Accrington Road, Whalley - FRA

Oakmere Homes

Final Report

December 2022

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Contract

This report describes work commissioned by Richard Gadsden of M&P Gadsden Consulting Engineers on behalf of Oakmere Homes. Gregory Brown of JBA Consulting carried out this work.

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Purpose

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Abbreviations

BGS	British Geological Survey
DEFRA	Department for Environment, Food & Rural Affairs
EA	Environment Agency
FMfP	Flood Map for Planning
FRA	Flood Risk Assessment
JBA	Jeremy Benn Associates Ltd
LiDAR	Light Detection and Ranging
mAOD	metres Above Ordnance Datum
NGR	National Grid Reference
NPPF	National Planning Policy Framework
OS	Ordnance Survey
PPG	Planning Practice Guidance
SuDS	Sustainable Drainage System

1 Introduction

1.1 Overview

Jeremy Benn Associates (JBA) was commissioned by M&P Gadsden Consulting Engineers to undertake a Flood Risk Assessment (FRA) for the proposed residential development on land off Accrington Road, Whalley. The Ordnance Survey (OS) National Grid Reference (NGR) for the approximate centre of the site is 373,580, 436,060.

Prior to preparing this FRA, there have been discussions in April 2021 between Oakmere Homes and the Environment Agency (EA) regarding the development of the site. Oakmere Homes is willing to contribute towards the construction of a flood defence along the southern site boundary beside the River Calder; this is dependent upon them being able to partially develop a portion of the site first. The EA has agreed that development of the site can take place on condition that compensatory storage be provided for the 1% annual exceedance probability (AEP) event with a 36% increase in flow due to climate change on a volume-for-volume basis without increasing flood risk elsewhere.

There has since been a review by the EA of the initial model outputs and reporting to demonstrate the impact of the proposed development and compensatory storage provided (July 2021). In summary, the EA was satisfied that proposed raised ground levels and compensatory storage would, in principle, be acceptable and is not likely to result in increasing flood risk elsewhere - the full response letter is provided in Appendix A.

This FRA has been prepared in accordance with the National Planning Policy Framework (NPPF) and associated Planning Practice Guidance (PPG).

1.2 Location

The proposed development site is located off Accrington Road to the east of Whalley (Figure 1-1). The site is approximately 2.5ha and currently consists of open grassland on the right (northern) bank of the River Calder.

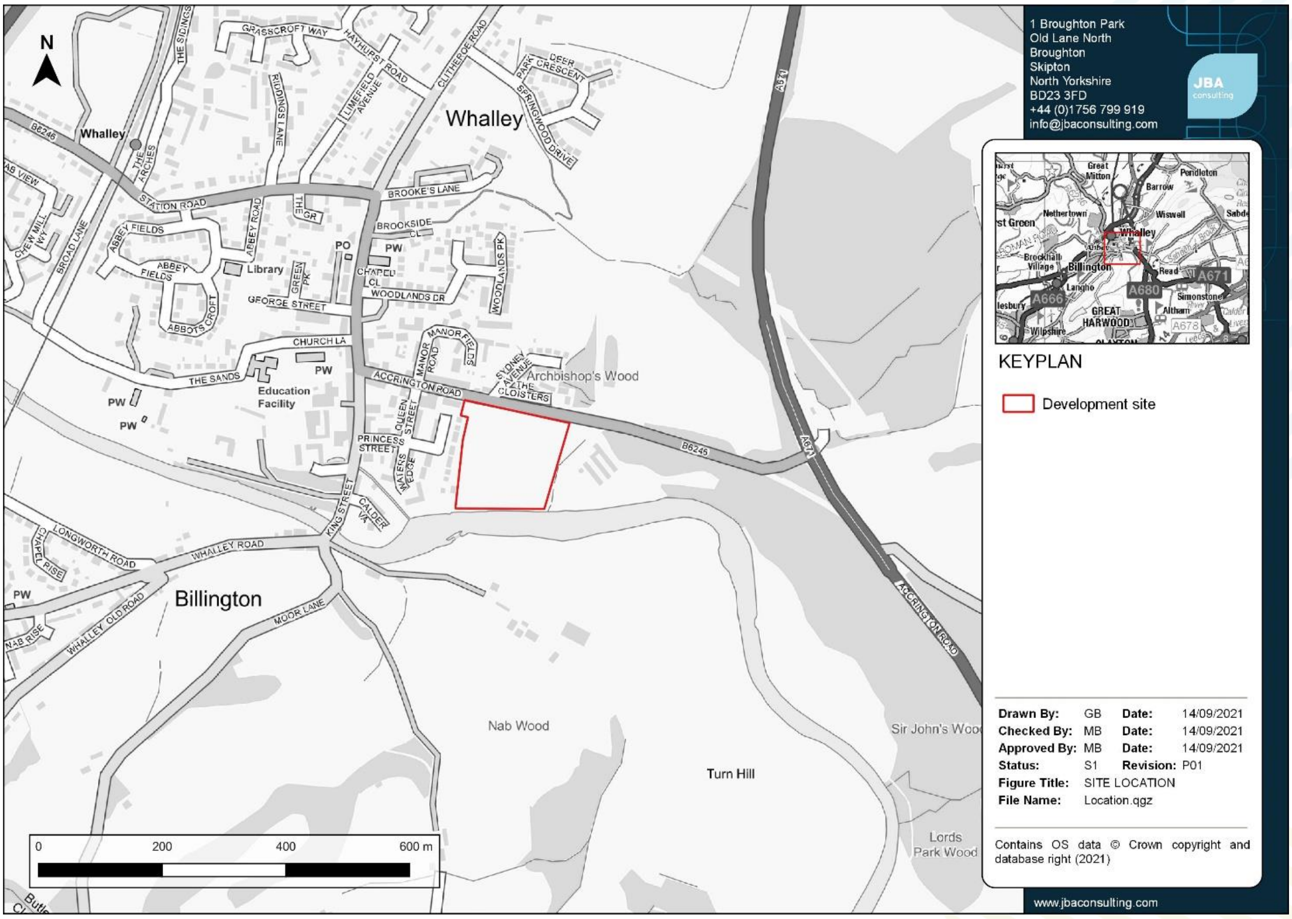

Figure 1-1: Location Plan

1.3 Proposed development

The proposed development aims to use the land for a residential development with associated car parking. This FRA has been produced based on the proposed site plan in Figure 1-2. The red outline indicates Phase 1 of the development. The applicant also owns the land to the south of the Phase 1 site. The development will be accessed via Accrington Road.

Figure 1-2: Proposed site plan (Phase 1)

1.4 Requirements for a Flood Risk Assessment

The requirements for an FRA are provided in the NPPF and associated PPG. The NPPF outlines that a site-specific FRA should be submitted as part of a planning application for all developments larger than 1ha in Flood Zone 1 or any sized development within Flood Zones 2 and 3. In this instance, the site is a development of approximately 2.5ha and in Flood Zone 3.

FRAs should describe and assess all flood risks to, and from, the development and demonstrate how they will be managed, including an evaluation of the effects of climate change.

2 National Planning Policy Framework

2.1 Overview

We have assessed the proposed development in accordance with the NPPF. Our assessment shows that:

- The proposed development is located within Flood Zone 2 based on updated modelling using the Mott MacDonald (2020) model for the River Calder and adapted by JBA to support and inform this FRA.
- The proposed development is classified as "More vulnerable" in the NPPF PPG.
- The site meets the criteria of the NPPF's Sequential Test in terms of flooding.

2.2 Flood Zone classifications

According to the EA's Flood Map for Planning (FMfP), the proposed site is in Flood Zone 3, as shown in Figure 2-1.

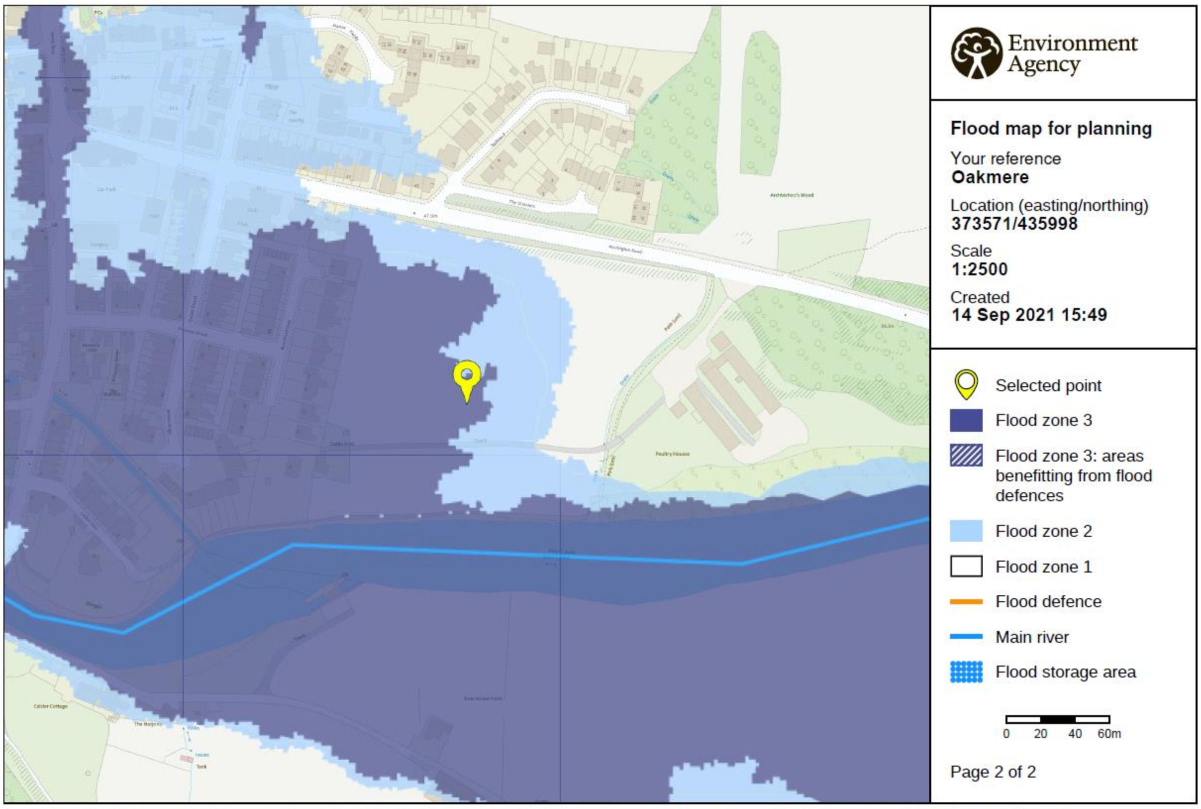

Figure 2-1: EA Flood Zones

However, updated modelling (see Appendix B) based on the EA provided 2020 Flood Risk Management Scheme appraisal model developed by Mott MacDonald[1] suggests that there would be no flooding within the site boundary under the existing conditions in the 1% annual exceedance probability (AEP) event (see Section 4.2). The EA's opinion is that this 2020 model was most suitable for use in this study as it:

- contains the most up-to-date hydrology and hydraulic components that the EA holds and;
- represents the weirs and Whalley Bridge more realistically meaning that levels upstream are lower than in previous models (which may result in lower water levels at the Accrington Road site).

[1] Mott MacDonald (2020) ENV0000427C-MMD-XX-XX-RP-HY-402462016-S8-A-L1900-3-LOD3-Whalley FRMS OBC: Hydraulic Modelling Report

Therefore, based on the updated 1% AEP flood extent (see Section 4.2.1, Figure 4-1), it is concluded that the site is no longer within Flood Zone 3. The updated 0.1% AEP flood extent (see Section 4.2.1, Figure 4-2) covers approximately 70% of the site; therefore, the site should be classified as partially in Flood Zone 2. In accordance with Table 1 of the PPG (reproduced in Table 2-1 below), the site is therefore categorised as 'Medium Probability – land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding'.

Table 2-1: Flood zones

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding (shown as 'clear' on the Flood Map – all land outside Zones 2 and 3).
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (land shown in light blue on the Flood Map).
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding (land shown in dark blue on the Flood Map).
Zone 3b The Functional Floodplain	This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise: • land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or • land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).

2.3 Sequential and Exception tests

According to Annex 3 of the NPPF PPG, the proposed land use of residential housing is "More vulnerable"[2]. As discussed in Section 1.1, with the contribution of funds from Oakmere Homes towards the building of flood defences along the River Calder, the EA has stated that development of the site can proceed on condition that compensatory storage be provided for the 1% annual exceedance probability (AEP) event with a 36% increase in flow due to climate change on a volume-for-volume basis without increasing flood risk elsewhere. As a result of this agreement, it should be considered that development of the site is feasible.

With regard to the Sequential Test, it is not necessary to be carried out in connection with either the Phase 1 development or potential Phase 2 development. This is because the site already has planning permission for a housing scheme. The permission has been lawfully implemented and therefore cannot ever expire, and construction work to complete it can resume immediately whenever Oakmere Homes may choose and without the need for further approval from the EA and Ribble Valley Borough Council. The proposals within this FRA are an update to the design from the original planning application with a reduction in flood risk to the proposed properties.

Since the proposed development is classified as 'More vulnerable' and is located within Flood Zone 2 an Exception Test is not required (refer to Table 2-2).

[2] Flood Risk Vulnerability Classification: https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-2-Flood-Risk-Vulnerability-Classification

Table 2-2: Flood risk vulnerability and flood zone incompatibility

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	×	Exception Test required	✓	✓
Zone 3b	Exception Test required	×	×	×	✓

✓ Development is permitted
× Development should not be permitted

3 Baseline environmental conditions

3.1 Topography

The topography of the area is shown in Figure 3-1 using local LIDAR (Light Detection and Ranging) data. The data was acquired in 2017 for the 2020 appraisal model, with 1m resolution LIDAR survey flown in 2009 (1m resolution data from 2013 also covers areas to the south and east of Whalley). This is the most recent data available with no flights in the area since this time. The site slopes in a westerly direction towards Whalley. The topography of the site ranges from around 51.3mAOD at the eastern side of the site down to a low spot on the western side at 45.0mAOD. Along the banks of the River Calder, there is a natural embankment which prevents the lower areas of the site flooding during lower magnitude events.

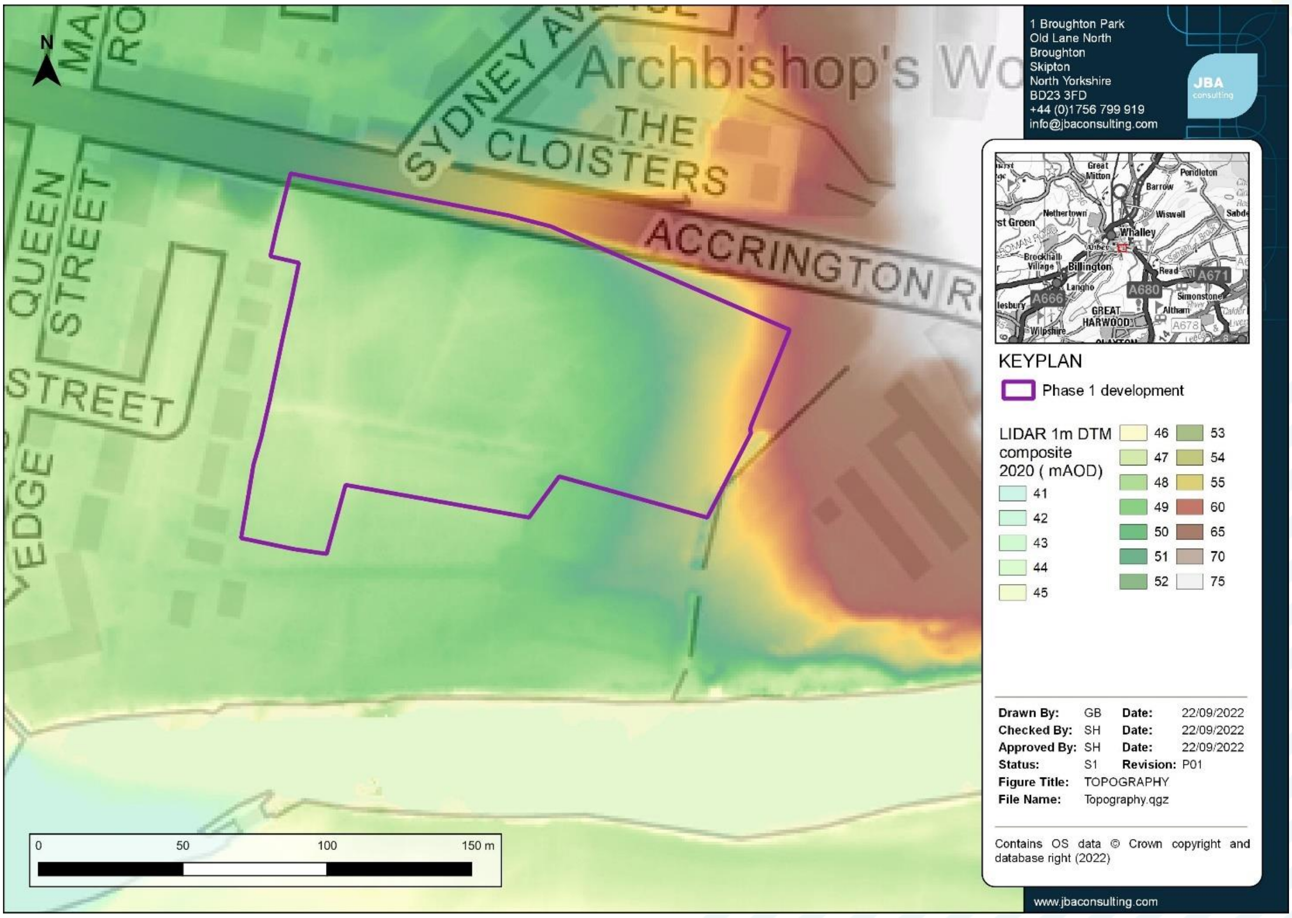

Figure 3-1: Local LIDAR Data

3.2 Local watercourses

There are several watercourses in the vicinity of the site. These are shown in Figure 3-2 and described below.

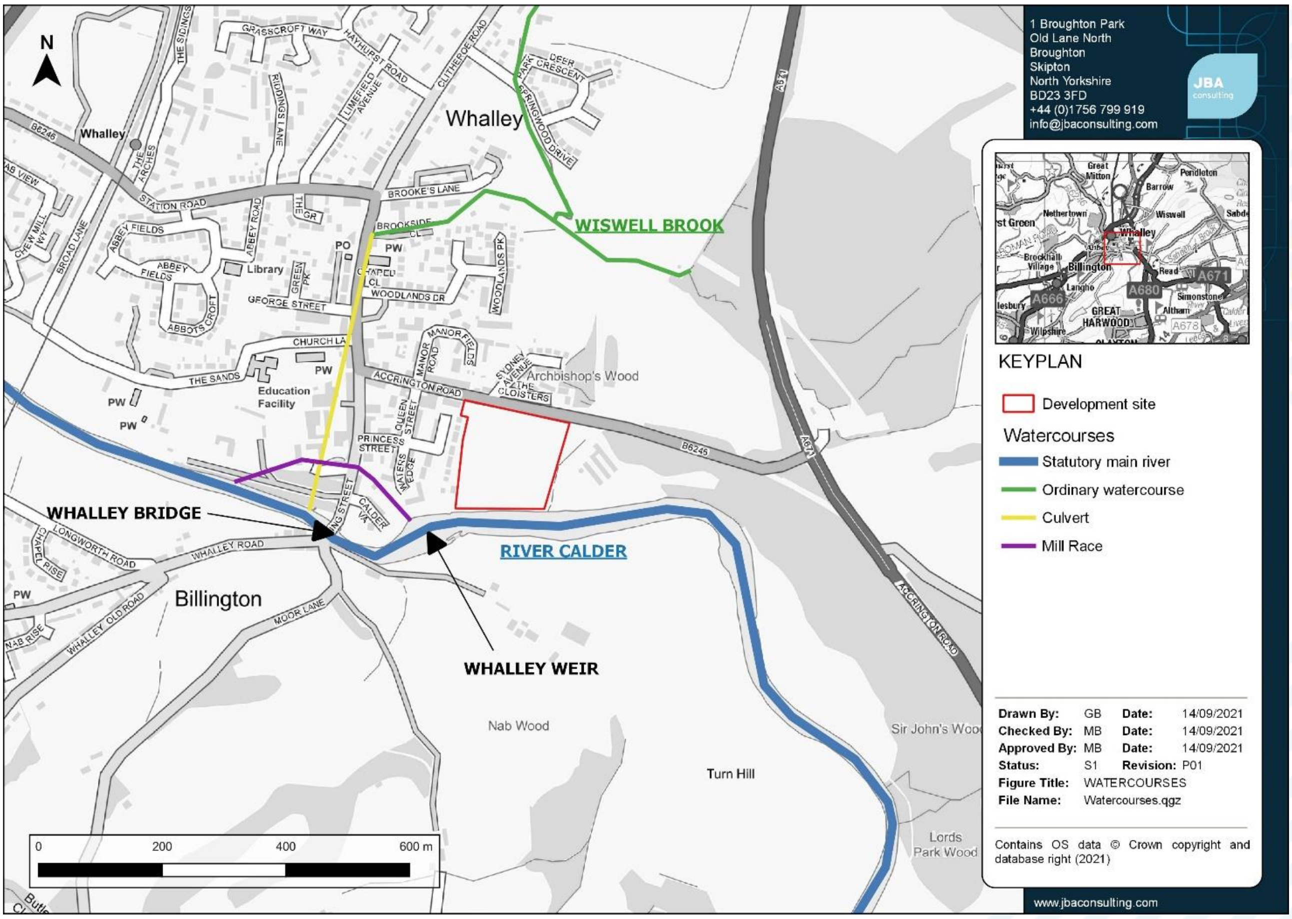

Figure 3-2: Local watercourses

3.2.1 Main rivers

The River Calder flows in a westerly direction and forms the southern boundary of the site.

3.2.2 Ordinary watercourses

Wiswell Brook is located to the north of the development site and flows westwards towards Whalley entering a culvert at Brookside Close before outfalling to the River Calder downstream of Whalley Bridge.

There is also a mill race which runs from the River Calder upstream of Whalley Weir, through the Calder Vale area, and re-enters the River Calder again further downstream.

3.3 Geology and hydrogeology

The British Geological Survey (BGS)[3] Geology of Britain viewer shows that the site bedrock geology is mudstone (Bowland Shale Formation) and sandstone (Pendle Grit Member). The superficial deposits comprise Alluvium (clay, silt, sand and gravel), Glaciofluvial deposits (sand and gravel) and Till (Diamicton). Historic borehole data from a nearby location (Manor Fields, 100m north of the site) found peat, above loose clayey sand, and loose sand/gravel.

Information from Soilscapes[4] shows soils in the area are mainly "*loamy and clayey floodplain soils with naturally high groundwater*". To the north of the site in the Wiswell Brook area, there are "*slowly permeable seasonally wet acid loamy and clayey soils*" which are typically associated with impeded drainage leading to very wet ground conditions.

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[3] https://mapapps.bgs.ac.uk/geologyofbritain/home.html
[4] http://www.landis.org.uk/soilscapes/

According to the Department for Environment, Food & Rural Affairs (DEFRA) Magic Map[5] the land situated around the site is used for enclosed agriculture.

A site investigation and ground assessment were undertaken by bEk Enviro Ltd across the development site in June/July 2019. As part of this assessment, the ground conditions were found to be relatively consistent across the site and comprised of topsoil overlying natural 'sand, clay, silts and gravels'.

[5] https://magic.defra.gov.uk/MagicMap.aspx

4 Flood Risk Assessment

4.1 Overview

- The nearest watercourse to the site is the River Calder, which forms the southern boundary of the site.
- Flow mechanisms indicate the River Calder is the main source of risk. The model results indicate that the site is not affected by flow from Wiswell Brook.
- EA data indicates there is a very low risk of surface water flooding and highlights the potential for reservoir flooding (although this is considered extremely unlikely, as discussed in Section 4.4.1 below).

4.2 Fluvial flood risk

According to the EA's FMfP, the development is located within Flood Zone 3 and so would flood during the 1% AEP event. However, the EA recommended the use of the Mott MacDonald 2020 Flood Risk Management Scheme appraisal model to establish the existing flood risk, for the reasons outlined in Section 2.2. As part of the 2020 modelling, all the design events tested included allowances for climate change, which might explain why the Flood Zone mapping has not been updated following the 2020 study. As part of this FRA, the standard design events with and without climate change were considered. The hydraulic model technical note in Appendix B provides details on the model updates.

4.2.1 Baseline

Peak water levels within the River Calder (see Table 4-1) during events up to the 1%AEP event are all lower than bank top levels (45.6mAOD or greater) along the site boundary. Figure 4-1 shows the existing flood risk during standard design events (up to the 1%AEP event) and demonstrates how the proposed development site is unaffected by flooding. Based on the updated flood extents, the site should no longer be categorised as Flood Zone 3. Bank overtopping would occur during the 0.1% AEP event resulting in flooding within the Phase 1 site (Figure 4-2) – this confirms that the site should be considered as partially (approximately 70%) in Flood Zone 2 and not in Flood Zone 3. The remainder of the site is in Flood Zone 1.

Table 4-1: Baseline flood levels

Event	River Calder peak water level adjacent to development site (mAOD)	Peak water level at Phase 1 area (mAOD)
4%AEP	45.43	N/A - No flooding
2%AEP	45.47	N/A - No flooding
1.33%AEP	45.49	N/A - No flooding
1%AEP	45.52	N/A - No flooding
0.1%AEP	46.79	46.68

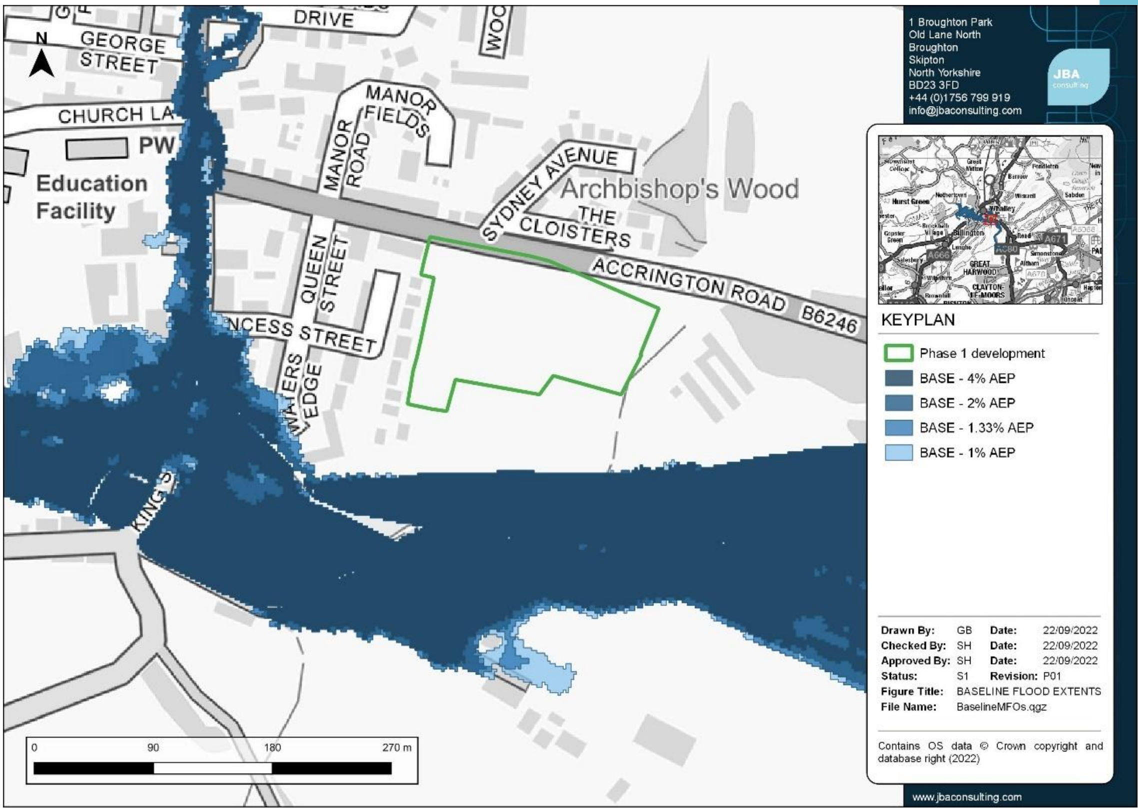

Figure 4-1: Maximum flood extents – Existing – standard events (4% to 1%AEP)

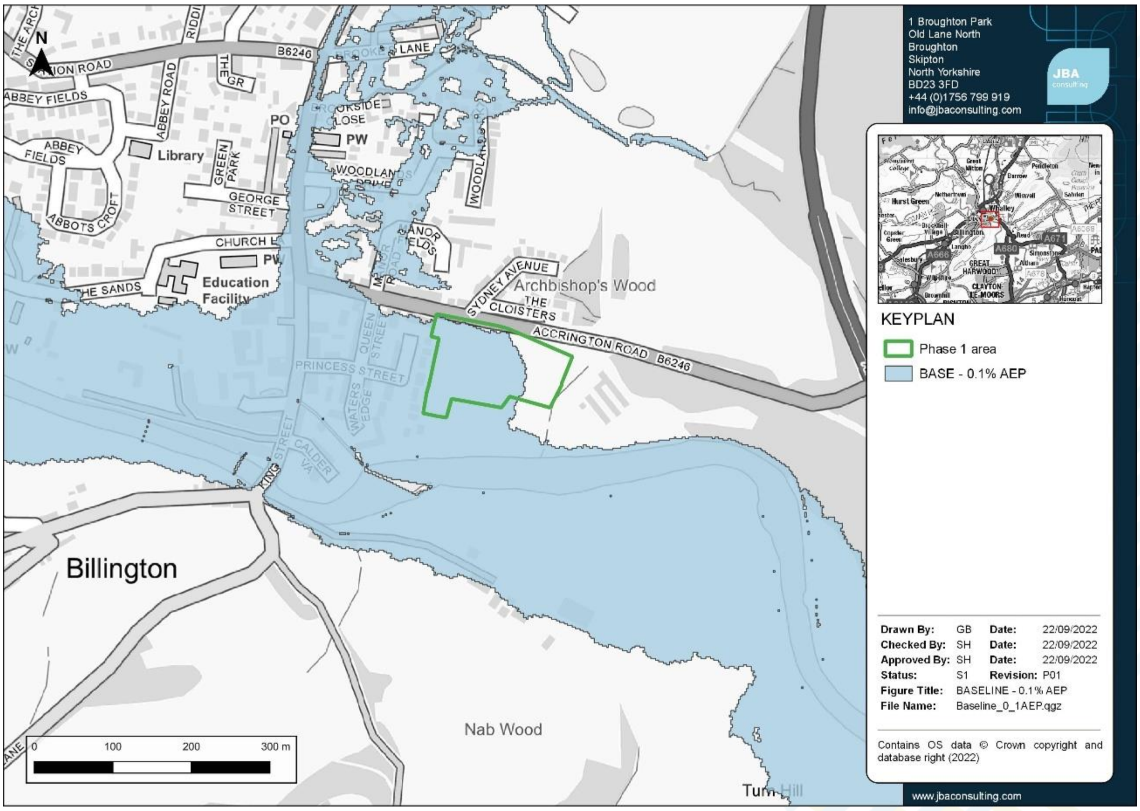

Figure 4-2: Maximum flood extents – Existing – standard event (0.1%AEP)

4.2.2 Climate change

Under current climate change guidance[6] (May 2022), the proposed land use of residential housing is "More vulnerable" and in Flood Zone 2 the 'central' peak river flow allowance should be considered (see Table 4-2 for the required flow allowances). The total anticipated change for the 2080s was therefore modelled (i.e. peak flow plus 36%).

Table 4-2: Peak river flow allowances (Ribble Management Catchment)

Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	27%	44%	71%
Higher central	19%	29%	44%
Central	16%	23%	36%

The climate change event model results show peak water levels above the channel bank tops, leading to flooding within the development site. Figure 4-3 shows the maximum flood depths in the area for the 1%AEP plus 36% event. The extent of flooding shows that approximately 40% of the Phase 1 development area is affected during this event.

Flow directional arrows indicate that the River Calder is the source of flood risk. Water overtops the channel banks and flows northwards to the development site before heading west towards Whalley and combining with floodwater from the Mill Race. The peak water levels in Table 4-3 at the Phase 1 development area show a slight decrease from those observed in the River Calder. With the predicted flood levels, water depths could be up to 0.62m within the Phase 1 boundary. The model results do not indicate any flow from the Mill Race towards the development site.

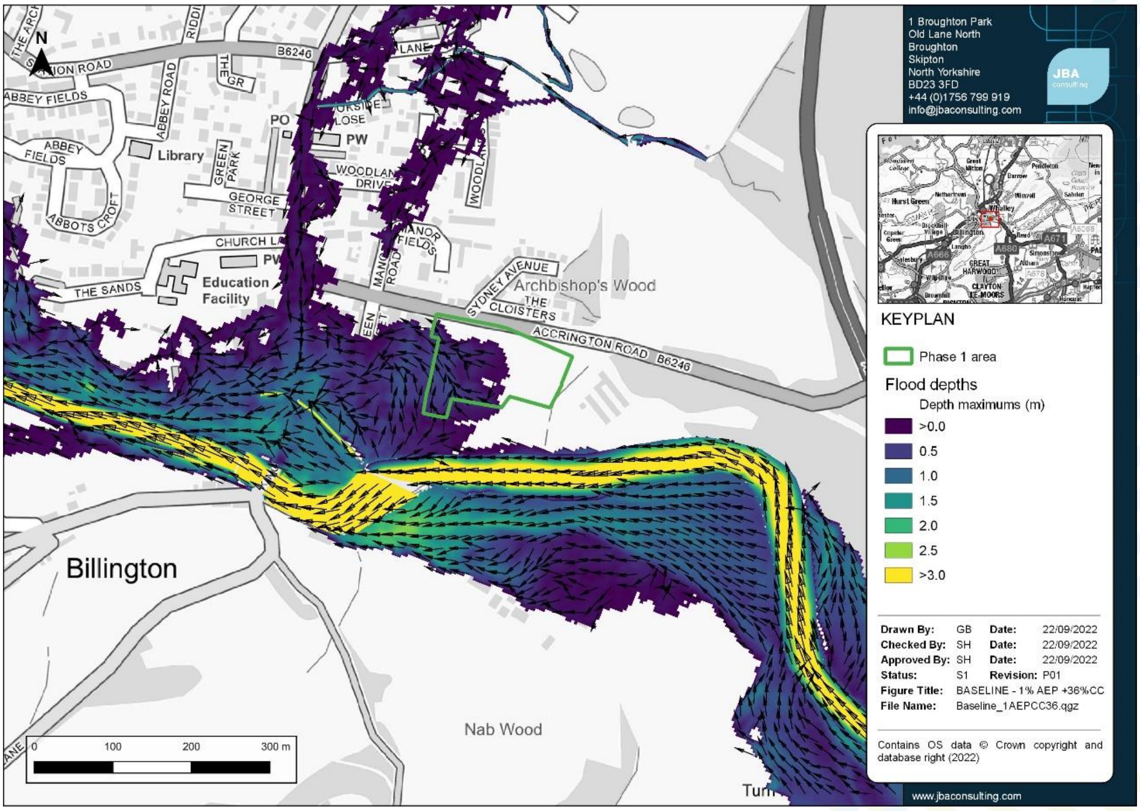

Figure 4-3: Flow mechanisms – Existing – 1%AEP plus 36% for climate change

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[6] Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)

Table 4-3: Baseline flood levels with allowance for climate change

Event	River Calder peak water level adjacent to development site (mAOD)	Peak water level at Phase 1 area (mAOD)
1%AEP +36%CC	46.12	46.06

4.3 Surface water flood risk

The EA's Surface Water Flood Map[7] shows the majority of the site is at a very low (less than 0.1% chance of flooding each year) risk of surface water flooding. There is a localised area of low-high risk on the western boundary of the site (see Figure 4-4); this coincides with a topographic 'low' where surface water would be expected to accumulate naturally following rainfall.

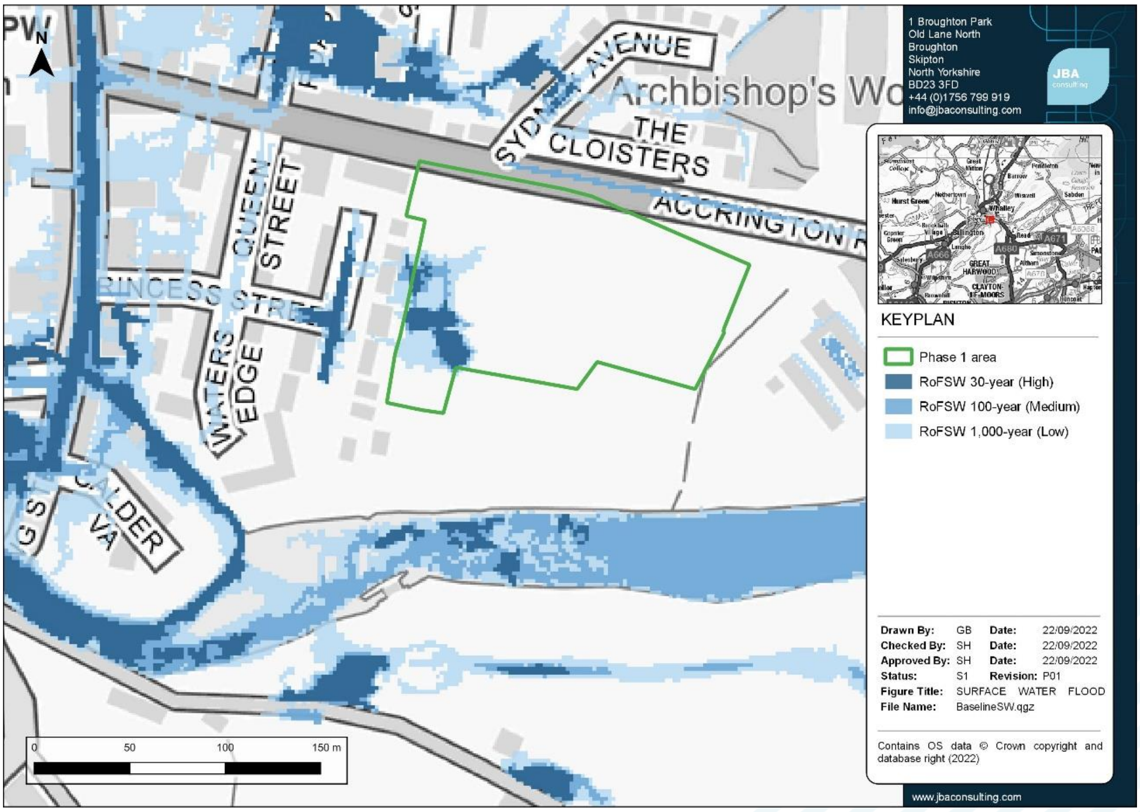

Figure 4-4: Surface water flood risk – Existing

4.4 Flood risk from other sources

4.4.1 Reservoir breach

The EA Long Term Flood Risk map[8] shows there is a risk of flooding at the site due to the possible uncontrolled release of water from reservoirs upstream. However, reservoir flooding is extremely unlikely to happen as all reservoirs with a capacity greater than 25,000m^3 are subject to statutory regulation under the Reservoirs Act 1975. In addition, all large, raised reservoirs are inspected and supervised by qualified civil engineers (referred to as Panel Engineers).

4.4.2 Groundwater

As stated in Section 3.3, groundwater levels are likely to be naturally high in the area according to information from Soilscape. However, ground investigations, performed by bEK Enviro Ltd, encountered groundwater at only 6 out of 11 exploratory locations. Two of these boreholes encountered water around 15-20m below ground; three boreholes found water at

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[7] https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?easting=386164&northing=434573&map=SurfaceWater
[8] https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

a depth of around 2m below ground level; the sixth borehole found water 1m below ground level. Based on these findings it was concluded that laterally continuous perched water is not present as 5 exploratory locations were dry and there was significant variation in depths when water was encountered. This water is likely to represent water held within less permeable horizons within the natural strata.

The site's proximity to the River Calder suggests that groundwater levels are likely to be influenced by water levels in the nearby watercourse. Due to the elevated nature of the site and the results/observations following the above ground investigations, it is likely that the water table will be sufficiently deep for it to be considered that there will be a low risk of groundwater emergence at the site.

According to the Ribble Valley Strategic Flood Risk Assessment[9] (2017) no evidence of groundwater flooding has been identified within the district.

[9] https://www.ribblevalley.gov.uk/download/downloads/id/11030/strategic_flood_risk_assessment_level_1_revised_2017.pdf

5 Post-development

5.1 Overview

The design of the proposed development takes into account the 1% AEP plus 36% event and the 0.1% AEP event, with the residential properties situated on a raised platform to allow flood-free access/egress during a flood event. To offset the loss of floodplain storage associated with this raising of ground levels, compensatory storage has been provided to prevent increases in flood risk elsewhere in the area.

5.2 Development site levels

With the proposed development as set out in Figure 1-2, building and ground levels for the site were based on the baseline model results for the 1% AEP plus 36% event and 0.1% AEP event. The peak flood level at the Phase 1 site as shown in Section 4.2.2 is 46.04mAOD; for the majority of the Phase 1 residential site, ground levels have been raised to a minimum of 47mAOD, well above the predicted flood level. Ground levels along the western boundary of the site tie into existing levels. Details of the proposed building finished floor levels and ground levels can be found in the detailed design drawing (see Appendix C). To allow for the loss of floodplain storage during the 1% AEP plus 36% event, due to the raised ground levels in the Phase 1 development, compensatory storage is proposed in the land to the south. The locations of the Phase 1 development area and adjacent compensatory storage area are shown in Figure 5-1.

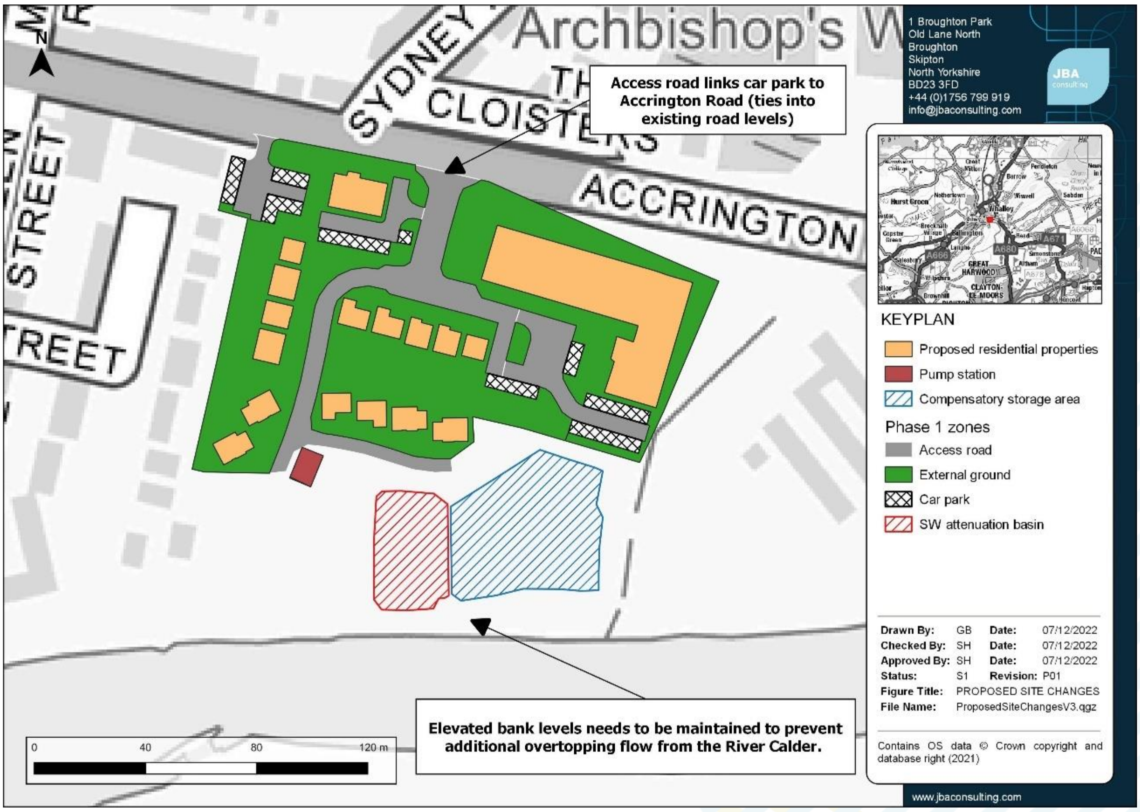

Figure 5-1: Location of planned changes in development site

The positioning of the proposed compensatory storage is away from the River Calder. An area of elevated bank levels needs to be maintained to prevent additional overtopping flow from the river. The storage area has been designed with 1:3 slopes tying in the 45.60mAOD base level to the surrounding existing ground levels. A series of drains with non-return valves fitted connect the compensatory storage area to the River Calder which means that the storage should not prematurely fill with surface water and so will leave the full storage capacity available were a flood event to occur on the River Calder.

5.3 Post-development fluvial flood risk

The following section evaluates the impact of the proposed development which incorporates ground raising in the Phase 1 site area and an accompanying compensatory storage area in the land to the south. These proposed changes were added to the hydraulic model and the results post-development were compared to the baseline (existing/pre-development) scenario.

As the development site area is unaffected in events up to the 1% AEP, the proposed development (and changes to ground levels) will have no impact upon fluvial flood risk elsewhere; the post-development flood risk analysis will therefore focus on the impacts of the 1% AEP plus 36% climate change event only.

The post-development peak water levels in the River Calder adjacent to the site and at the Phase 1 development site are shown in Table 5-1. There is no difference in peak water level in the River Calder when compared to the values for the baseline in Table 4-3. There is a negligible difference in floodplain water levels within the site area to the south of the planned development.

Table 5-1: Flood levels with allowance for climate change post-development

Event	River Calder peak water level adjacent to development site (mAOD)	Peak water level at Phase 1 area (mAOD)
1%AEP +36%CC	46.12 (Baseline – 46.12)	46.06 (Baseline – 46.06)

The resulting post-development flood extent for the 1%AEP event plus 36% for climate change can be seen in Figure 5-4. After the proposed changes (ground raising and provision of floodplain storage compensation), the Phase 1 area is largely unaffected by flooding with the compensatory storage area accommodating the flood volume instead. The exception being low-lying areas on the western boundary with shallow flooding affecting a narrow strip of gardens and a small and localised area of the community car park. The flow mechanisms are comparable to the baseline with water overtopping the River Calder bank upstream of Whalley weir, flowing north towards the development site and entering the compensatory storage area. Water near the development site then flows west towards the Mill Race. As with the baseline, there is no indication of flow from the Mill Race towards the development site.

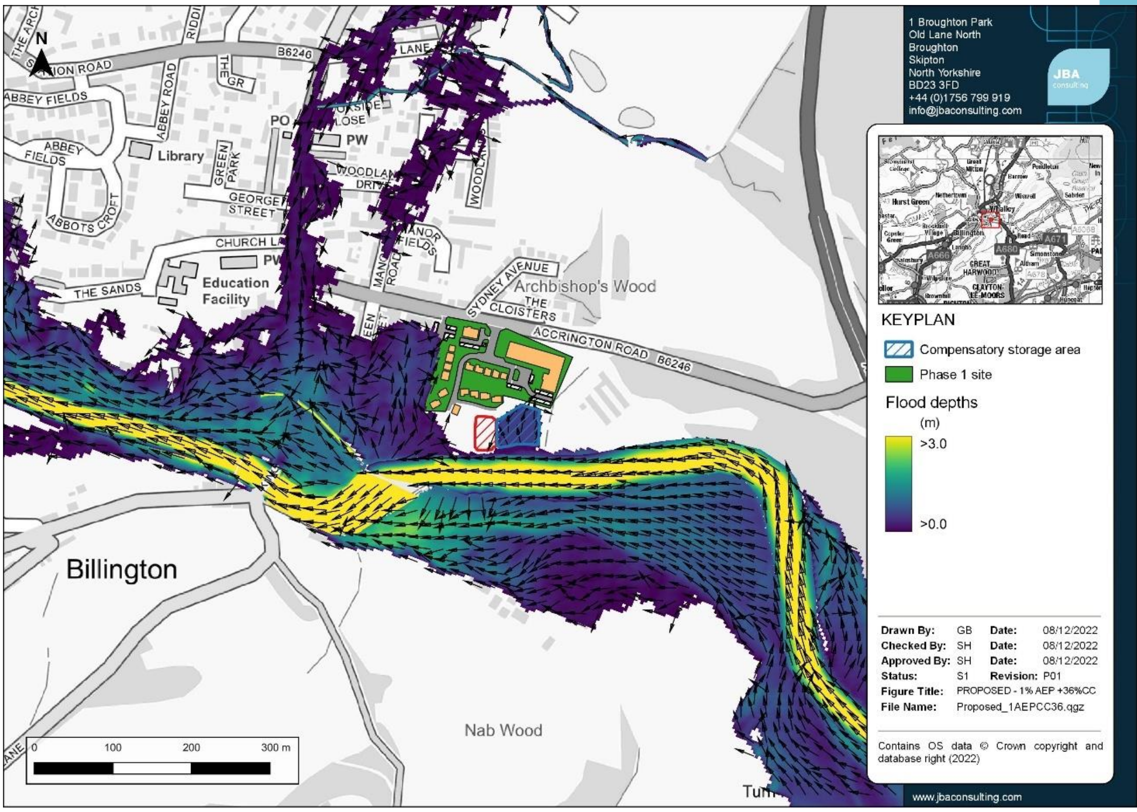

Figure 5-2: Flow mechanisms – post-development – 1%AEP plus 36% for climate change

The proposed development causes no additional flood risk to other properties in the area. A sample of locations in adjacent residential areas were selected (locations shown in Figure 5-5) and comparisons were made for peak water levels before and after the proposed development. All locations showed either no change or reduced water levels following the proposed development (see Table 5-2).

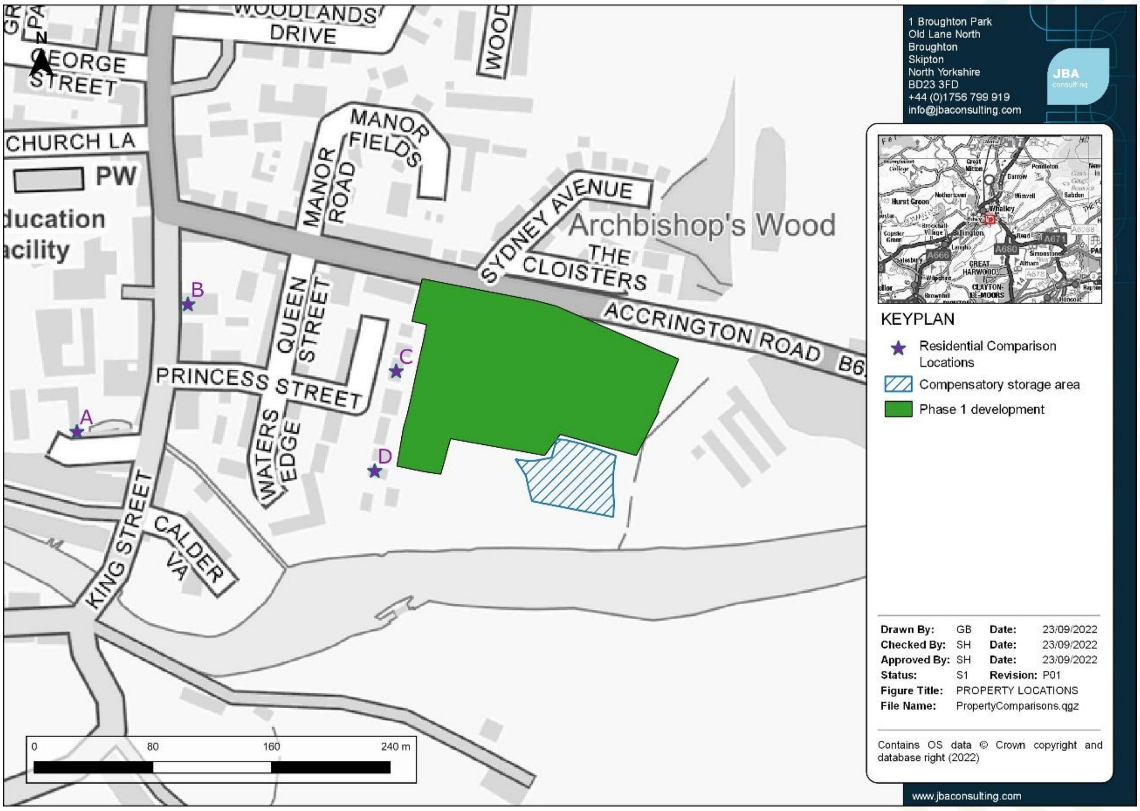

Figure 5-3: Neighbouring residential area comparison locations

Table 5-2: Neighbouring residential area peak flood levels

Location	Event	BASELINE - peak water level (mAOD)	PROPOSED - peak water level (mAOD)
A (Abbey Mews)	1%AEP +36%CC	45.62	45.62
B (King Street)	1%AEP +36%CC	45.81	45.80
C (Woodland View)	1%AEP +36%CC	46.02	46.01
D (Woodland View)	1%AEP +36%CC	46.03	46.03

Modelled flood levels and flows for locations (see Figure 5-6) within watercourses downstream of the development site are shown in Table 5-3. The locations include downstream of Whalley Weir, Whalley Bridge and within the Mill Race near Calder Vale. There is no difference in water level between the existing/baseline and proposed development scenarios in the 1%AEP event plus 36% for climate change. The flows in the proposed scenario showed minor differences compared to the baseline but were within +/-0.1m^3/s and do not affect flood levels, so flood risk remains unchanged.

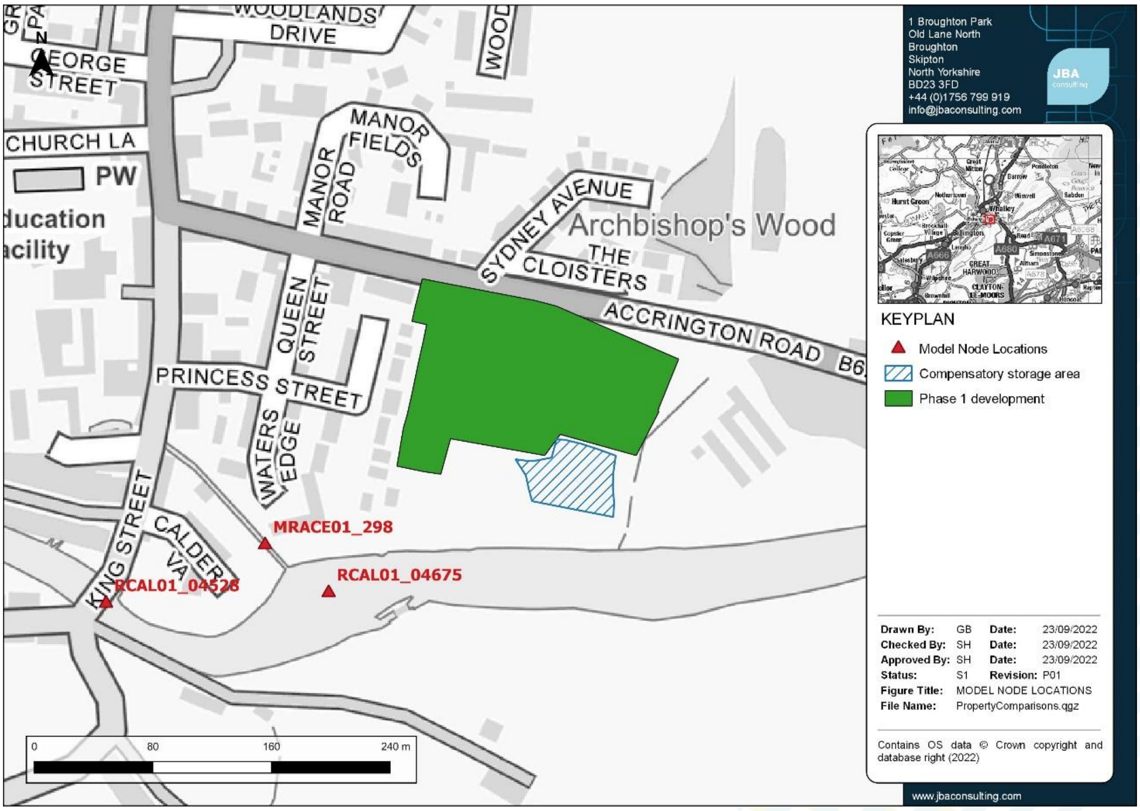

Figure 5-4: Model node comparison locations

Table 5-3: Downstream impacts

Location	1%AEP plus 36%CC	BASELINE	PROPOSED
Whalley Weir D/S (model node: RCAL01_04675)	Water level (mAOD)	46.02	46.02
	Flow (m^3/s)	357.41	357.29
Whalley Bridge U/S (model node: RCAL01_04528)	Water level (mAOD)	45.76	45.76
	Flow (m^3/s)	421.09	421.06
Mill Race (model node: MRACE01_298)	Water level (mAOD)	45.98	45.98
	Flow (m^3/s)	12.14	12.16

6 Surface Water Management

Surface water flows from a developed site should, as far as is practicable, be managed to mimic surface water drainage from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere. As the site is undeveloped, there is currently no existing surface water drainage. As stated in Section 4.3, surface water is likely to accumulate in a low spot on the western edge of the site. With the development of the Phase 1 site, there will be an increase in the impermeable area. In the absence of mitigation, there would be increased surface water run-off to the surrounding area.

M&P Gadsden Consulting Engineers has produced a drainage strategy to deal with the increased surface water runoff arising from the development (see Appendix D for this report).

At this point, no major constraints on surface water management have been identified. The depth of the water table below the ground should allow the installation of SuDS. A consideration identified in the bEk Site Investigation & Ground Assessment report was the risks associated with contamination in the made ground and/or natural strata affecting water quality in the superficial Secondary 'A' Aquifer and bedrock Secondary 'A' Aquifer. Risks are also associated with the dissolution of contamination into perched water/leachate and lateral migration to surface water receptors including the River Calder and the land drain to the east of the site.

The surface water management strategy has therefore been designed such that the rate of surface water run-off leaving the site will be restricted to 1-year rate for the same return period and Q_{BAR} for return periods up to 100-year plus 50% climate change with a 10% allowance for urban creep and a 35% allowance for the remaining greenfield areas. These measures will reduce flood risk downstream as the existing greenfield runoff rate will be matched for the 1-year event and Q_{BAR} will be matched for events up to the designed return period. This will provide an improvement for return periods above the 1-year event.

If possible, infiltration drainage should be installed; however, percolation tests are required to establish whether such sustainable drainage systems can be utilised. It has been assumed that infiltration drainage is not suitable on this site and consequently the surface water from the development will be discharged into the River Calder. The discharge will be restricted to greenfield runoff rates (as stated above).

Surface water storage will be provided by the piped network and an attenuation basin.

Land profile changes associated with the development will infill the existing topographic 'low' on the western boundary of the site, such that water will be unlikely to accumulate as indicated in the existing surface water flood risk map.

In accordance with planning policy requirements, surface water run-off from the Phase 1 development site will therefore be managed in a sustainable manner.

7 Design Considerations

7.1 Access and egress

Access to the development will be via a new junction to Accrington Road. Access road levels will be set to provide flood-free access during the 1% AEP plus 36% for climate change event.

7.2 Finished Floor Levels

The proposed development consists of several residential dwellings. According to standing advice from the government[10], it is recommended that finished floor levels are set approximately 300mm above the river level in the design event (1% AEP plus climate change flood level).

Further modelling was carried out to establish residual risk for the development with the 0.1% AEP event considered (see Section 8). Based on the results of this modelling, the peak flood level adjacent to the site was found to be 46.78mAOD.

As indicated in the detailed design drawing for the development (Appendix C), the minimum finished floor level is 46.85mAOD providing around 800mm freeboard above the 1% AEP plus 36% event flood level (46.06mAOD) and so meets the government standing advice. This minimum finished floor level is also approximately 70mm higher than the 0.1% AEP peak flood level. Most of the building finished floor levels are set higher (47mAOD and above) providing even more freeboard above the design event flood level. Building floor levels will also be raised compared to their surrounding ground levels.

7.3 External ground levels

The surrounding ground levels should be set above the peak flood level during the 1% AEP plus 36% event to allow flood-free access to and from buildings during such an event.

With most of the ground levels set to approximately 47mAOD or above (Appendix C), the external areas/access road should not be affected by flooding, with the design flood event predicted to reach 46.06mAOD.

The 1% AEP plus 36% modelled flood extents (see Figure 5-4) indicate a small and localised area flooding in the south-west corner of the community car park (located on the western side of the site, see Figure 1-2). However, the flood depth is relatively shallow (0.25m or less) and this area, being located on the fringe of the floodplain, is characterised by low flow velocities, such that the flood hazard is considered to be low.

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10 Preparing a flood risk assessment: standing advice - GOV.UK (www.gov.uk)

8 Residual risk

While the above results indicate that the Phase 1 development would have a low flood risk during the 1% AEP plus 36% for climate change event, there is still a residual risk of flooding. There is potential for even larger events than the design event which could lead to additional flooding. The 0.1% AEP event model results indicate that most of the phase 1 site would remain unaffected due to the elevated ground well above the peak flood water level. As set out in Section 7.2 above, finished floor levels have been set above the 0.1% AEP peak flood level. This includes the proposed pump station building, as marked on the design drawing towards the south of the site, and so no internal flooding of the building should occur; shallow floodwater (<0.05m) during this event is shown surround this building meaning access should remain possible.

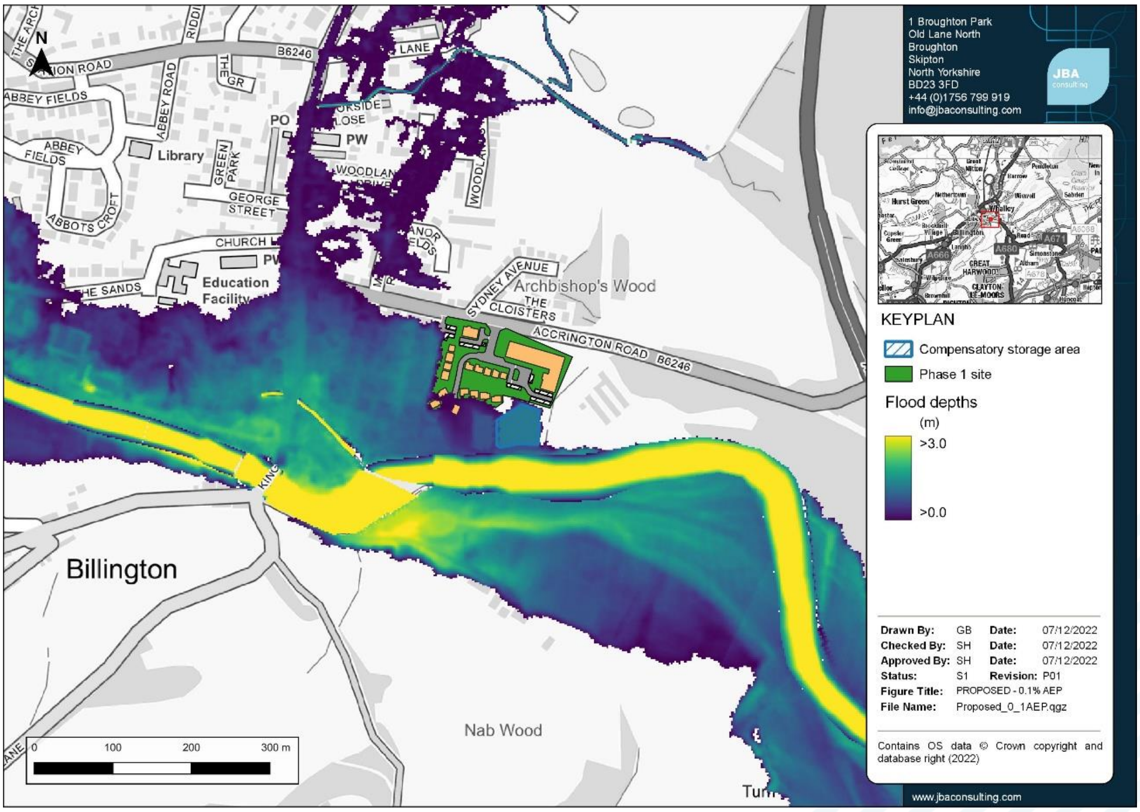

Figure 8-1: Flood extent – post-development – 0.1%AEP

Another potential residual risk is associated with the performance of the surface water drainage infrastructure. Rainfall events in excess of the design capacity of the surface water drainage network may result in temporary above ground flooding, potentially giving rise to overland flows. However, residual flood risk may be mitigated/minimised through the application of 'best practice' design principles, including careful consideration of the design of external ground levels to facilitate the routing of overland flows away from buildings and towards the surface water storage infrastructure. 'Best practice' design principles include requirements to ensure all proposals account for the potential effects of climate change and therefore much of the potential residual risk is accounted for within the design.

9 Summary

9.1 Overview

Jeremy Benn Associates (JBA) was commissioned by M&P Gadsden Consulting Engineers to undertake an FRA for the proposed residential development on land off Accrington Road, Whalley. This FRA has been prepared as part of a planning application to obtain planning permission for the site.

9.2 Sources of flood risk

- Fluvial: the site lies partially within Flood Zone 3 according to FMfP, however, updated modelling suggests that approximately 70% of the site is located Flood Zone 2 is a more appropriate classification (Medium Probability – land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding). The remainder of the site is within Flood Zone 1. The River Calder is shown to be the main risk of fluvial flooding according to hydraulic modelling;
- Fluvial with climate change: with an allowance for climate change (+36% peak river flow), the predicted flood extent affects approximately 40% of the Phase 1 site (prior to proposed ground level changes);
- Surface water: Very low risk across the majority of the site. There is a localised area of low-high risk on the western boundary of the site which coincides with a topographic 'low';
- Reservoir breach: in the unlikely event that a breach of an upstream reservoir was to occur, the site could be at risk from reservoir flooding;
- Groundwater: the results/observations reported following a ground investigation in 2019 suggest that the likelihood of groundwater emergence at the surface is low.

9.3 Sequential test

The Sequential Test is not necessary to be carried out in connection with either the Phase 1 development (current FRA) or the potential Phase 2 development. This is because the site already has planning permission for a housing scheme. The permission has been lawfully implemented and therefore cannot ever expire, and construction work to complete it can resume immediately whenever Oakmere Homes may choose and without the need for further approval from the EA and Ribble Valley Borough Council. The proposals within this FRA are an update to the design from the original planning application with a reduction in flood risk to the proposed properties.

Oakmere Homes has agreed with the EA to contribute funds towards the building of flood defences along the River Calder. The EA has stated that development can proceed on condition that compensatory storage be provided for the 1% Annual Exceedance Probability (AEP) event with a 36% increase in flow due to climate change on a volume-for-volume basis without increasing flood risk elsewhere. As a result of this agreement, it should be considered that development of the site is feasible. With regard to the Sequential Test, there is a need for housing in the area which this residential development can provide.

It should be noted that installation of the new potential flood defence has not been considered within this FRA; a flood defence is not required to facilitate the proposed development.

9.4 Flood risk mitigation

To manage the flood risk to the proposed Phase 1 development and not increase risk elsewhere the following measures have been incorporated into the design:

- Ground raising within the Phase 1 area so that residential properties and access routes are elevated above both the 1%AEP plus 36% for climate change and 0.1% AEP event predicted flood levels and;
- A compensatory storage area in the land to the south of the Phase 1 site to offset, on a volume basis, the loss of floodplain storage resulting from ground raising within the floodplain.

9.5 Surface water management

There is no existing surface water drainage on the site and currently surface water is likely to accumulate in a low spot on the western edge of the site. With the development of the Phase 1 site, there will be an increase in the impermeable area.

To deal with surface water runoff from the site, the following mitigation measures will be used:

- Oversized underground pipes
- Attenuation basin

It is proposed that surface water will discharge to the River Calder to the south. Discharge will be limited to existing greenfield runoff rates – the 1-year rate for the 1-year event and QBAR for larger events.

9.6 Design considerations

The following considerations should be included in the final development design:

- Finished floor levels for buildings should be set no less than 300mm above the predicted flood level at the site during the design event. Based on this, finished floor levels should be set at 46.36mAOD or above.
- Taking into account the 0.1% AEP flood event, finished floor levels should be set at 46.85mAOD, above the predicted 0.1% AEP flood level (46.78mAOD).
- External ground levels should also be set above the design event flood level to provide 'flood-free' access to the properties during such a flood event.

The design of the development has taken account of these design considerations with finished floor levels set at or above the 46.85mAOD level. For most of the Phase 1 site, external ground levels (at 47mAOD or higher) are also above the recommended 46.36mAOD value.

9.7 Residual risk

The design approach includes an allowance for the potential impacts of climate change and recognises the potential for more extreme conditions than associated with the design event. Taking into account the 0.1% AEP event, the higher predicted flood levels suggest that building finished floor levels should be set above 46.78mAOD to minimise the residual risk. Development levels have been set accordingly.

Similarly, it is recognised that rainfall events in excess of the design capacity of the surface water drainage network may result in temporary above ground flooding, potentially giving rise to overland flows. This is reflected in the design of external levels, such that overland flows are routed away from buildings and towards the surface water storage infrastructure.

Appendices

A Environment Agency draft outputs review letter

B Hydraulic model technical note

C Detailed Phase 1 development design drawing

D Surface water drainage strategy

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