			8.00-8.30	B						8.3
	9.00		9.00							
25/10/77				SPT					13	16
26/10/77			9.45							

REMARKS
Groundwater encountered at 4.00m, casing at 3.20m
Borehole dry on completion of shell and auger drilling
Slow water seepage into borehole overnight of the 26/10/77
Rotary coring commenced at 12.20m using water flush
Final standing water level in openhole was 3.25m

SE 40 SW / 67E FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 5

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 2 OF 2

BORING METHOD/SIZE(MM) Shell and Auger - 150mm/Rtoary Coring - 98mm

BORING DATE	CASING (M)	WATER (M)	SAMPLES DEPTH (M)	TYPE	KEY	STRATA DEPTH (M)	LEVEL (M)	DESCRIPTION	TESTING 'N' RQD	%
			10.25	SPT				Medium dense, medium brown fine to coarse grained clayey SAND and GRAVEL	11 for 150mm 104 for 150mm	15
	10.70		10.70			10.55	16.63			
			10.70-11.00	B				Medium grey-brown silty shaly weathered MUDSTONE		18
			11.00			11.20	15.98		136	8.4
			11.45	SPT				Light grey silty MUDSTONE (Fireclay)		
	11.60									
			12.05						100 blows for 150mm	
26/10/77				SPT		12.20	14.98			5.4
31/10/77			12.20					Light grey medium bedded slightly fractured, silty, slightly weathered MUDSTONE	N>300 R.Q.D.	
						12.70	14.48			
				Core 1 (100%)				Light grey white, thickly bedded weak MUDSTONE		
						13.30	13.88	(Fireclay)	36%	
						13.60	13.58	Medium grey silty shaly strong MUDSTONE		
						13.74	13.44	Light grey thinly bedded, fresh SILTSTONE		
						14.05	13.13	Medium grey well bedded slightly fractured silty fresh MUDSTONE		
						14.55	12.63	Medium grey thinly bedded, laminated, fractured fresh SILTSTONE, strong, brittle		
						15.30	11.88	Medium to dark grey, medium bedded, fractured silty fresh MUDSTONE, strong, brittle		
31/10/77			15.50							
1/11/77						15.90	11.28	Medium grey, medium bedded, laminated, fractured, fresh SILTSTONE, strong		
				Core 2 (100%)				Medium grey, medium bedded, laminated, fractured, fresh SILTSTONE, strong, with thin bands of dark grey MUDSTONE	19%	
			17.40			17.40	9.78			
				Core 3 (100%)				Light to medium grey, medium bedded, laminated fresh SILTSTONE, strong with occasional thin mudstone bands	46%	
			20.00			20.00	7.18	End of borehole		

REMARKS

SE 40 SW / 67 G

FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 7

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 1 OF 2

BORING METHOD/SIZE(MM) Shell and Auger - 150mm/Rotary Coring - 98mm

BORING DATE	CASING (M)	WATER (M)	SAMPLES DEPTH (M)	TYPE	KEY	STRATA DEPTH (M)	LEVEL (M)	DESCRIPTION	TESTING 'N' RQD	TESTING %
31/10/77						0.00	26.00			
			0.30			0.30	25.70	TOPSOIL		
			0.30	U4				MADE GROUND		12
			0.75					Well compacted dark grey mudstone with red and black shale and traces of coal fragments		
			0.90							
			0.90	SPT					12	14
			1.35							
	1.70									
		water struck								
		1/11 4m	2.40			2.40	23.60			
			2.40	SPT				MADE GROUND		
			2.85					Loosely compacted dark grey mudstone with black shale, coal, clay and limestone, concrete and glass	7	41
	3.20									
31/10/77 1/11/77	4.00		4.00							
			4.00	SPT					11	19
			4.45							
	5.00		5.00							
			5.00	SPT					9	17
			5.45							
	6.20									
			6.45			6.45	19.55			
			6.45	SPT				Medium dense, medium brown, fine to coarse grained clayey SAND and GRAVEL	21	12
			6.90							
	7.70									
			7.90							
			7.90	SPT					17	13
			8.35							
	9.20									
			9.20							
			9.20	SPT					9	14
1/11/77 2/11/77			9.65			9.65	16.30			
								Medium grey silty weathered MUDSTONE		

REMARKS Groundwater encountered in openhole at 2.40m

SE 40 SW / 67 G

FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 7

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 2 OF 2

BORING METHOD/SIZE(MM) Shell andAuger - 150mm/Rotary Coring - 98mm

BORING			SAMPLES		STRATA				TESTING	
DATE	CASING (M)	WATER (M)	DEPTH (M)	TYPE	KEY	DEPTH (M)	LEVEL (M)	DESCRIPTION	'N' RQD	%
	10.00							Medium grey silty weathered MUDSTONE		
			10.75	SPT		10.90	15.10			
	11.20		11.20			11.10	14.90	Light grey silty CLAY (Fireclay)	14	13
			11.20-11.50	B		11.35	14.65	Pieces of wood		
2/11/77			11.35	SPT				Probably old pit props and workings	80 blows for 150mm	
3/11/77			11.50					Medium grey silty fracture, medium bedded slightly weathered MUDSTONE, moderately strong	N>240 R.Q.D.	8.8
				Core 1 (100%)						
						12.50	13.50		56%	
								Light grey-white silty thickly bedded slightly weathered weak MUDSTONE (Fireclay)		
						13.50	12.50			
						13.90	12.10	Light grey thinly bedded, fractured fresh SILTSTONE, strong		
3/11/77			14.00			14.00	12.00	Medium grey silty thinly bedded shaly fresh MUDSTONE, strong, brittle		
								End of borehole		

REMARKS

SE40SW/67C

FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 7A

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 1 OF 2

BORING METHOD/SIZE(MM) Rotary Openhole 100mm

BORING			SAMPLES		STRATA				TESTING	
DATE	CASING (M)	WATER (M)	DEPTH (M)	TYPE	KEY	DEPTH (M)	LEVEL (M)	DESCRIPTION	'N' RQD	%
3/11/77						0.00	26.00			
						0.20	25.80	TOPSOIL		
								MADE GROUND Dark grey mudstone with red shale and coal fragments		
						2.30	23.70			
								MADE GROUND Dark grey mudstone, brown clay and black shale		
						6.50	19.50			
								Brown SAND and GRAVEL		
						9.50	16.50			
								Light grey MUDSTONE		

REMARKS Good water returns all the way down
No cavities detected

SE40SW/67G

FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 7A

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 2 OF 2

BORING METHOD/SIZE(MM) Rotary Openhole - 100mm

BORING			SAMPLES		STRATA				TESTING	
DATE	CASING (M)	WATER (M)	DEPTH (M)	TYPE	KEY	DEPTH (M)	LEVEL (M)	DESCRIPTION	'N' RQD	%
								Light grey MUDSTONE		
						10.50	15.50			
								Soft light grey MUDSTONE		
						11.00	15.00			
								Soft light grey-white MUDSTONE (Fireclay)		
						11.50	14.50			
								Light grey-white MUDSTONE (Fireclay)		
3/11/77						14.00	12.00	End of borehole		

REMARKS

SE 40 SW/67G

FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 7 B

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 1 OF 2

BORING METHOD/SIZE(MM) Rotary Openhole - 100mm/73mm

BORING			SAMPLES		STRATA				TESTING	
DATE	CASING (M)	WATER (M)	DEPTH (M)	TYPE	KEY	DEPTH (M)	LEVEL (M)	DESCRIPTION	'N' RQD	%
4/11/77						0.00	26.00			
						0.30	25.70	TOPSOIL		
								MADE GROUND Medium grey mudstone with coal, red and black shale		
						3.00	23.00			
								MADE GROUND Black shale, red shale, mudstone and ash		
						6.00	20.00			
								Brown clayey SAND and GRAVEL		
						7.00	19.00			
								Loss of returns very soft drilling		

REMARKS Loss of water returns at 7.00m
No cavities detected

SE 40 SW/67 G

FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Hombwell BOREHOLE No. 7 B

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 2 OF 2

BORING METHOD/SIZE(MM) Rotary Openhole - 100mm/73mm

BORING			SAMPLES		STRATA				TESTING	
DATE	CASING (M)	WATER (M)	DEPTH (M)	TYPE	KEY	DEPTH (M)	LEVEL (M)	DESCRIPTION	'N' RQD	%
								Loss of returns very soft drilling		
						10.60	15.40			
								Hard drilling No returns		
						11.00	15.00			
								Very hard drilling No returns		
4/11/77						12.40	13.60	End of borehole		

REMARKS

SE 49 SW / 67 ++ FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 8

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 1 OF 2

BORING METHOD/SIZE(MM) Shell and Auger - 150mm/Rotary Coring - 100mm

BORING DATE	CASING (M)	WATER (M)	SAMPLES DEPTH (M)	TYPE	KEY	STRATA DEPTH (M)	LEVEL (M)	DESCRIPTION	TESTING 'N' RQD	TESTING %
16/11/77						0.00	27.33			
						0.20	27.13	TOPSOIL		
			0.35	U4		0.50	26.83	MADE GROUND Red shale		11
			0.80					MADE GROUND		
				SPT				Well compacted medium grey mudstone with black and red shale, brown clay and black ashes	24	17
16/11/77 17/11/77	1.25		1.25							
	1.70		1.80							
				U4						15
	2.20		2.25							
			2.30	SPT		2.50	24.83		9	25
	2.90		2.75					Firm medium brown silty sandy CLAY with sandstone fragments		
			3.00-3.30	B						32
	3.60					3.50	23.83			
			3.75					Firm medium brown mottled silty sandy stony CLAY with sandstone pebbles		
	4.10			U4						17
		water struck	4.20	SPT					16	16
			4.65			4.65	22.68			
	5.00		4.90-5.20	B				Medium dense, medium brown, fine to coarse grained clayey SAND and GRAVEL		17
			5.20							
				SPT					21	13
			5.65							
	5.90		6.00							
				SPT						
			6.45						23	14
	6.70		6.80-7.10	B						
17/11/77 18/11/77	7.20	21/11 a.m.								9.7
			7.60							
				SPT					33	13
			8.05							
	8.60									
			8.75							
				SPT						
			9.20			9.10	18.23		27	20
	9.40		9.25-9.55	B		9.40	17.93	Soft medium grey-brown silty sandy CLAY with sandstone pebbles		22
			9.55							
				SPT				Medium grey silty shaly weathered MUDSTONE	39	14
			10.00							

REMARKS Groundwater struck at 4.65m, casing at 4.10m
Borehole continually topped up with water to maintain stability in gravel

SE 40 SW / 67 ++ FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 8

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 2 OF 2

BORING METHOD/SIZE(MM) Shell and Auger - 150mm/Rotary Coring - 100mm

BORING DATE	CASING (M)	WATER (M)	SAMPLES DEPTH (M)	TYPE	KEY	STRATA DEPTH (M)	LEVEL (M)	DESCRIPTION	TESTING 'N'	RQD	%
	10.10		10.15	SPT				Medium grey silty shaly weathered MUDSTONE		26	13 16
	10.60		10.20-10.60	B		10.60	16.73				
18/11/77	11.00		10.60	SPT				Medium to dark grey silty shaly weathered MUDSTONE		27	15
21/11/77			11.05 11.10	SPT						36	15
			11.55								
			12.35	SPT							
21/11/77			12.80	Core 1 (40%)		12.80	14.53			58 R.Q.D.	13
22/11/77			13.20	Core 2 (40%)		13.50	13.83	Dark grey-black silty carbonaceous thinly bedded highly fractured moderately weathered MUDSTONE, weak		11%	
			13.50							0%	
				Core 3 (50%)		14.20	13.13	Dark grey-black silty carbonaceous thinly bedded shaly fresh MUDSTONE, strong with ironstained joints		5%	
						14.50	12.83	Hard light grey laminated medium bedded SILTSTONE			
						15.30	12.03	Lost water returns soft medium grey mudstone with pit props MADE GROUND - Backfilled workings			
			15.40	Core 4 (75%)		15.80	11.53	Medium grey shaly broken mudstone and pit props MADE GROUND - Backfilled workings		0%	
22/11/77			15.80								
23/11/77				Core 5 (100%)		16.10	11.23	Broken medium grey mudstone - cavities		0%	
23/11/77			16.40			16.40	10.93	Light to medium grey silty medium bedded fractured weak MUDSTONE (Fireclay)			
								End of borehole			

REMARKS

FORM 407

SE 4 SW 1/67 2

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 9

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 1 OF 2

BORING METHOD/SIZE(MM) Shell and Auger - 150mm/Rotary Coring - 98mm

BORING			SAMPLES		STRATA				TESTING	
DATE	CASING (M)	WATER (M)	DEPTH (M)	TYPE	KEY	DEPTH (M)	LEVEL (M)	DESCRIPTION	'N' RQD	mS
27/10/77						0.00	25.77			
			0.20			0.20	25.57	TOPSOIL		
			0.20	U4				MADE GROUND		18
			0.60					Well compacted medium grey mudstone with red and black shale, ash, glass and coal fragments		
			1.05	SPT		1.00	24.77		16	20
		28/10 a.m.						MADE GROUND		
						1.60	24.17	Well compacted black ashes with mudstone, black shale, and coal fragments		
								Firm medium grey-brown mottled silty sandy stony CLAY		19
			2.30	U4						
			2.75			2.80	22.97			
			2.80	SPT				Firm dark grey-brown mottled very sandy pebbly CLAY with sandstone and traces of coal fragments	18	13
	3.00	water struck	3.25							
			3.85							
		27/10 p.m.		SPT					19	12
	4.30		4.30			4.30	21.47			
								Firm medium to dark brown mottled very sandy very pebbly CLAY with sandstone fragments and traces of coal fragments		
			5.30	SPT						
			5.75			5.80	19.97		47	10
27/10/77	6.00							Medium dense, medium brown fine to coarse grained clayey SAND and GRAVEL		
28/10/77			6.55	W						
			6.55-7.00	B						
	7.00									17
			7.10	SPT						
			7.55			7.45	18.32		38	15
								Dark grey silty shaly weathered MUDSTONE		
						8.00	17.77			
28/10/77	8.15		8.15	SPT		8.15	17.62	Hard light grey SILTSTONE	35 blows for zero penetration	
2/11/77						8.40	17.37	Hard black carboniferous very shaly brittle MUDSTONE		
				Core 1 (100%)				Medium grey, medium bedded, shaly fresh SILTSTONE, strong	R.Q.D.	
						8.90	16.87			
								Dark grey-black thinly bedded fractured, fresh MUDSTONE, strong, brittle	30%	
						9.80	15.97			
	8.15							Light grey-white silty MUDSTONE (Fireclay)		

REMARKS Groundwater encountered in open borehole at 3.25m
Rotary coring commenced at 8.15m using water flush

SE 4 5 SW / 57 I FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 9

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 2 OF 2

BORING METHOD/SIZE(MM) Shell and Auger - 150mm/Rotary Coring - 98mm

BORING			SAMPLES		STRATA				TESTING	
DATE	CASING (M)	WATER (M)	DEPTH (M)	TYPE	KEY	DEPTH (M)	LEVEL (M)	DESCRIPTION	'N' RQD	%
								Light grey-white thickly bedded silty slightly weathered MUDSTONE, weak. (Fireclay)		
						10.80	14.97			
			11.10	Core 2 (100%)				Light grey-white silty slightly shaly, slightly weathered MUDSTONE, weak, blocky. (Fireclay)	69%	
						12.40	13.37			
								Medium grey, medium bedded fractured fresh MUDSTONE, strong		
						13.05	12.72			
						13.30	12.47	Hard medium grey fractured silty MUDSTONE		
								Light grey, medium bedded slightly fractured fresh SILTSTONE, strong		
2/11/77			14.00			14.00	11.77	End of borehole		

REMARKS

SE 4[illegible] SW / 67 J FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 10

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 1 OF 2

BORING METHOD/SIZE(MM) Shell and Auger - 150mm/Rotary Coring - 100mm

BORING			SAMPLES		STRATA				TESTING	
DATE	CASING (M)	WATER (M)	DEPTH (M)	TYPE	KEY	DEPTH (M)	LEVEL (M)	DESCRIPTION	'N' RQD	%
10/11/77						0.00	26.58			
		water struck				0.20	26.38	TOPSOIL		
			0.50-0.70	B				MADE GROUND		
			0.70	SPT				Medium grey mudstone with black and red shale	14	6.4
	1.20		1.15							
			1.35	U4						11
			1.65	SPT					19	13
			2.10							
	2.40					2.50	24.08			
			2.60	U4		2.75	23.83	Soft medium to dark brown silty CLAY		36
			3.05					Soft dark grey-brown-green silty organic CLAY		
			3.10	SPT					6	42
			3.55							
	3.90									
			4.05	U4		4.20	22.38			30
			4.50					Medium brown fine to coarse grained very clayey SAND and GRAVEL	8	16
	4.70	water struck		SPT						
10/11/77			4.95			5.00	21.58			
14/11/77		15/11 p.m.	5.00-5.30	B						8.6
			5.30	SPT				Medium dense, medium brown fine to coarse grained SAND and GRAVEL	16	14
	5.80		5.75			5.90	20.68			10
	6.10		5.95-6.25	B						
			6.45	W				Medium dense, medium brown fine to medium grained SAND and GRAVEL with sub-angular sandstone fragments		
			6.25	SPT					7	14
14/11/77			6.70							
15/11/77	7.00									7.7
			7.15-7.45	B						
			7.50	SPT					20	16
			7.95							
			8.20-8.50	B						10
			8.50	SPT					17	22
			8.95			8.90	17.68			
	9.20		8.95-9.20	B		9.00	17.58	Soft medium grey silty CLAY with mudstone fragments		23
			9.45	SPT				Dark grey silty highly weathered MUDSTONE	22	16
			9.90							
15/11/77						10.00	16.58			

REMARKS Groundwater struck in open borehole at 0.30m
Groundwater again struck at 4.95m, casing at 3.90m
Rotary coring commenced at 11.80m using water flush

SE 4[illegible]W / 67 J

FORM 407

SOUTH YORKSHIRE COUNTY COUNCIL
DEPARTMENT OF ENGINEERING
ENGINEERING SERVICES LABORATORY

BOREHOLE RECORD

SITE: Station Road Industrial Estate LOCATION: Wombwell BOREHOLE No. 10

CUT/FILL(M) — CHAINAGE(M) — OFFSET(M) — SHEET 2 OF 2

BORING METHOD/SIZE(MM) Shell and Auger - 150mm/Rotary Coring - 100mm

BORING			SAMPLES		STRATA				TESTING	
DATE	CASING (M)	WATER (M)	DEPTH (M)	TYPE	KEY	DEPTH (M)	LEVEL (M)	DESCRIPTION	'N' RQD	%
16/11/77			10.00			10.00	16.58			
	10.30		10.45	SPT				Dark grey-black silty shaly highly weathered MUDSTONE	26	11
			10.45-10.65	B		10.50	16.08			
			10.65					Dark grey-black silty shaly weathered MUDSTONE		27
			11.10	SPT					53	13
	11.30		11.45							
			11.80	SPT		11.80	14.78		110 for 200mm N=165	
16/11/77										
17/11/77						12.10	14.48		R.Q.D.	
						12.20	14.38	Weak dark grey-black silty carbonaceous highly fractured shaly MUDSTONE		
				Core 1 (30%)				Medium grey laminated interbedded thinly bedded silty MUDSTONE and SILTSTONE	0%	
								Medium grey shaly broken mudstone. MADE GROUND - Backfilled cavities Lost water returns		
			14.15			14.20	12.38			
				Core 2 (100%)				Light to medium grey silty fractured MUDSTONE (Fireclay)	52%	
						14.75	11.83			
								Light grey medium bedded fractured fresh SILTSTONE, strong with occasional thin MUDSTONE bands		
17/11/77			15.50			15.50	11.08	End of borehole		

REMARKS

BOREHOLE No. AND LOCATION	DEPTH From	DEPTH To	SOIL DESCRIPTION 405L, 035O	SAMPLES Depth	SAMPLES Test and Result
Borehole 3 9.7.73.	0	0.2	Grass and topsoil.		
	0.2	0.35	Light brown very clayey sand.		
	0.35	1.45	Dark grey weathered mudstone with fragments of burnt colliery shale, sandstone and clay. (Fill.)	1.0-1.3	m 18
				1.3-1.6	m 44 LL 63 PL 49
	1.45	1.6	Black sandy topsoil with fragments of mudstone and brick.		
	1.6	1.7	Firm dark brown very clayey sand with fragments of mudstone.	1.7-1.95	m 28 LL 40 PL 26
	1.7	2.45	Firm to stiff rusty brown and light grey mottled sandy clay with occasional fragments of mudstone.	2.0-2.45	M 26 LL 28 PL 21 DD 1750 dU 20 ϕU 7
	2.45	7.1	Loose brown medium and coarse grained sand with fine to coarse subrounded gravel and with some soft thin clayey bands.	3.1-3.55	m 16 N 6
				3.5-4.5	m 14 P[illegible] 100 P[illegible] 83 P7 48 P36 15 P200 7
				4.6-5.05	m 16 N 4
				4.6-5.6	m 17
				5.7-6.1	m 5
				6.4-6.85	m 14 N 10
				6.4-7.1	m 12

BOREHOLE No. AND LOCATION	DEPTH From	DEPTH To	SOIL DESCRIPTION	SAMPLES Depth	SAMPLES Test and Result
Borehole 3 (Cont ....)	7.1	7.25	Firm to stiff dark brown and grey very sandy silty clay with fragments of sandstone, mudstone and subrounded gravel.	7.1-7.25	m 13 LL 24 PL 17
	7.25	7.45	Brown medium and coarse grained sand with fine to coarse subrounded gravel.	7.25-7.7	m 14 P1½ 100 P[illegible] 87 P7 66 P36 24 P200 9
	7.45	9.2	Dark grey highly weathered shaly ironstained mudstone.	7.7-7.8	m 14 LL 36 PL 25
				7.3-8.25	m 14 N 66
	9.2	9.9	Old workings containing abundant water and mudstone fragments.	9.9-10.35	m 21 Non Plastic
	9.9	11.05	Fragments of dark grey ironstained water bearing shaly mudstone with a piece of timber showing saw marks.	10.5-10.7	m 16
	11.05	11.35	Light grey very sandy mudstone.	10.7-11.1	LL 25 PL 18
				11.1-11.25	m 7
				11.25-11.35	m 5 125 blows for 110mm initial penetration. N >350
		11.35	End of Borehole. Water from old workings rose to with 1.5m of ground level.		

BOREHOLE No. AND LOCATION	DEPTH From	DEPTH To	SOIL DESCRIPTION 4048/0372	SAMPLES Depth	SAMPLES Test and Result
Borehole 3A	0	0.2	Grass and topsoil.		
	0.2	1.3	Light brown clayey sand.	0.6-1.3	m 33 LL 26 PL 34
	1.3	1.65	Firm light brown very sandy clay.	1.35-1.7	m 38 LL 50 PL 33 DD 1380 cU 7 φU 4
	1.65	2.25	Very soft rusty brown and grey mottled sandy clay with occasional fragments of weathered mudstone.	1.7-1.8	m 38
				1.9-2.35	m 34 LL 43 PL 29 DD 1370 cU 20 φU 0
				FI 0-27 27-54 54-107 107-214	MV 0.95 0.62 0.44 0.32
				2.35-2.45	m 41
	2.25	2.9	Soft dark grey clayey silt and silty clay with veins of iron-staining, fragments of mudstone and peat.	2.5-2.95	m 44 LL 56 PL 36 DD 1220 cU 19 φU 0
				2.95-3.05	m 86
	2.9	3.1	Soft clayey organic silt with fragments of mudstone and pieces of rotten wood.	3.1-3.55	m 17 N 13
	3.1	5.05	Dark brown medium and coarse grained slightly clayey sand and fine to coarse gravel with occasional fragments of mudstone.	3.5-4.1	m 16 P1½ 100 P¼ 69 P7 39 P36 12 P200 6
				4.7-5.15	m 21 N 13
				5.2-5.4	m 14

BOREHOLE No. AND LOCATION	DEPTH From	DEPTH To	SOIL DESCRIPTION	SAMPLES Depth	SAMPLES Test and Result
Borehole 3A (cont ....)	5.05	5.4	Firm dark grey sandy clay and clayey sand with occasional fine gravel and fragments of mudstone.	5.4-5.8	m 24
				6.0-6.3	m 13 P2 100 P5 46 P7 33 P36 19 P200 8
	5.4	5.6	Dark brown medium grained sand.		
	5.6	6.8	Dark brown medium and coarse grained sand with fine to coarse subrounded gravel.	6.8-7.0	m 23
	6.8	6.85	Firm dark brown very sandy clay with occasional subrounded gravel.	7.0-7.35	m 14 LL 46 PL 23 DD 2000 cU 120 φU 0
	6.85	7.0	Firm grey very silty clay with occasional gravel.	7.35-7.45	m 16
	7.0	7.6	Stiff light grey silty clay with fragments of mudstone.	7.85-8.3	m 13 LL 31 PL 22 DD 2090 cU 45 φU 24
	7.6	8.3	Light grey weathered mudstone with bands of dark grey silty shaly mudstone.	8.3-8.4	m 10
	8.3	11.5	Dark grey weathered mudstone with some silty shaly bands.	8.5-8.95	m 10 N 41
				8.9-9.4	m 14
				9.5-9.95	m 10 LL 29 PL 22
				9.95-10.05	m 10
	11.5	12.4	Light grey weathered mudstone.	10.9-11.35	m 8 N 43
	12.4	13.15	Dark grey weathered mudstone, silty in parts.	12.0-12.45	m 8 LL 22 PL 16 DL 2130 cU 65 φU 28
				12.45-12.55	m 7

BOREHOLE No. AND LOCATION	DEPTH From	DEPTH To	SOIL DESCRIPTION	SAMPLES Depth	SAMPLES Test and Result
Borehole 3A (cont ....)	13.15	16.2	Light grey sandy ironstained weathered mudstone becoming less weathered below 15m.	13.1-13.55	n 6 P 118
				14.4-14.85	n 5 P 222
	16.2	17.5	Light grey fractured very sandy mudstone.	14.7-15.55	Core 1. Recovery 95% RQD 15%
	17.5	18.0	Light grey fine to medium grained sandstone.	15.55-17.0	Core 2 Recovery 55% RQD 15%
	18.0	19.7	Dark grey fractured silty mudstone with sand weathered bands, sandy below 19.4m.	17.0-17.95	Core 3 Recovery 75% RQD 50%
	19.7	19.8	Light grey fine grained sandstone	17.95-19.1	Core 4 Recovery 65% RQD 20%
	19.8	19.9	Dark grey fractured sandy mudstone	19.1-20.55	Core 5 Recovery 100% RQD 50%
	19.9	20.55	Light grey fine grained sandstone with some thin mudstone bands.		
		20.55	End of Borehole.		

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Appendix 9 – Drainage Calculations

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Greenfield runoff estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	
Site name:	Station Road
Site location:	Wombwell

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

Site coordinates

Latitude:	53.52796° N
Longitude:	1.39001° W

Reference:	
Date:	2019-05-30 09:33

Methodology	IH124

Site characteristics

Total site area (ha)	1.7

Methodology

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

	Default	Edited
SOIL type	2	4
HOST class	---	---
SPR/SPRHOST	0.3	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm)	615	615
Hydrological region	3	3
Growth curve factor: 1 year	0.86	0.86
Growth curve factor: 30 year	1.75	1.75
Growth curve factor: 100 year	2.08	2.08

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

(3) Is SPR/SPRHOST ≤ 0.3?

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)	2.66	7.05
1 in 1 year (l/s)	2.29	6.07
1 in 30 years (l/s)	4.66	12.34
1 in 100 years (l/s)	5.54	14.67

HR Wallingford
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Greenfield runoff estimation for sites

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Calculated by:	
Site name:	Station Road
Site location:	Wombwell

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

Site coordinates

Latitude:	53.52796° N
Longitude:	1.39001° W

Reference:	
Date:	2019-05-30 09:31

Methodology	IH124

Site characteristics

Total site area (ha)	1.02

Methodology

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

	Default	Edited
SOIL type	2	4
HOST class	---	---
SPR/SPRHOST	0.3	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm)	615	615
Hydrological region	3	3
Growth curve factor: 1 year	0.86	0.86
Growth curve factor: 30 year	1.75	1.75
Growth curve factor: 100 year	2.08	2.08

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

(3) Is SPR/SPRHOST ≤ 0.3?

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)	1.6	4.23
1 in 1 year (l/s)	1.37	3.64
1 in 30 years (l/s)	2.8	7.41
1 in 100 years (l/s)	3.32	8.8

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	2	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	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)	Cover Level (m)	Diameter (mm)	Depth (m)
1	1.496	100.000	1200	3.000

Simulation Settings

Rainfall Methodology	FEH-13	Skip Steady State	x	1 year (l/s)	3.7
Summer CV	0.750	Drain Down Time (mins)	1440	30 year (l/s)	7.5
Winter CV	0.840	Additional Storage (m³/ha)	20.0	100 year (l/s)	8.9
Analysis Speed	Normal	Check Discharge Rate(s)	✓	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 years	1.75
Greenfield Method	IH124	Growth Factor 100 years	2.08
Positively Drained Area (ha)	2.720	Betterment (%)	0
SAAR (mm)	615	QBar	4.3
Soil Index	2	Q 1 year (l/s)	3.7
SPR	0.30	Q 30 year (l/s)	7.5
Region	3	Q 100 year (l/s)	8.9
Growth Factor 1 year	0.86		

Node 1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	97.000	Product Number	CTL-SHE-0092-5000-2000-5000
Design Depth (m)	2.000	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.0	Min Node Diameter (mm)	1200

Node 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	97.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	683.0	0.0	2.000	683.0	0.0	2.001	0.0	0.0

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	1	735	97.390	0.390	17.7	257.3393	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
960 minute winter	1	Hydro-Brake®	4.1	387.6

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	1	1410	98.997	1.997	47.8	1317.6390	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m³)
1440 minute winter	1	Hydro-Brake®	5.0	726.9

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