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NPPF Flood Risk Assessment

Project Ref: 15184/I/02A

Nether Mill Farm

Prepared for:
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November 2015

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Flood Risk Assessment

Paul Waite Associates have been appointed by Dave Hoyland of Duchy Homes to support a planning application for proposed redevelopment of existing farm buildings and land associated with Nether Mill Farm to north of Barnsley Road in Penistone, South Yorkshire to provide residential accommodation.

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Documents Revision Status

<i>ISSUE:</i>	<i>DATE</i>	<i>COMMENTS</i>
-	September 29, 2015	FINAL
A	November 12. 2015	Revised Following Planners Comments

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Executive Summary

Paul Waite Associates have been appointed to support a planning application for proposed redevelopment of existing farm buildings and land to provide residential development of 11No dwellings and 3No associated access roads.

The proposed development is within the Nether Mill Farm site and covers an area totalling 0.69 Hectares.

The majority of the site has been identified to be located within Flood Zone 1, with a small proportion of the site located within Flood Zone 2 of the Environment Agency's Flood Map.

The primary sources of flood risk to the proposed development is identified to be from the River Don and its tributary Scout Dike.

Following a comparison of modelled flood levels flood information it has been evaluated that the site is encroached during the 1 in 1000 year event and is therefore partially located within Flood Zones 2.

It is recommended that finished floor levels for all the properties are elevated at least 300mm above the 1 in 1000 year flood level or 600mm above the existing ground level, whichever is the highest.

At present engineering judgment suggests that the proposed development does not discharge surface water into the ground via infiltration or into the public sewer network, therefore the Modified Rational Method has been used to calculate the runoff rates for the 1 in 2, 1 in 30 and 1 in 100 year events as 21.3l/s, 61.8l/s and 94.9l/s.

In accordance with the hierarchy of surface water disposal set out within Approved Document H of the Building regulations, surface water should be directed to a) infiltration; b) watercourse; c) sewer in order of preference.

Investigations indicate that infiltration methods are unlikely to be feasible at the location of the development due to the underlying ground conditions.

Due to the site being located within close proximity the River Don it is recommended that surface water is directed to watercourse.

Post development attenuation volumes have been calculated using MicroDrainage restricting discharge rates to 14.9l/s, 43.26l/s and 94.9l/s.

The impermeable area within the proposed development is increased as a result of the proposed works.

The indicative attenuation volumes have been calculated for the 1 in 2, 1 in 30 and 1 in 100 year plus 30% added to account for climate change over the lifetime of a residential building as 22 - 44m³, 26 – 68m³ and 25 – 82m³.

An evaluation of Sustainable Urban Drainage methods indicates that online/offline underground storage is the most appropriate methods for inclusion within the surface water drainage strategy at Nether Mill Farm due to the underlying conditions not being suitable for infiltration.

It is recommended that foul from the proposed development is to be directed to the 150mm diameter public combined sewer located within Barnsley Road, however this needs to be confirmed via a pre development enquiry to Yorkshire Water.

Any part of the proposed drainage system within the redevelopment at Nether Mill Farm in Penistone which is not to form part of Section 104 agreement with Yorkshire Water i.e. private drainage system, must be inspected and maintained on a regular basis, to prevent siltation at gullies and flow control chambers; thereby reducing the risk of surface flooding.

1.0 Introduction

Paul Waite Associates have been appointed by Dave Hoyland to support a planning application for proposed redevelopment of existing farm buildings and land to provide residential development at Nether Mill Farm, north of Barnsley Road in Penistone, South Yorkshire.

The proposed development covers an area totalling 0.69 Hectares.

The development site is shown to be situated partially within Flood Zone 2 of the Environment Agency Flood Map.

Land and property within Flood Zone 2 has a medium probability of flooding is defined as land assessed as having 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.

The primary sources of flood risk to the proposed development areas within the Nether Mill Farm site have been identified as the River Don; and its tributary known as Scout Dike. It is noted however, that other non-fluvial sources of flooding have been considered within this assessment.

It is usual for the Environment Agency to raise an objection to development applications within the functional floodplain or Zone 2 or 3 of the flood map until the question of flood risk has been properly evaluated. The Agency will also object to developments where the total site area is in excess of 1 Hectare until suitable consideration has been given to surface water runoff.

2.0 Approach to the Flood Risk Assessment

2.1 Approach

A topographical survey of Nether Mill Farm has been provided by Duchy Homes; and it is understood that it has been calibrated to Ordnance Datum. As such, the levels provided by the topographical survey have been utilised within this report.

The requirements for flood risk assessments are generally as set out in the 'Technical Guidance to the National Planning Policy Framework', published in March 2012 and updated in March 2014; and in more detail from the Environment Agency's 'Standing Advice on Flood Risk' available from (www.gov.uk).

2.2 Application of the Sequential and Exceptions Test

The risk based sequential test should be applied at all stages of planning. Its aim is to steer new development to areas at the lowest probability of flooding, within Zone 1. The flood zones are the starting point for the sequential approach.

The proposed development is shown to be situated within Flood Zones 1, and 2 of the Environment Agency Flood Map.

Proposals for the site incorporate residential development, and as such Table 2 of the Technical Guidance to the National Planning Policy Framework (March 2012) indicates that the development is classified as 'more vulnerable'.

Table 1: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	✗	Exception Test required	✓
	Zone 3b	Exception Test required	✓	✗	✗	✗

- ✓ Development is appropriate
- ✗ Development should not be permitted

In accordance with the vulnerability table above, residential development within Flood Zone 1 is deemed to be appropriate; whilst similar development within the areas shown to be situated within Flood Zones 2 will need to pass the Sequential Test before being considered appropriate for the site.

A Sequential Test has been undertaken by Paul Waite Associates to support development at the Nether Mill Farm site and is presented within PWA document reference 15184/I/01.

3.0 Site Details

3.1 Location

The site is centred on ordnance survey grid reference:

- SE 244038

An Ordnance Survey plan of the proposed development is presented below.

Figure 1: Location Plan – Nether Mill Farm, Penistone



Image produced from the Ordnance Survey Get-a-map service.

Image reproduced with kind permission of Ordnance Survey and Ordnance Survey of Northern Ireland.

3.4 Boundaries

Nether Mill Farm is situated within the small market town of Penistone in South Yorkshire.

The proposed development site is situated approximately 650 metres to the north of central Penistone; and 10.3 kilometres west of Barnsley.

Table 2: Boundaries

North	North of the site is the newly expanded Penistone Grammar School, beyond which is 'Scout Dike' mill pond with a residential development to the east, further to this is the Halifax Road, 'Scout Dike' Reservoir and a large expanse of land used for agricultural purposes.
East	East of the development is the existing Nether Mill House complex of buildings and then the watercourse known as 'Scout Dike', beyond which is Barnsley Road and a residential area associated with Windermere Road.
South	Directly south of the site is Barnsley Road and the River Don, beyond which is an agricultural field and a children's football pitch and play area and then the junction between Barnsley Road and Bridge Street, further to this is the White Heart Pub.
West	West of the site is Huddersfield Road, beyond which is a section of the River Don which meanders north for approximately 100m before changing direction south west. Further to this is an area of agricultural land before the residential development associated with Towngate.

The River Don is classified as a 'Main River'; and flows eastwards on the southern side of Barnsley Road adjacent to the proposed development.

Scout Dike is a tributary of the River Don and is classified as 'Ordinary Watercourse'. The watercourse flows generally in a south easterly direction along the east boundary of Nether Mill Farm, joining with the River Don immediately to the east of the site.

Vehicular access into the proposed development will be via roads/shared driveways available directly from Barnsley Road.

Figure 3: Aerial View of the Site



Image courtesy of Google Maps

Figure 4: Existing Site Access



Image courtesy of Google Maps

3.5 Topography

A topographical survey of Nether Mill Farm has been undertaken and highlights the high point within the development area is elevated at 197.61mAOD, and situated within the north corner of the site.

The low point within this area is elevated at 193.30mAOD, and is situated along the north east boundary.

Barnsley Road forms the south boundary of the site and ranges in level from 193.45mAOD and the eastern extremity, rising to 195.00mAOD within the south west part of the site.

The vehicular access is from Barnsley Road via 2No access roads at levels approximating 194.92mAOD; and 194.58mAOD.

Existing Development Levels

The existing ground levels for each of the plots have been provided below:

Table 3: Existing Ground Floor Levels

Plot 1	195.84m AOD
Plot 2	195.95m AOD
Plot 3	194.98m AOD
Plot 4	194.58m AOD
Plot 5	196.49m AOD
Plot 6	196.69m AOD
Plot 7	196.11m AOD
Plot 8	195.60m AOD
Plot 9	195.85m AOD
Plot 10	196.25m AOD
Plot 11	195.90m AOD

3.6 Existing Drainage

The existing site is largely undeveloped and as such these parts are not positively drained, it has been identified that the farm buildings do not have any gutters therefore engineering judgment suggests that these are also not positively drained and surface water flows overland towards the road.

Information obtained from Yorkshire Water's sewer record indicate that a 150mm diameter public combined sewer flowing from north to south, it passes through the development along the north east boundary of the site (on the west of Nether Mill House), where it connects to another 150mm diameter combined sewer flowing west to east within Barnsley Road, the combined sewer changes direction south outside the access the Nether Mill House where it then passes over the River Don.

A copy of the water supply and sewer record plans supplied by Yorkshire Water are provided for reference within Appendix E of this report.

3.7 History of Flooding

3.7.1 Internet Search for Historical Flooding

Following what was reported to be 2 months' worth of rainfall over a 24 hour period in July 2012, an area of Penistone to the south of the development areas at Nether Mill Farm, known as Green Road became flooded.

Penistone Cricket Club located off Sheffield Road to the south east of the proposed development was also reported to have become inundated due to overtopping of the natural river bank, along the River Don.

Information obtained from Barnsley Council's website indicates that during this period, Green Road was closed to vehicles and the flood status along part of the A628 in Penistone was upgraded to 'Flood Warning' from 'Flood Alert'.

It is not clear from the reports however which part of the A628 through Penistone that this report refers to.

The Barnsley Chronicle reported the following:

'In Penistone areas such as Green Road and Barnsley Road had water running down the streets, and Hoyle Mill Lane, next to the River Don in Thurlstone, along with Manchester Road at Millhouse Green were also badly affected.'

3.7.2 Barnsley Council's Level 1 SFRA (2010)

Table 5.1 within the SFRA document outlines the major historical flood events within the Upper Don Catchment and Dearne Valley. It is noted that all events listed are related to flood events along the River Dearne; with no incidents listed in Penistone or within the immediate vicinity of Nether Mill Farm.

3.7.3 Barnsley Council's PFRA (2011)

The Preliminary Flood Risk Assessment document has been prepared to assist Barnsley Council meet their duties to manage local flood risk and deliver the requirements of the Flood Risk Regulations (2009).

Within the new legislative framework Barnsley Council is defined as a Lead Local Flood Authority (LLFA).

A review of the historical flood information provided within Table 4-2 of this report, did not deliver evidence of flooding within the vicinity of the proposed development sites at Nether Mill Farm or indeed the Penistone area.

3.7.5 Environment Agency Historical Flood Level Data

The Environment Agency has provided details of historic flooding during the autumn 2000 and June 2007 flood events.

It has been identified that the application site has not suffered past historic flooding, the nearest historic event was directly north east within the adjacent field, however there is no flood level associated with this.

The nearest historic flood event with a flood level is south east on the south side of Barnsley Road on the agricultural field (north of the children's football pitch). The information provided by the Environment Agency indicate that the flooding was at a level of 194.02m AOD, another flood level associated with the east of Huddersfield Road is at 195.38m AOD.

3.7.6 Anecdotal Information

During the event of 2012 it was advised that flooding occurred just outside of the redline boundary of the site, figure 13 overleaf identifies the location, the following information was supplied by the previous land owner:

'During the exceptional flooding of last summer Scout Dike backed up as the flow of water down Scout Dike was not able to get into the River Don due in part to the flow in the Don and, according to the land owner at the time, the restricted space available within the culvert beneath Barnsley road due to silting of the bed of Scout Dike.

Flood water from Scout Dike gained access to the site by flowing through the existing dry stone boundary wall.

It was advised that the flooding within the site covered the area in front of the tractor shed, the interior of the tractor shed and a small part of the front lower internal floor area of the principle stone barn that stands at right angles to the tractor shed.'

The depth of flooding within the tractor shed is understood to have approximated 0.5 metres.

The ground levels along to the east boundary range from 194.3m AOD up to 196.44m AOD and therefore it is considered that the land contained within the current application remains unaffected.

Figure 5: Anecdotal Historic Flooding



Image Source: Google Earth

4.0 Flooding Mechanisms

Table 4: Sources of Flooding

Source/Pathway	Significant?	Comment/Reason
Fluvial	Yes	River Don; Scout Dike
Tidal/Coastal	No	Not Applicable
Canal	No	Not Applicable
Pluvial (urban drainage)	Yes	Surface Water Runoff
Surface Water	No	Small SW flow route at the south east corner of the site.
Groundwater	No	SFRA states that this area is not affected.
Reservoir	No	Environment Agency map identifies that the site will not be affected by reservoir flooding
Overland flow	Yes	Due to topography of the area – there is potential for flooding via this mechanism
Blockage	No	Existing road bridges
Infrastructure failure	No	Existing road bridges; reservoirs
Rainfall Ponding	No	No low points within development areas

4.1 Fluvial: River Don

4.1.1 General

The River Don rises in the Pennines and flows for 70 miles generally in an easterly direction, through the Don Valley, via Penistone, Sheffield, Rotherham, Mexborough, Conisbrough, Doncaster and Stainforth.

It originally joined the River Trent, but was re-engineered by Vermuyden in the 1620's, and now joins the River Ouse at Goole in the East Riding of Yorkshire.

The upper reaches of the River Don, and those of several of its tributaries, are defined by dams built to provide a public water supply. The middle section of the river contains many weirs, which were built to supply mills, foundries and cutlers' wheels with water power, while the lower section of the watercourse contains weirs and locks, designed to maintain water levels for navigation.

The River Don's major tributaries are the Loxley, the Rivelin, the Sheaf, the Rother and the Dearne.

The river channel near to the proposed developments at Nether Mill House in Penistone is predominantly open channel, with a substantial road crossing associated with Barnsley Road upstream of the site.

Due to the size of the bridge it is highly unlikely that blockage of a structure of this size would actually occur.

Furthermore there are no formal flood defenses along the river banks within the immediate vicinity of the proposed development.

Due to the development being located within Flood Zone 2 of the Environment Agency Flood Map a comparison of flood levels associated with the River Don against levels onsite has been undertaken.

4.1.2 Environment Agency Flood Level Data

The Environment Agency have provided modelled flood levels for a range of probabilities at a number of locations along the River Don.

In order to assess the impact of flooding within the River Don node Ref: 27870 has been used due to its proximity to the site.

Table 5: Modelled Flood Levels (River Don)

Return Period	Water Level Node Ref 27870 (mAOD)
1 in 5 years	193.582
1 in 10 years	193.709
1 in 25 years	193.856
1 in 50 years	193.959
1 in 75 years	194.019
1 in 100 years	194.054
1 in 200 years	194.152
1 in 1000 years	194.457

4.1.3 Overtopping: 1 in 100 Year Flood Event

Surveyed ground levels within this development site area range from 194.30mAOD to 197.61mAOD.

During the 1 in 100 year event associated with the River Don it is anticipated that flooding will be at a level of 194.054m AOD, the lowest onsite level identified from the topographical survey is at a level of 194.300m AOD.

Therefore flooding will not encroach into the redline boundary during the 1 in 100 year event associated with the River Don. This concurs well with the Environment Agency Flood Map.

4.1.4 Overtopping: Climate Change

In accordance with the requirements of the NPPF (2012), the impact of climate change over the lifetime of the development must be evaluated.

Unfortunately the modelled flood levels have not provided for climate change.

From Table 5 of the 'Technical Guidance for the NPPF' an increase of 20% to peak river flows is deemed appropriate to assess the impact of climate change.

Therefore through interpolation of modelled flows and flood levels, the estimated flood level within the River Don, during the 1 in 100 year plus 20% climate change for node ref: 27870 has been estimated and is tabulated below.

Table 6: Estimated 1 in 100 year plus 20% Climate Change Flood Levels (River Don)

Return Period	Water Level Node Ref 27870 (mAOD)
1 in 100 year + 20%	194.162

With the application of climate change to the 1 in 100 year flood level, the site is shown to marginally encroach the north east corner of the application site by 0.138m.

4.1.4 Overtopping: 1 in 1000 year Flood Event

During the 1 in 1000 year event with determines Flood Zone 2 the level associated with the River Don at Node 27870 is identified to be at a level of 194.457m AOD.

The lowest level onsite has been determined to be 194.30m AOD, as such the site will not be encroached, however the discrepancy is less than 250mm.

In conclusion the flood levels associated with Node Ref 27870 for the 1 in 1000 year event are shown not to flood the proposed development site.

4.2 Fluvial: Scout Dike

4.2.1 General

Scout Dike is a tributary of the River Don. The watercourse begins as a number of small streams on moorland located to the north west of Penistone.

The watercourse serves a number of reservoirs, including Broadstone; Ingbirchworth; Royd Moor and Scout Dike, emerging from this final reservoir as Scout Dike.

Scout Dyke is located approximately 100m north east of the development site on the east side of the Neither Mill House, there are no raised flood defences evident along the banks of the watercourse.

The flood mechanisms in respect of the watercourse are similar to those identified for the River Don i.e. overtopping of the river bank, along with blockage and/or infrastructure failure of the existing road bridge.

The watercourse is classified as 'Ordinary Watercourse' and as such the responsibility for managing activity on or alongside the watercourse lies with the Local Lead Flood Authority i.e. Barnsley Council. The responsibility for maintenance of the watercourse however lies with the riparian owner.

Unfortunately the Environment Agency has been unable to provide modelled water levels for Scout Dike.

4.2.2 Overtopping

It is considered that flood levels within the lower reaches of the watercourse are dominated by water levels within the River Don.

As such inundation at the Nether Mill Farm site attributed to this mechanism has been investigated previously within Section 4.1 of this report.

Flow into the upper reaches of the watercourse is largely controlled via Scout Dike reservoir. However historic flood maps provided by the Environment Agency indicate that out of bank flooding occurred immediately upstream of Nether Mill Farm during 2007.

The historic flood outline indicates that the open field north east of the development was inundated over a large area. Reference is made to the Environment Agency Maps provided within Appendix D of this report.

4.2.3 Infrastructure Failure: Blockage or Collapse at Barnsley Road Bridge

The bridge which provides a conveyance route under Barnsley Road is considered to be a highway asset, and therefore from a structural perspective is the responsibility of the Highways and Transportation Department at Barnsley Council.

As such, it is considered that the bridge structure undergoes a regular schedule of inspection, with the Highways Authority undertaking maintenance as required.

It is therefore considered that the road bridge has a low probability of structural failure.

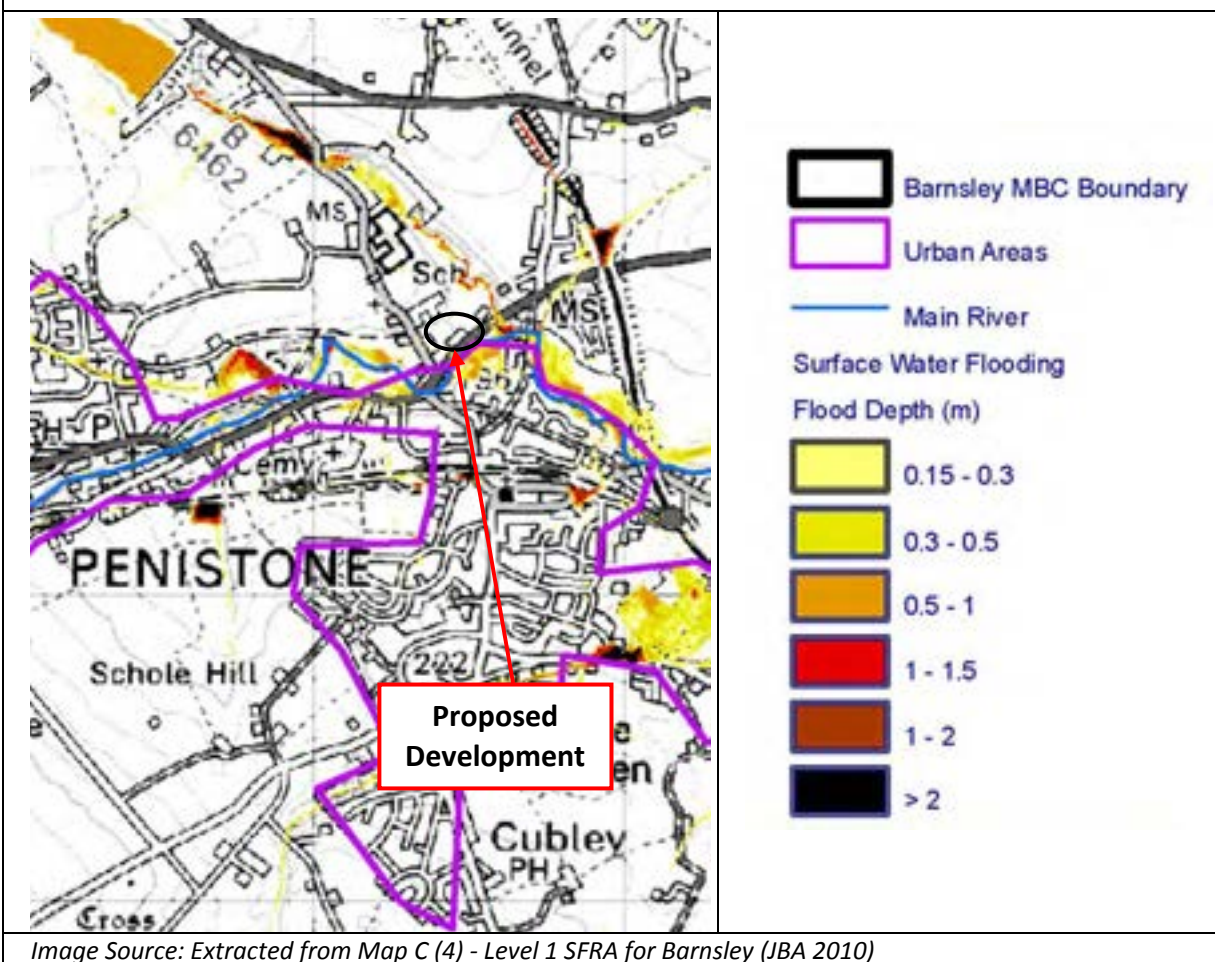
4.3 Pluvial: Surface Water Runoff

4.3.1 Barnsley MBC Level 1 SFRA – Surface Water Flooding

In regard to the potential for surface water flooding within the Penistone area, the following details have been extracted from the Level 1 SFRA document.

‘Surface water flooding occurs where high rainfall events exceed the drainage capacity in an area and these events can lead to serious flooding of property and possessions as demonstrated by the summer 2007 floods. In addition, large amounts of surface water runoff can lead to water quality problems and potential health risks to people.’

Figure 6: Extract from SFRA Map C - Surface Water Flooding



‘The topography of the Barnsley MBC area, especially in and around a number of the built-up areas makes them potentially prone to flooding caused by direct rainfall due to the amount of impermeable surfaces and the lack of sufficient sewer capacity. Some modelling of the possible surface water flooding within the urban areas as a result of the 100 year rainfall event has been undertaken in order to provide an indication of areas where surface water (derived from rainfall only) will naturally flow towards and possibly pond.’

'Areas where surface ponding may generate flood depths in excess of 0.5m (which could also be further exacerbated by flooding from local watercourses), are distributed across the Barnsley MBC urban areas with particular concentrations in:

- *The railway area just east of Market Hall in Barnsley town centre*
- *South western parts of Thurnscoe*
- *North western parts of Bolton-on-Dearne*
- *Eastern parts of Penistone'*

A review of Map C illustrates that there is no surface water flooding predicted for the proposed development site.

The Environment Agency's Surface Water Flood Map however does identified a small area at the south west of the site that is affected by a surface water flow route that flows into Barnsley Road itself, as a result of flooding from the River Don on the east side of Huddersfield Road.

Figure 7: Environment Agency Surface water Flood Map



Image Source: Google Earth

It must be noted that flooding of this scale is only expected to occur during the low probability event and does not occur during the medium and high probability events. As such the raising the proposed finished floor levels in line with the requirements associated

with properties within Flood Zone 2 should suitably mitigated against any surface water flooding.

4.3.2 Increased Runoff Due to Development: General

The total development area within the Nether Mill Farm site approximates 0.69 Hectares.

Proposals involve provision of residential accommodation comprising of 11No detached properties and 3No associated access roads/shared driveways.

Figure 8: Existing Dwellings within Development Area



Image Source: Google Earth

Roof water from the existing dwelling is shown to have downpipes; however the topographical survey did not highlight any manhole chambers within this area of the site. It is therefore surmised that roof water is allowed to discharge to ground surface level; where it flows overland to Barnsley Road via the site access or via the south west boundary of the development; where it is collected by road gullies; and is ultimately directed into the River Don.

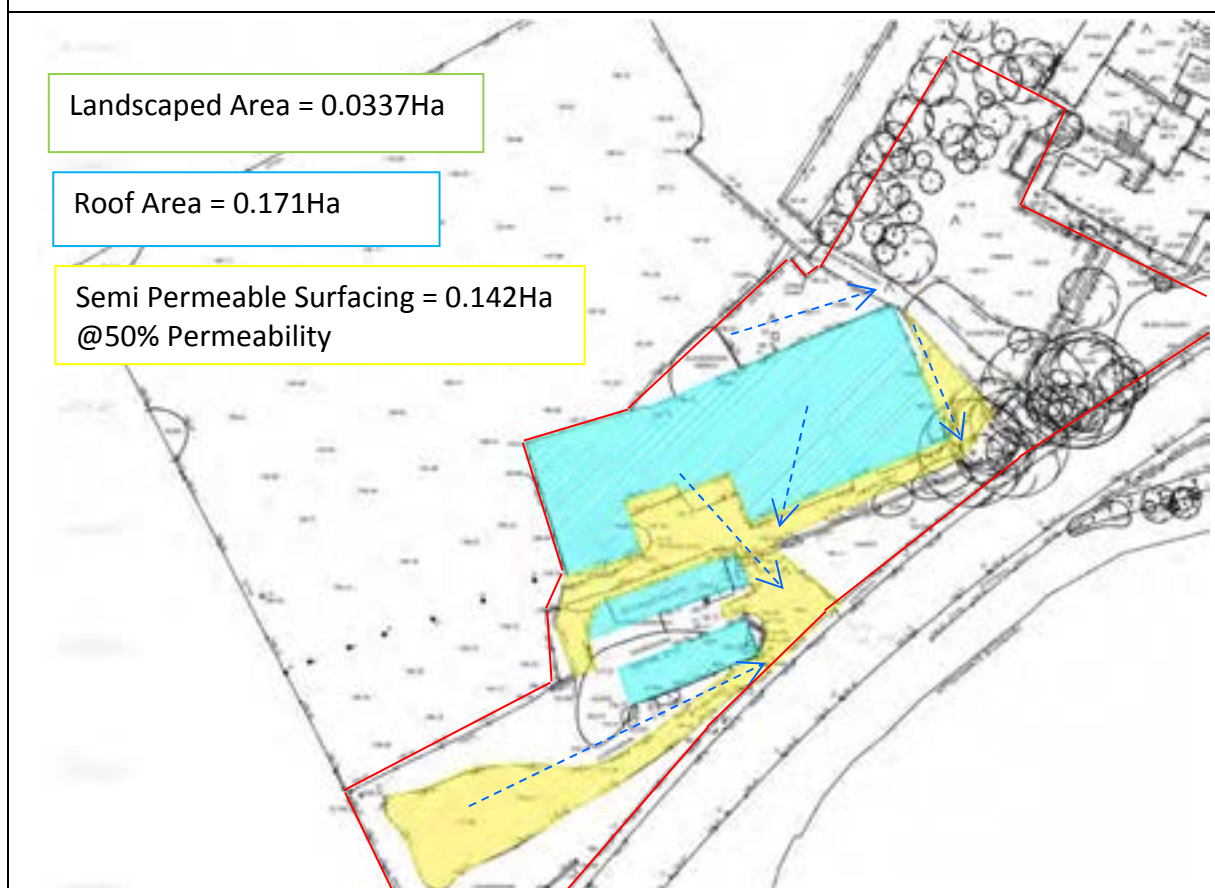
An evaluation of the roof and hardstanding areas within the site has been undertaken, and is tabulated below. A sketch illustrating this assessment is provided within the figure below.

Table 7: Existing Contributing Areas

Surface Type	% Impermeable	Total Area (Ha)	Contributing Area (Ha)
Roof/Building Footprint	100	0.171	0.171
Open storage & yard areas (Gravel/Chippings)	50	0.142	0.071
Concrete/Tarmacadam Hardstanding	100	0	0
Landscape	10	0.337	0.034
Total		0.690	0.276

It is estimated therefore that the site is roof and paved to approximately 42% of the total development area.

Figure 9: Existing Areas Contributing to SW Runoff



4.3.4 Estimation of Existing Peak Surface Water Runoff

Utilising rainfall profiles obtained from the FEH CD-ROM (Version 3.0) and the Modified Rational Method, the peak surface water flows for a range of probabilities have been

calculated and tabulated below. The full calculation spreadsheets are provided for reference within Appendix F of this report.

Table 8: Existing Surface Water Runoff

Return Period	Ex. Peak Runoff Rate (l/s)	30% Reduction (l/s)
1 in 2 year	21.3	14.9
1 in 30 year	61.8	43.26
1 in 100 year	94.9	66.43

In order to accommodate future climate change and provide a betterment to the existing situation, the Environment Agency; Yorkshire Water and Barnsley Council requires the application of a 30% reduction to existing peak runoff rates generated by the existing development.

Flows in excess of this should be attenuated on-site prior to discharge into the receiving sewer or watercourse.

4.3.10 Post Development Contributing Areas

From the latest Development Masterplan, the areas contributing to surface water runoff from each development area has been evaluated and tabulated below.

Table 9: Post-Development Contributing Areas

Surface Type	% Impermeable	Total Area (Ha)	Contributing Area (Ha)
Roof & Hardstanding	100	0.320	0.320
Landscape	10	0.330	0.033
Total		0.690	0.353
Comments: Existing area of roof/building footprint = 0.171Ha. Following development this is increased significantly in comparison; the overall increase in impermeable area within the site also rises from 0.276Ha to 0.353Ha i.e. 42% to 54% of the total area available within the site.			

It is advised that the contributing areas provided above should be re-evaluated during the detailed design phase to accommodate any changes made to the proposed development plan for each phase.

4.3.11 Attenuation Requirements

Due to the general increase in impermeable area within the proposed development at Nether Mill Farm, surface water runoff rates will be increased; and consequently will need to be attenuated prior to discharge from the site.

In accordance with Table 5 from the Technical Guidance for the National Planning Policy Framework (2012); peak rainfall intensities should be increased by 30% to accommodate climate change over the lifetime of the development i.e. 100 years for residential development.

The Environment Agency and Local Authority will insist that the proposed 1 in 2 year runoff can be maintained and also insist that the 1 in 30 year event is not allowed to flood the surface; hence the water must remain within the pipes, manholes, and storage systems.

The resulting runoff from the 1 in 100 year event, is allowed to flood the surface, however flood water must not be allowed to enter any of the buildings; or migrate to adjoining development outside of the site boundary.

Using the ICP SUDS Method storage volumes for each development area, for the 1 in 2 year, 30 year, 100 year plus climate change events have been calculated and tabulated below. The allowable discharge rates from the proposed development have been set to existing rates for the matching probabilities; or 5l/s whichever is the highest.

The area contributing to the site is estimated to be 0.353 Hectares i.e. 54% of the overall site area.

Utilizing the allowable surface water discharge rates calculated within Section 4.3.4 of this report 14.9l/s; 43.26l/s; and 66.46l/s indicative attenuation volumes have been estimated for the 1 in 2 year; 1 in 30 year; and 1 in 100 year plus climate change storm events.

Table 10: Indicative Volume of Attenuation: (0.353 Hectares)

Return Period	Storage Volume (m ³)
1 in 2 year + 30% climate change	22 - 44
1 in 30 year + 30% climate change	26 - 68
1 in 100 year + 30% climate change	25 - 82

General Comment

It is noted that the storage volumes provided are indicative only at this stage and should be recalculated during the detailed design stage to reflect the following:

- Planning Conditions
- Agreed allowable discharge from the site
- The finalised development proposals
- The extent of impermeable areas and runoff to be generated.

4.4 Overland Flow

Spicer Hill is situated to the north west of the proposed development, with a top elevation of 349mAOD; and Hartcliff Hill to the south west with a crest level approximating 364mAOD.

From the Ordnance Survey Maps for the area, it is identified that surface water from these elevated areas is collected by a network watercourses and reservoirs.

Furthermore existing development at Thurlstone and within Penistone lies in between the site and these points; and so it is considered that surface water runoff along the overland flow routes will be intercepted by existing infrastructure, such as road gullies; highway drains and the public sewer network.

It is noted however that more immediate lead to the Nether Mill farm site, open field areas immediately to the north side of proposed development slope down towards the site boundary; providing an overland flow route.

In conclusion overland flows are considered to present a flood risk to the proposed development.

4.5 Groundwater

The following text in relation to the potential for groundwater flooding at the proposed development has been extracted from the Level 1 SFRA for Barnsley.

'Groundwater flooding is caused by the emergence of water originating from underground, and is usually very local and governed by the local geology.'

Unlike flooding from rivers and the sea, groundwater flooding does not generally pose a significant risk to life, but is more associated with significant damage to property, with flooding persisting over a number of weeks for some types of groundwater flooding.

Groundwater flooding is a significant but localised issue that has attracted an increasing amount of public concern in recent years; and can also exacerbate fluvial flooding in certain circumstances.

Groundwater flooding arises from:

- *Natural exceptional rises in groundwater level, reactivating springs and short lived watercourses (often referred to as 'clearwater' flooding);*
- *Rising groundwater (rebound) following reductions in historic abstraction; Mine water recovering to natural levels following cessation of pumping; and*
- *Local shallow drainage/flooding problems unrelated to deep groundwater responses.*

Key issues are:

- *Groundwater flooding is sporadic in time and location, but when it occurs, it usually lasts longer than surface water flooding and interferes with property and infrastructure (such as roads).*
- *In most cases groundwater flooding cannot be easily managed or lasting solutions engineered.*

There are many other localised and site-specific reasons for water to emerge at the surface or to appear in basements, for example, leaking water mains and sewers, blocked drains, and impedance of natural drainage routes by urban development or deepening of cellars to below the natural water table.

Likely candidates for groundwater flooding in the Barnsley MBC area are:

- *Kingstone area of Barnsley*
- *Kingwell area of Worsbrough*
- *Millhouses area of Hoyland*
- *Upperwood area of Darfield*

The Coal Authority was consulted with respect to the possibility of flooding caused by the re-emergence of mine waters from the formerly very important South Yorkshire mining region following the cessation of mine water pumping. These discussions indicated that The Coal Authority have a comprehensive network of groundwater monitoring boreholes across South Yorkshire and, by working in partnership with the Environment Agency and other local coal

mining interests are developing a strategic forward plan to manage mine water levels to minimise the risk of re-emerging mine waters causing both flooding and/or initiating water quality problems in the major Sherwood Sandstone water resource aquifer.'

In conclusion groundwater flooding is deemed to present a low flood risk to all of the proposed development areas within the proposed development site.

4.6 Reservoirs

The following text in relation to the potential for flooding from reservoirs at the proposed development has been extracted from the Level 1 SFRA for Barnsley.

'According to the Environment Agency's Register of Reservoirs, there are 19 operational 'large raised reservoirs' located within the boundaries of the Barnsley MBC boundary ranging in capacity between about 35,250m³ and 8,296,000m³.

Reservoirs can both store and attenuate flows in a similar manner to washlands and floodplains, depending upon how they are managed. At present these reservoirs are often full in winter and so would therefore provide little potential attenuation for flooding. Service reservoirs are not included in this register.

Reservoirs can also act as a major source of flood risk, as experienced recently during the 2007 summer floods in England and Wales, where 18 reservoirs were affected.

Reservoir flooding is therefore an important source of flood risk which has been noted within Pitt Review.

Whilst the probability of dam failure or breaching occurring is very small, the consequences of such an event can be devastating hence presenting a risk of flooding which has to be considered.

Currently the Water Act 2003, which amended the Reservoirs Act 1975, requires all reservoir undertakers to prepare reservoir flood plans for those reservoirs where the dam failure could put people's lives at risk or lead to major damage.

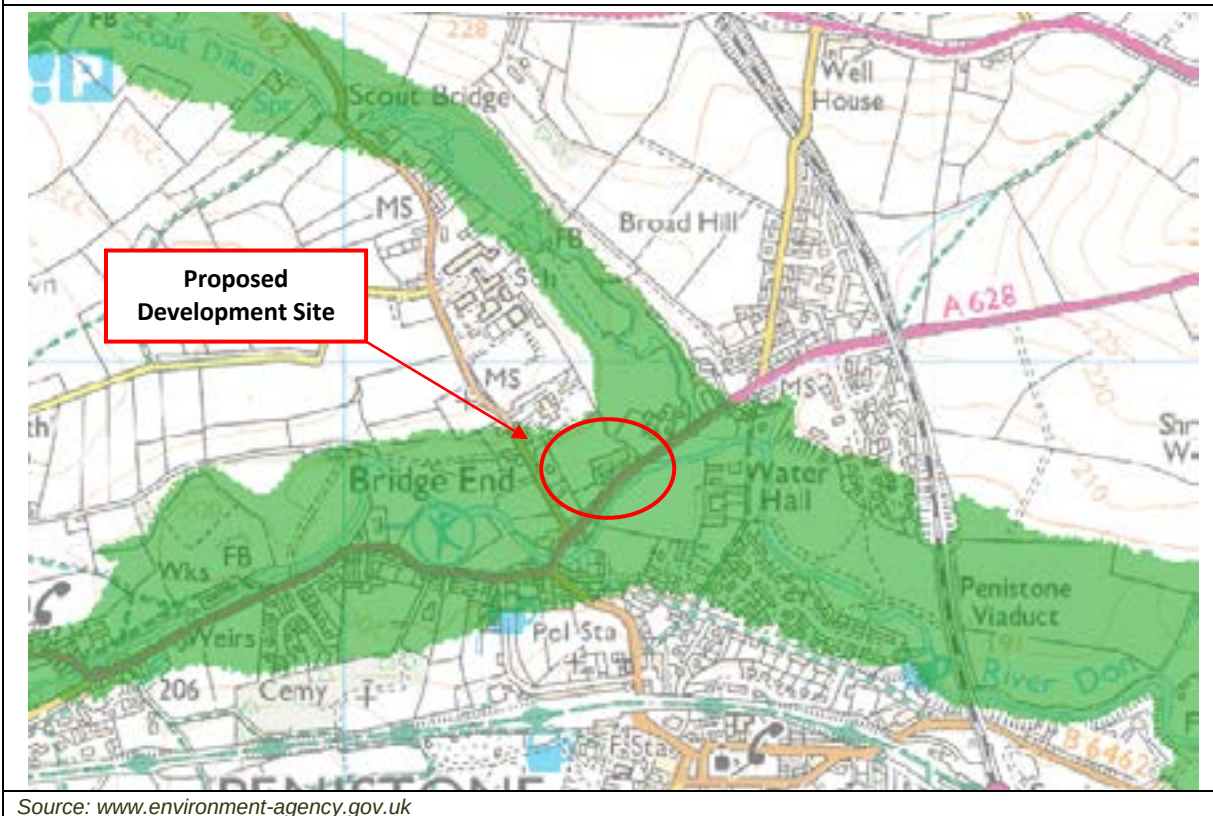
The reservoir flood plan includes:

- An inundation analysis to identify the extent and severity of flooding which could result from an uncontrolled release of water (i.e. breaching or failure).
- An on-site plan setting out what the undertaker would do in an emergency to try and to contain and limit the effects of the incident, and
- A communications plan with external organisations, mainly the emergency services.'

It is noted that there are a series of reservoirs upstream of the proposed development; the nearest being Scout Dike, located approximately 150 metres from the north boundary; although Windleden Lower; Royd Moor; Ingbirchworth; Winscar; Windleden Upper; and

Broadstone Reservoirs also impact the potential risk of flooding within the area surrounding the development site.

Figure 10: Risk of Flooding from Reservoirs



All of the reservoirs named are Yorkshire Water assets.

The map shown within Figure 10 above illustrates the largest area that might be flooded if a reservoir were to fail and release the water it holds. Since this is a prediction of a worst case scenario, it's unlikely that any actual flood would be this large.

In conclusion reservoir flooding is extremely unlikely. There has been no loss of life in the UK from reservoir flooding since 1925; and since this time reservoir safety legislation has been introduced to make sure reservoirs are well maintained.

As such the flood risk at the proposed development site presented by this source is considered to be low.

4.7 Ponding

The topographical survey indicates that in general there are no low points where localised ponding during heavy rainfall is likely to happen.

Following redevelopment it is recommended that proposed levels are carefully designed to avoid any ponding within the site boundary from occurring; and where this is unavoidable suitable arrangements are incorporated within the design for drainage.

5.0 Material Consideration In Respect of the National Planning Policy Framework

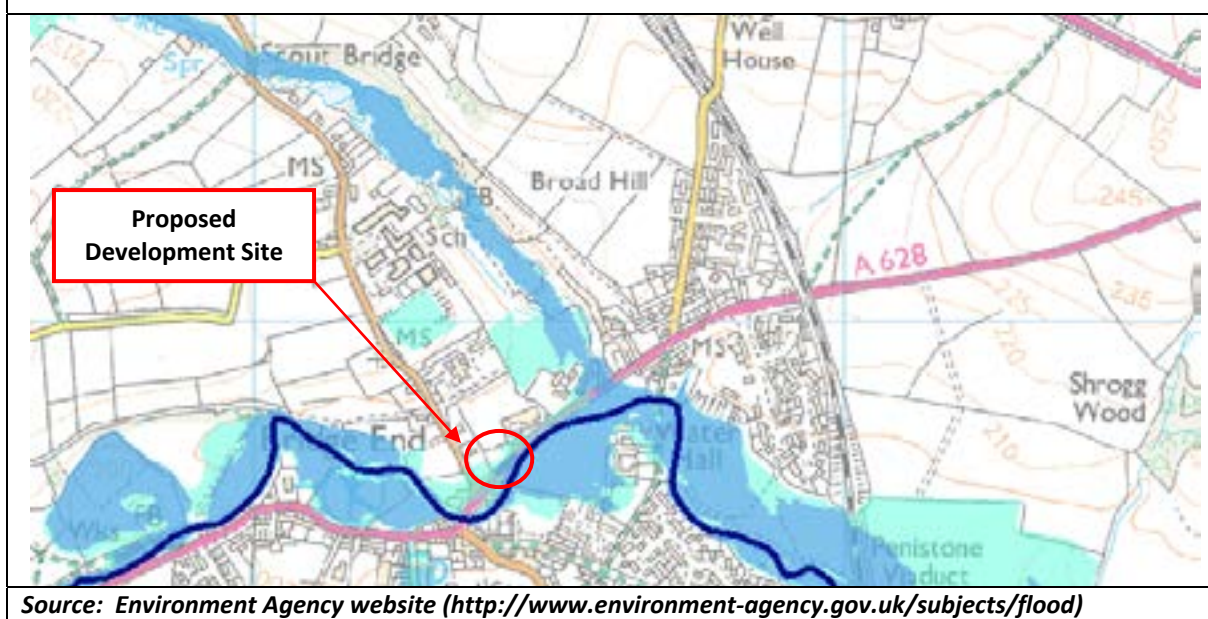
5.1 Climate Change

Published evidence suggests that winters will become wetter over the whole of the UK, by as much as 20% by the year 2050. In making an assessment of the impact of climate change, flooding from rivers and land will give a peak flow allowance of up to 20% increase in rainfall for a given return period by 2050 and 30% by 2110. These considerations will provide an appropriate precautionary assessment for climate change impact on flood flows and rainfall intensities.

As such 30% has been applied to the modelled flood levels to account for climate change over the lifetime of a residential development.

5.2 Environment Agency Flood Map

Figure 11: Environment Agency Flood Map



Key

- Flooding from rivers or sea without defences (Flood Zone 3)
- Extent of extreme flood (Flood Zone 2)
- Flood defences
- Areas benefiting from flood defences
- Main rivers

The Environment Agency flood zone map indicates that the site lies partially within Flood Zone 2 which has a medium probability of flooding is defined as land assessed as having 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.

5.3 Finished Floor Levels

The site is shown to be located partially within Flood Zone 2 therefore the finished floor levels should be set to a minimum of whichever is highest:

- 300mm above existing ground level; or
- 600mm above the 1 in 100 year + climate change flood level, whichever is the highest.

The existing levels and the recommended finished floor levels are identified within the table below for all the individual properties.

Table 11: Finished Floor Levels

Property	1 in 1000 yr Flood Level (m AOD)	Existing Ground Level (m AOD)	Elevation Above the Flood Level (m AOD)	Recommend Minimum Finished Floor Level (m AOD)	Design Finished Floor Level (m AOD)
No1	194.47	195.04	+1.383	196.14	195.85
No2		195.95	+1.493	196.25	196.45
No3		194.98	+0.523	195.28	195.40
No4		194.58	+0.123	194.88	196.00
No5		196.49	+2.033	196.79	196.45
No6		196.69	+2.233	196.99	197.05
No7		196.11	+1.653	196.41	197.20
No8		195.96	+1.503	196.26	196.30
No9		195.85	+1.393	196.15	195.70
No10		196.25	+1.793	196.55	196.75
No11		195.90	+1.443	196.20	196.50

The table identifies that properties No1, No5 and No9 have design finished floor levels below the recommended finished floor level. As such it is recommend that finished floor levels within properties are elevated in line with the recommended levels i.e.

- Property No1 = 196.14m AOD
- Property No 5 = 196.79m AOD
- Property No 9 = 196.15m AOD

5.10 Preliminary Drainage Strategy

5.10.1 Building Regulations Hierarchy

The impermeable area and hence surface water flows from the proposed development are considered to increase following completion of the development.

The hierarchy for disposal of surface water from new development is outlined within The Building Regulations Approved Document H and specifies the following methods in order of preference:

- Infiltration via soakaway or other suitable infiltration device
- Discharge to watercourse
- Discharge to public sewer.

Infiltration

A site investigation report for the proposed development is not currently available. Therefore in order to assess the potential for infiltration methods to dispose of surface water from the development, an investigation of the general ground conditions within the Penistone area was undertaken.

Catchment wide data for the site was obtained from the FEH CD-ROM (V3.0), which indicates that, the SPRHOST (Standard Percentage Runoff) for the site has a value of 38.7%; with a value of 45% indicated by MicroDrainage Source Control. These values are fairly high and are considered generally to represent ground which is not suited for dissipation of surface water flows into the ground.

To further investigate, a review of historical borehole logs within the general vicinity of the development from the British Geological Society records indicates that ground is predominantly underlain by impermeable siltstone.

A copy of the borehole logs which have been reviewed is provided within Appendix M of this report.

Information from the National Soil Resource Institute: www.landis.org.uk/soilscapes details the development area as being situated on slowly permeable seasonally wet acid and loamy and clayey soil with impeded drainage characteristics.

It is noted however that the large number of natural streams which emanate from the high areas surrounding Penistone do not provide a positive case for infiltration; as it is considered likely that most surface water drainage within the area is discharged to watercourse.

Watercourse

The River Don is located approximately 30m south east of the application site on the opposite side of Barnsley Road, therefore due to the proximity of a watercourse it is recommended that surface water is directed to the River Don.

5.10.2 Surface Water Drainage Design Criteria

The following criteria for designing surface water drainage systems for new development have been extracted from the Joint DEFRA/EA R&D Technical Report 'Preliminary Rainfall Runoff Management for Developments' (W5-074/A/TR/1) published in January 2012.

1. Discharge Rate

The Environment Agency normally require that, for the range of annual flow rate probabilities, up to and including the 1% annual probability (1 in 100 year event) the developed rate of runoff into a watercourse should be no greater than the undeveloped rate of runoff for the same event based on the calculation of QBAR or QMED and the use of FSSR growth curves.

Exceptions only apply where it is not practical to achieve this due to either constraints on the size of the hydraulic control unit, or excessive storage volumes. The purpose of this is to retain a natural flow regime in the receiving watercourse and not increase peak rates of flow for events of an annual probability greater than 1%. Three annual probabilities are used to define discharge compliance limits though the critical criteria are for the lowest and highest frequency events; 100% (1 year), 3.33% (30 year) and 1% (100 year).

2. 1 in 1 year Design Event

The 1 in 1 year event is the highest probability event to be specifically considered to ensure that flows to the watercourse are tightly controlled for frequent events to provide good morphological conditions.

3. 1 in 30 year Design Event

The 1 in 30 year event is of importance because of its linkage with the level of service requirement of Sewers for Adoption 7th Edition, which requires that surface water sewers should be capable of carrying the 1 in 30 year flows generated by a development within the system without causing flooding to any part of the site.

4. 1 in 100 year Design Event

The 1 in 100 year event has been selected since it represents the boundary between high and medium risks of fluvial flooding defined by the National Planning policy Framework (2012) and also recognises that it is not practicable to fully limit flows for the most extreme events. Also Sewers for Adoption 7th Edition recognises that, during extreme wet weather, the capacity of surface water sewers may be inadequate.

Sewers for Adoption 7th Edition requires that the site layout should be such that internal property flooding does not result, by demonstrating safe above ground flow paths.

The return period for this analysis is not specified, but it is recommended that 1% annual probability event (i.e. an event with a return period of 100 years) is used.

5. Flood Flows

Runoff up to the 1 in 100 year return period should preferably be managed within the site at designated temporary storage locations unless it can be shown to have no material impact by leaving the site in terms of nuisance or damage, or increase river flow during periods of fluvial flooding. Analysis for overland flood flows within the site will need to use appropriate duration events which may be different to critical events for designing surface water control storage structures.

6. Surface Water Runoff Volume

Theoretically the surface water runoff volume from a site should be limited to the greenfield runoff volume for all event frequencies. However this is technically extremely difficult to achieve and therefore compliance to two criteria on runoff volume is required.

- a. Interception:** Where possible, infiltration or other techniques are to be used to try and achieve zero discharge to receiving waters for rainfall depths up to 5mm.

- b. Additional Runoff Due to Development:** The difference in runoff volume pre- and post-development for the 100 year 6 hour event, (the additional runoff generated) should be disposed of by way of infiltration, or if this is not feasible due to soil type, discharged from the site at flow rates below 2 l/s/ha, unless Point 9 (See below) is applicable to the development.

7. Climate Change

In accordance with Table 5 of the Technical Guidance for the NPPF (2012), a 20% increase to rainfall intensities should be applied for development with a lifetime up to 2085; and 30% for development with a prospective lifetime beyond this date.

Residential development is generally expected to have a design life of 100 years; and as such an additional 30% must be applied within the drainage design for the proposed development.

8. Minimum Limit of Discharge Rate

A practicable minimum limit on the discharge rate from a flow attenuation device is often a compromise between attenuating to a satisfactorily low flow rate while keeping the risk of blockage to an acceptable level.

This limit is set at 5 litres per second, using an appropriate vortex or other flow control device.

Where sedimentation could be an issue, the minimum size of orifice for controlling flow from an attenuation device should normally be 150mm laid at a gradient not flatter than 1 in 150, which meets the requirements of Sewers for Adoption 7th Edition.

5.10.3 Sustainable Urban Drainage Systems (SUDS)

Due to the nature of the proposals, the impermeable area within the site will be increased following development. There will therefore be an increase in surface water runoff rates and volumes from the site when it is developed.

The Statutory Authorities will request that the runoff from the proposed development is restricted to brownfield runoff rates with a reduction of 30%.

Additionally, the Local Authority; Yorkshire Water and Environment Agency will require that adequate pollution control is incorporated into the drainage system in order to prevent deterioration of the quality of the water environment.

To reduce the impact of surface water runoff from the development in accordance with the requirements of the Statutory Authorities, the employment of SUDS techniques to limit runoff volumes and rates from the site are recommended.

This section provides an indication of the possible SUDS techniques which could be employed on the site to balance flows within the proposed development. SUDS techniques are also able to provide treatment to the runoff to remove a proportion of the pollution and protect the quality of the downstream watercourses. Following guidance from CIRIA Report C522 the following levels of treatment should be provided:

- Roofs – 1 level
- Driveways – 1 level
- Roads and communal parking areas – 2 levels.

The level of treatment indicates the number of SUDS techniques that will be used to treat pollution. For example if two levels are required the runoff may enter a filter drain that leads to a basin or pond before outfall.

The implementation of source control techniques means in practice there will be little outflow for a 1 in 1 year storm as most of the rainfall will be held within the system and will disperse via evapotranspiration.

Undertaking an assessment using the SUDS Planner Module within MicroDrainage Windes revealed that a number of different methods would be suitable for inclusion within the proposed drainage strategy for the development. A summary of the results is tabulated below:

Table 15: SUDS Planner Results

SUDS Criteria	Rank 1	Rank 2	Rank 3
Hydrological	Permeable Paving	Green Roof	Infiltration Trench/Soakaway
Land Use	Online/Offline Storage	Wet Ponds	Stormwater Wetlands
Site Features	Green Roofs	Filtration Techniques	Online/Offline Storage
Community & Environment	Online/Offline Storage	Grassed Filter Strip	Bioretention area
Economics & Maintenance	Wet Ponds	Grassed Filter Strip	Dry Detention
Total	Permeable Paving	Online/Offline Storage	Green Roof

It is noted that the precise combination of methods used will be dependent upon the site constraints identified at the final design stage.

1. Permeable Paving

Groundwater recharge via infiltration is not a viable option for this site, due to underlying ground conditions.

However, permeable paving may be used to provide shallow attenuation of surface water runoff; prior to discharge into a receiving watercourse or on-site drainage system.

It is unlikely that Yorkshire Water will adopt a permeable paving drainage solution as part of a Section 104 Agreement; and an underground storage structure is their favoured method for providing attenuation volume within a drainage system which will become part of the public sewer network.

It should therefore be considered that permeable paving is restricted to car park spaces, within the proposed development plan.

2. Online/Offline Storage

Due to the limited space available within the development to provide sufficient volume to attenuate flows to greenfield run off rates; online structures such as oversized pipes or box culvert sections may be easily placed within proposed road network within the development to provide ease of access for maintenance purposes.

Alternatively shallow attenuation structures such as Hydro-Internationals Stormcell System may be used as an alternative.

As described within Section 5.10.1 infiltration at the site is not viable, as such the proposed drainage strategy includes large diameter pipes to attenuate flows prior to disposal.

5.10.4 Layout

The proposed drainage strategy has been undertaken by Eastwood and Partners which incorporates attenuation in the form of large diameter pipes located within an area of green open space central at along the south boundary of the site.

It is recommended that prior to disposal into the River Don a Hydrobrake or similar device is located within the last manhole prior to the outfall to restrict flows to brownfield runoff rates with a 30% reduction.

5.10.5 Residual Flood Risk

In order to prevent exacerbation of surface flooding within the development site and along Barnsley Road during extreme rainfall events, it is recommended that the proposed drainage system is designed such that there will be no residual risk from flooding due to surface water discharge for storms with a return period of 100 years or less (with a 30% increase for climate change).

5.11 Foul Drainage

Yorkshire Water Sewer Records indicate that 150mm diameter public combined sewer located within Barnsley Road, it is recommended that foul from the site will be directed to this sewer, subject to approval with Yorkshire Water.

5.12 Easements

Existing public sewers will require a minimum easement of 3 metres either side of the pipe.

No permanent structures will be permitted within the easement areas.

5.13 Maintenance

From the drainage strategy provided by Eastwood and Partners part of the proposed surface water system will be offered for adoption to Yorkshire Water under a Section 104 Agreement. Following adoption maintenance responsibility will be transferred to Yorkshire Water, this will include the attenuation tank and flow control.

Remaining drainage elements within the curtilage of individual plots will remain the responsibility of the owner/occupant.

6.0 Conclusions and Recommendations

The primary sources of flood risk to the proposed development site at Nether Mill Farm in Penistone are identified to be the River Don and its tributary Scout Dike.

Detailed assessment concludes that the majority of the site is located within Flood Zone 1 with a small proportion partially located within Flood Zone 2 of the Environment Agency Flood Map.

The following measures have been recommended to mitigate against residual flooding within these development areas:

Finished floor levels to be set to a minimum of 300mm above existing ground levels or 600mm above the 1 in 100 year plus climate change level, whichever is the highest.

Overall impermeable areas within the site will be increased, therefore increasing surface water runoff rates and volumes generated by the site.

Within the areas designated as brownfield development; surface water runoff must be restricted to existing rates, incorporating a 30% reduction to accommodate future climate change; and lessen the burden on the receiving watercourse and sewer systems.

Flows in excess of these values must be attenuated on-site prior to discharge to watercourse or sewer.

An assessment of SUDS methods indicates that online/offline storage is the most appropriate for this particular site following a review of the underlying ground conditions.

In accordance with Approved Document H of the Building Regulations, surface water from the development must be disposed of via a) infiltration; b) watercourse; and c) sewer in order of preference.

An initial evaluation indicates that infiltration methods such as soakaways will not be feasible at the location of the proposed development.

Owing to the location of the River Don, flows are to be directed to watercourse restricted to brownfield runoff with a 30% reduction, flows in excess of this are to be attenuated onsite via tanks located at the south of the site.

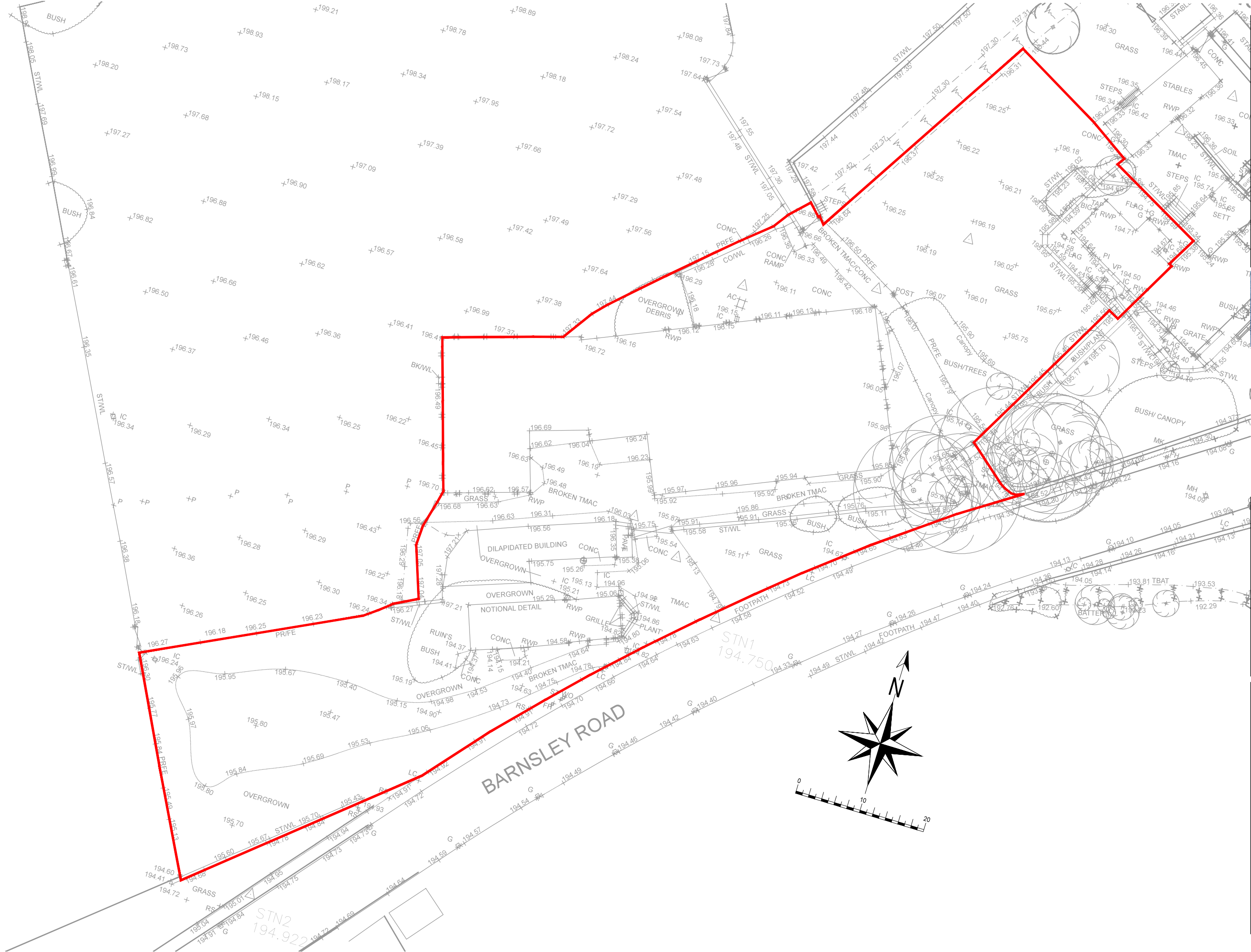
Foul or wastewater flows will be directed to the 150mm diameter public combined sewer located within Barnsley Road, following a pre development enquiry to Yorkshire Water.

The measures outlined within this report will mitigate residual flood risk at the development to acceptable levels.

APPENDIX A

Existing Site:

Topographical Survey



Date 28/10/15 03/11/15 04/11/15	Description Red line revised Levels added Red line revised	Rev B C D	House Type 4100 Park Approach Thorpe Park Leeds LS15 8GB	Drawing Title Existing Site Plan	Site Barnsley Road, Penistone	Rev. D
		Scale @ A3 1:500	Date 14/04/15			
duchy homes		Drawn MF	Checked	Drawing No. PS-003		