Bradford Level 2 Strategic Flood Risk Assessment - Site H229

Final Draft

July 2026

Prepared for:

City of BRADFORD METROPOLITAN DISTRICT COUNCIL

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1 Background

This is a Level 2 Strategic Flood Risk Assessment (SFRA) site screening report for the City of Bradford Metropolitan District Council (CBMDC) Local Plan Site H229. The content of this Level 2 SFRA site screening report assumes the reader has already consulted the 'CBMDC Level 1 SFRA' (2023) and read the 'CBMDC Level 2 SFRA Main Report' (2026) and is therefore familiar with the terminology used in this report.

1.1 Site H229

- Location: Land West of Wharf Street
- Existing site use: Brownfield
- Existing site use vulnerability: Less vulnerable
- Proposed site use: Residential
- Proposed site use vulnerability: More vulnerable
- Site area: 0.5 hectares
- Proposed development impermeable area: 0.44 hectares
- Watercourse: Bradford Beck
- CBMDC river model: Bradford Beck 2026
- Summary of requirements from scoping stage:
    - Level 1 SFRA recommendation was for withdrawal from allocation or more detailed assessment through Level 2 SFRA
    - Assessment of modelled fluvial flood depths, velocities and hazards
    - Assessment of all other sources of flood risk

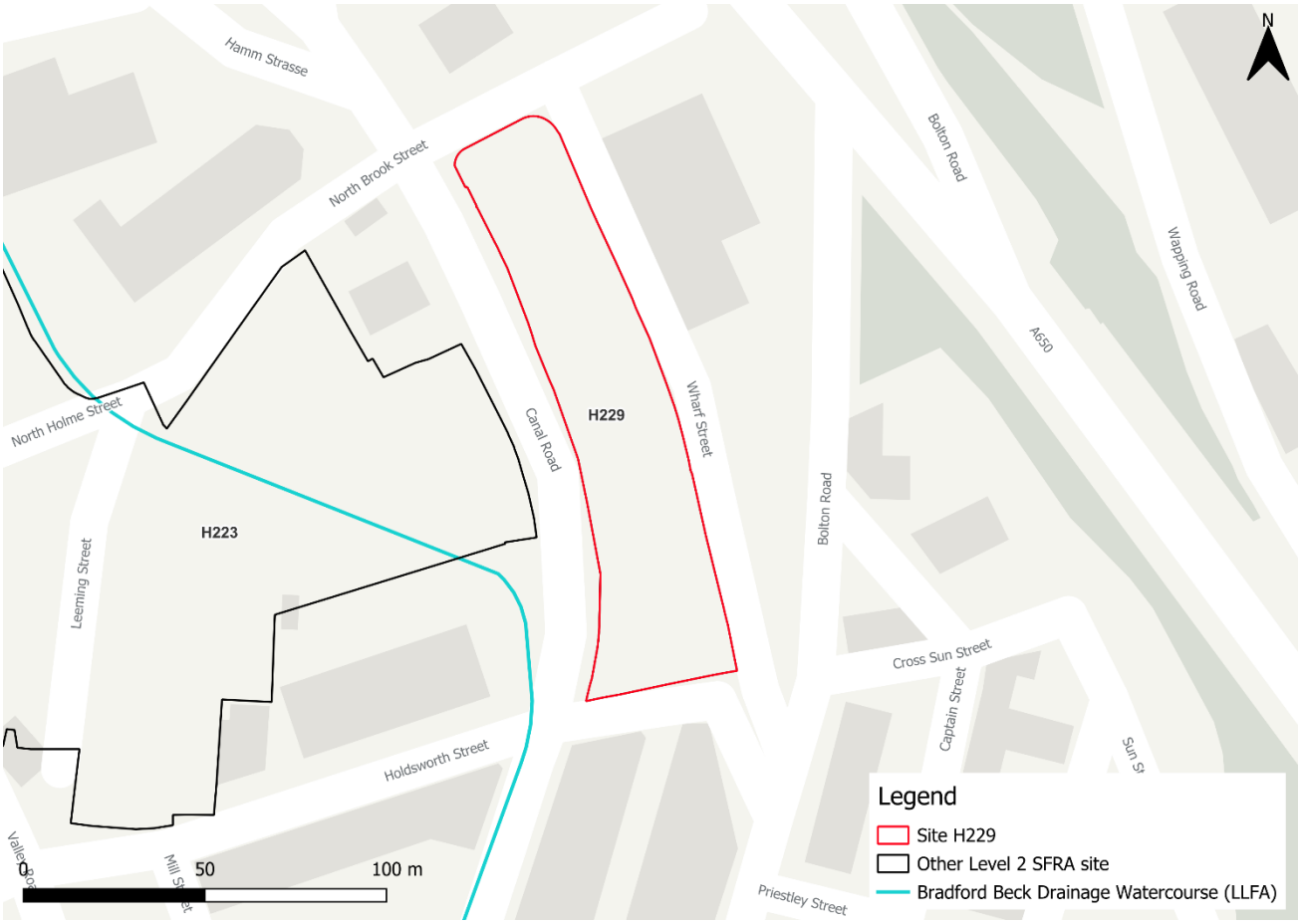


Figure 1-1: Existing site location boundary

The topography of the site is varied, with land sloping from east to west. This gradient is steepest in the south of the site where maximum elevations are the highest, at approximately 5m higher than the areas of lowest elevation (Figure 1-2).

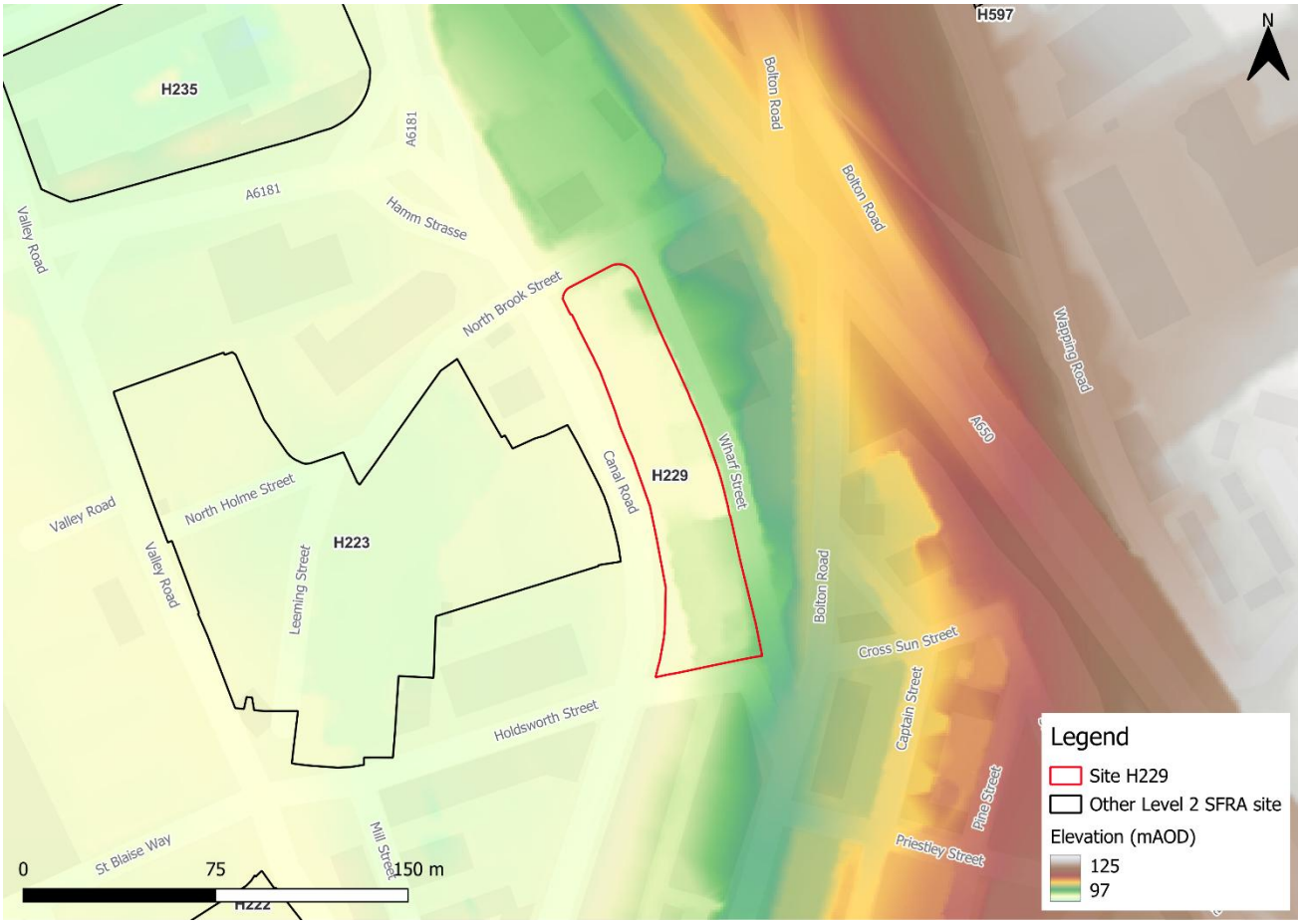


Figure 1-2: Topography

The underlying bedrock within the site is defined as 'Pennine Lower Coal Measures Formation', which comprises mudstone, siltstone, sandstone, coal, ironstone and ferricrete (Figure 1-3). This is overlain with superficial deposits of till. Mudstone, siltstone, coal, ironstone and ferricrete typically have low permeability, however this can be highly variable. Sandstone has a higher permeability.

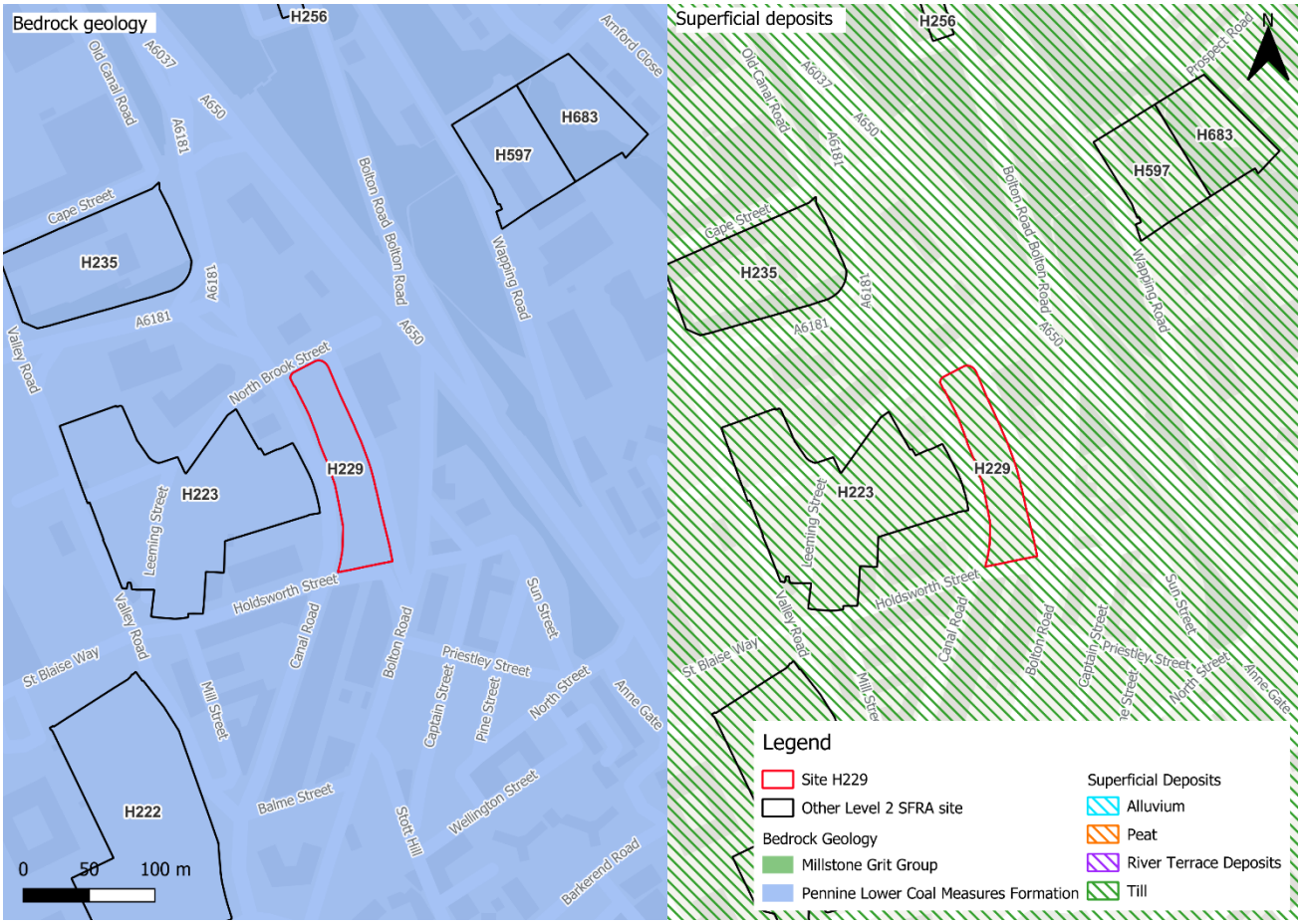


Figure 1-3: Soils and geology

2 Flood risk from rivers

2.1 Existing risk

2.1.1 Flood Map for Planning and functional floodplain

Based on the EA's Flood Map for Planning (January 2026) and Flood Zone 3b (functional floodplain), as updated in this Level 2 SFRA, the percentage areas of the site within each fluvial flood zone are stated in Table 2-1 and can be viewed on Figure 2-1. This version of the Flood Map for Planning does not consider flood defence infrastructure (Section 2.3.

Fluvial flood risk to the site comes from Bradford Beck which is culverted to the west of the site. A small area on the southwest boundary of the site is situated within Flood Zone 2 and is therefore at medium risk of fluvial flooding. The remaining area of the site is within Flood Zone 1 and therefore at low risk.

Table 2-1: Existing fluvial flood risk based on percentage area of site at risk

Flood Zone 1 (% area)	Flood Zone 2 (% area)	Flood Zone 3a (% area)	Flood Zone 3b (% area)
98	2	0	0

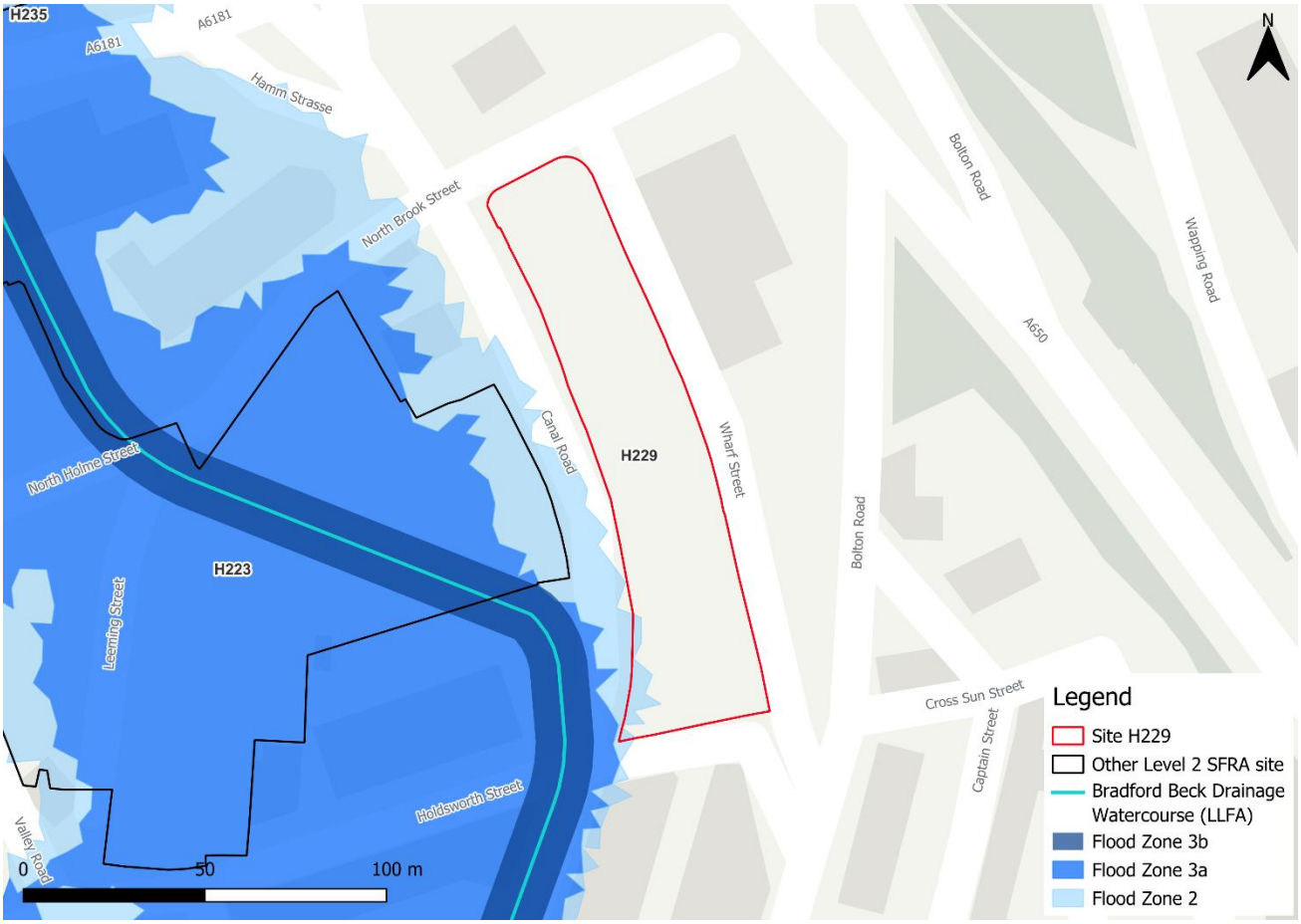


Figure 2-1: Existing risk from rivers to the site

2.1.2 Bradford Beck 2026 model outputs - present day

The Bradford Beck 2026 model does not show the site to be at risk of fluvial flooding during the present day 0.1% AEP undefended event. However, it is noted that the current Flood Zone 3a does not yet account for the latest Bradford Beck model outputs.

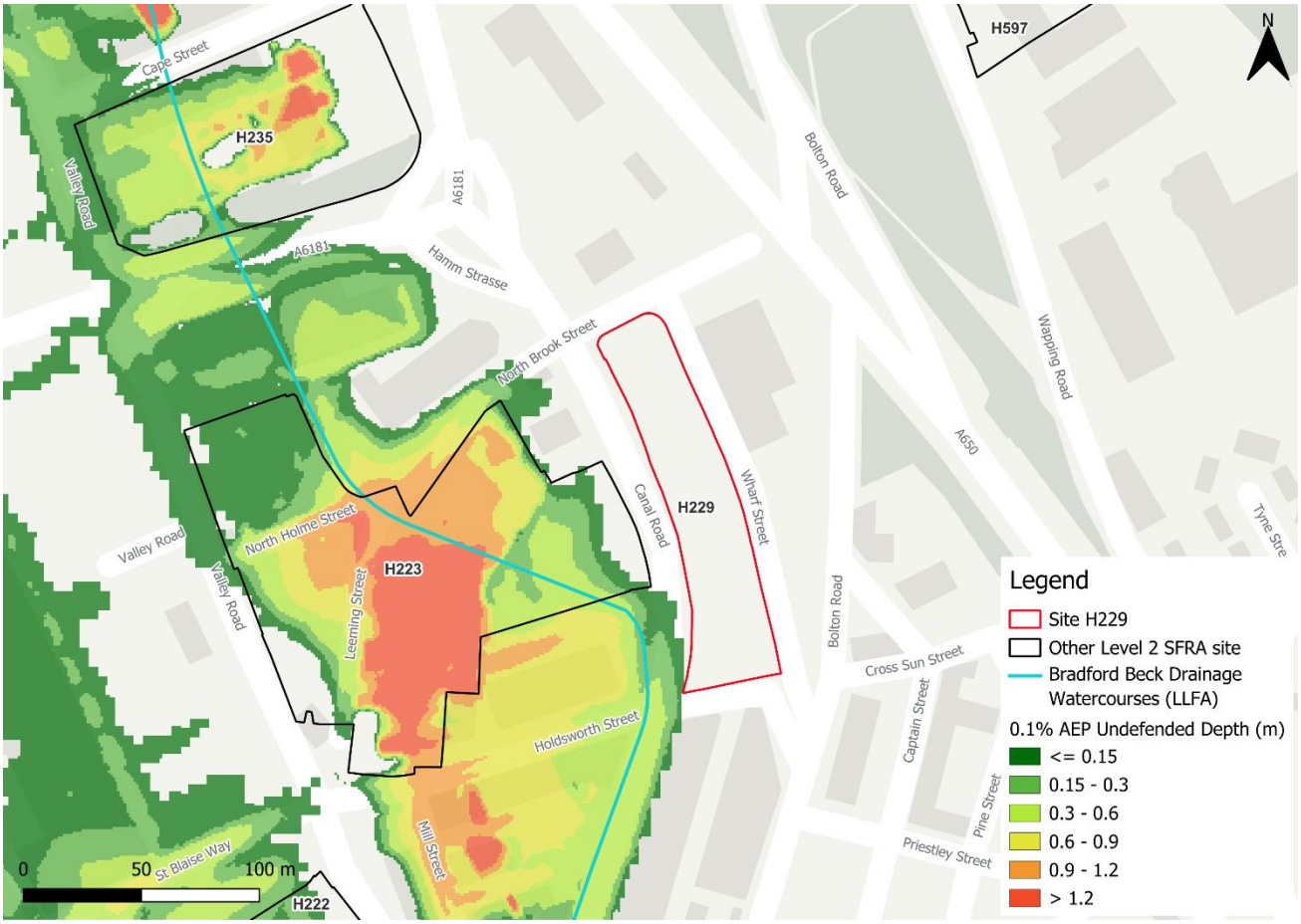


Figure 2-2: Flood depths for 0.1% AEP undefended flood event

2.2 Impacts from climate change

The EA's SFRA guidance states that SFRAs should assess the central allowance for less vulnerable, more vulnerable, highly vulnerable and water compatible development (Table 2-2). The impacts of climate change on flood risk from the Bradford Beck 2026 model have been modelled without flood defence infrastructure in place. As documented in Section 2.3.1, there are no formal engineered flood defences that would benefit the site.

Table 2-2: Modelled climate change allowances for peak river flows for the Aire and Calder Management Catchment

Return period (AEP event)	Central allowance 2080s (% increase)	Higher central allowance 2080s (% increase)	Upper end allowance 2080s (% increase)
3.3% (functional floodplain)	23%	31%	51%
1%	23%	31%	51%
0.1%	23%	31%	51%

2.2.1 Bradford Beck 2026 model outputs - climate change

Figure 2-3 shows the onsite modelled flood depths for the 0.1% AEP undefended event plus central allowance for climate change. The Bradford Beck 2026 model shows that the site is at risk in this event, however this is confined to a very small area of low depths along the western site boundary.

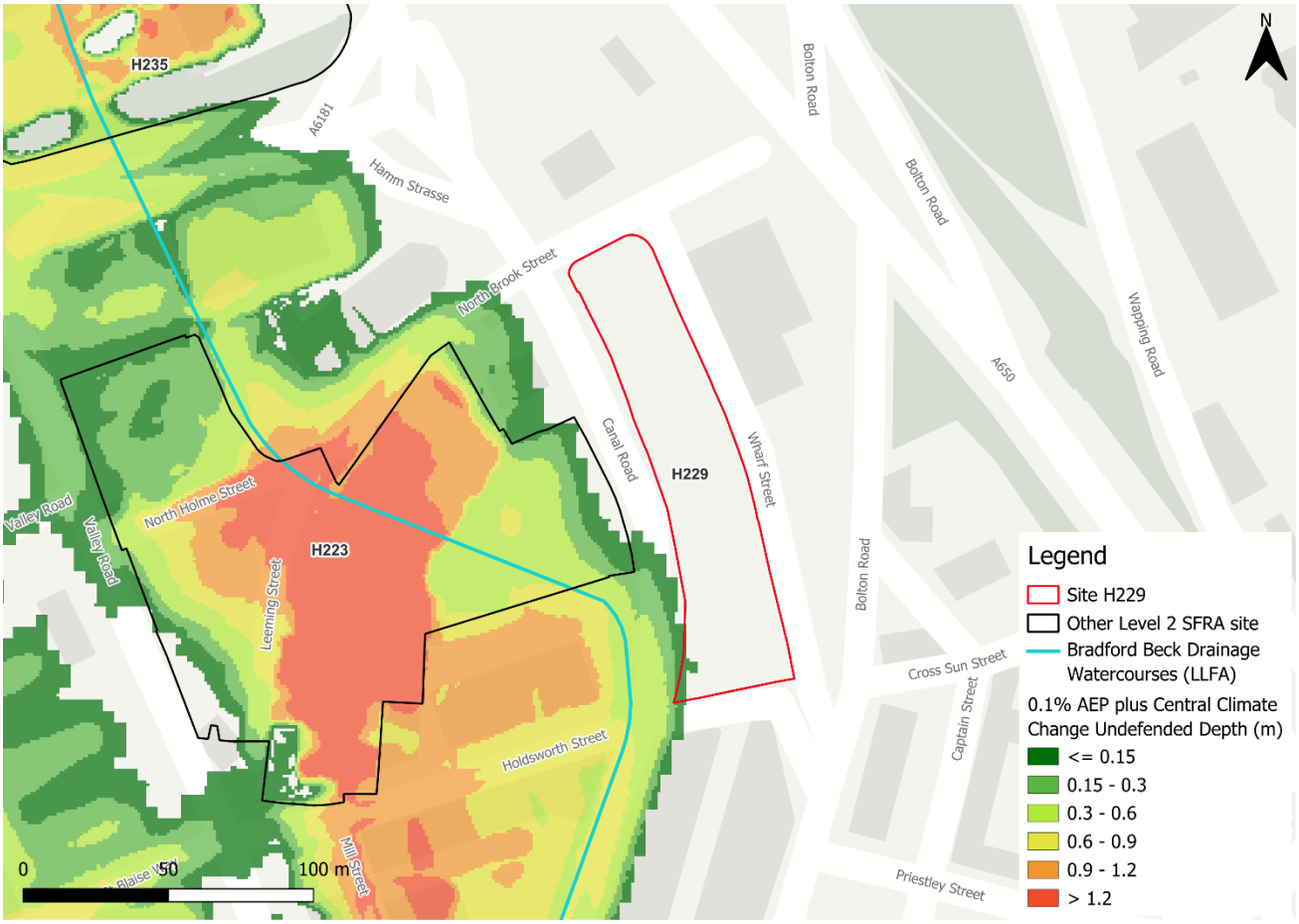


Figure 2-3: Flood depths for 0.1% AEP undefended flood event +23% (central climate change allowance)

2.2.2 Flood Map for Planning - Climate Change

Climate change data in this area is unavailable from the EA's Flood Map for Planning plus Climate Change (2070-2125) dataset, as shown in Figure 2-4.

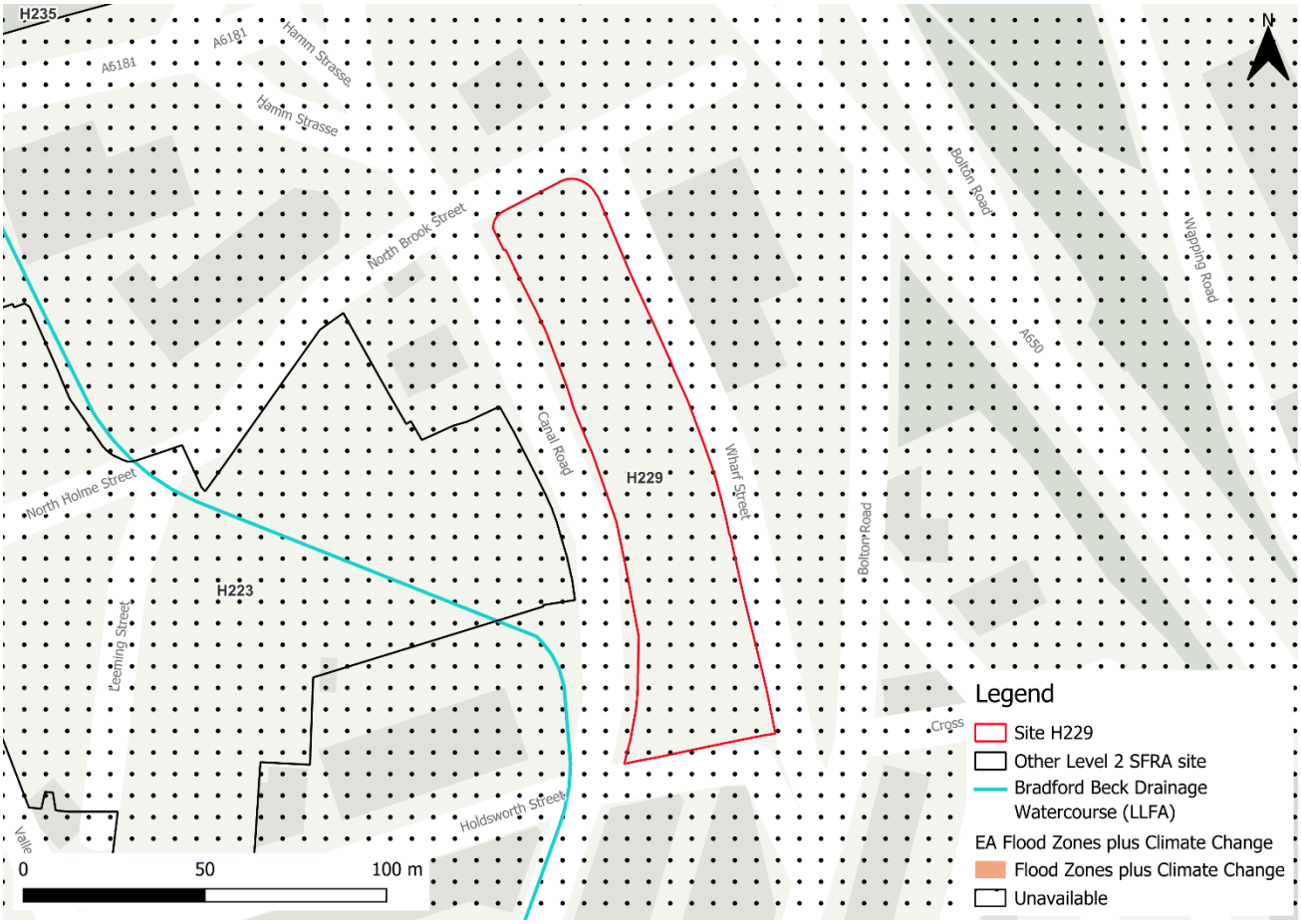


Figure 2-4: EA Flood Zones plus Climate Change

2.3 Flood risk management

2.3.1 Flood defences

The site does not benefit from any formal engineered flood defences, according to the EA's spatial flood defences dataset.

2.3.2 Working with Natural Processes

The EA's Working with Natural Processes (WwNP) dataset has been interrogated to identify opportunities for Natural Flood Management (NFM) to reduce flood risk to the site and surrounding areas. There are no applicable areas that could benefit the site.

2.4 Historic flood incidents

The EA's Historic Flood Map (HFM) and Recorded Flood Outlines (RFO) datasets have been considered. There are no recorded historic flood events within the vicinity of the site.

2.5 Emergency Planning

2.5.1 Flood warnings

The EA operates a Flood Warning Service for properties located within a Flood Warning Area (FWA) for when a flood event is expected to occur. An area in southwest of the site is located within a FWA, namely 123FWF785 - Bradford Beck and tributaries at Bradford.

Flood alerts may be issued before a flood warning for properties located within a Flood Alert Area (FAA) to provide advance notice of the possibility of flooding. A flood alert may be issued when there is less confidence that flooding will occur in a FWA. An area in southwest of the site is also located within a FAA, namely 123WAF961 - Middle River Aire catchment.

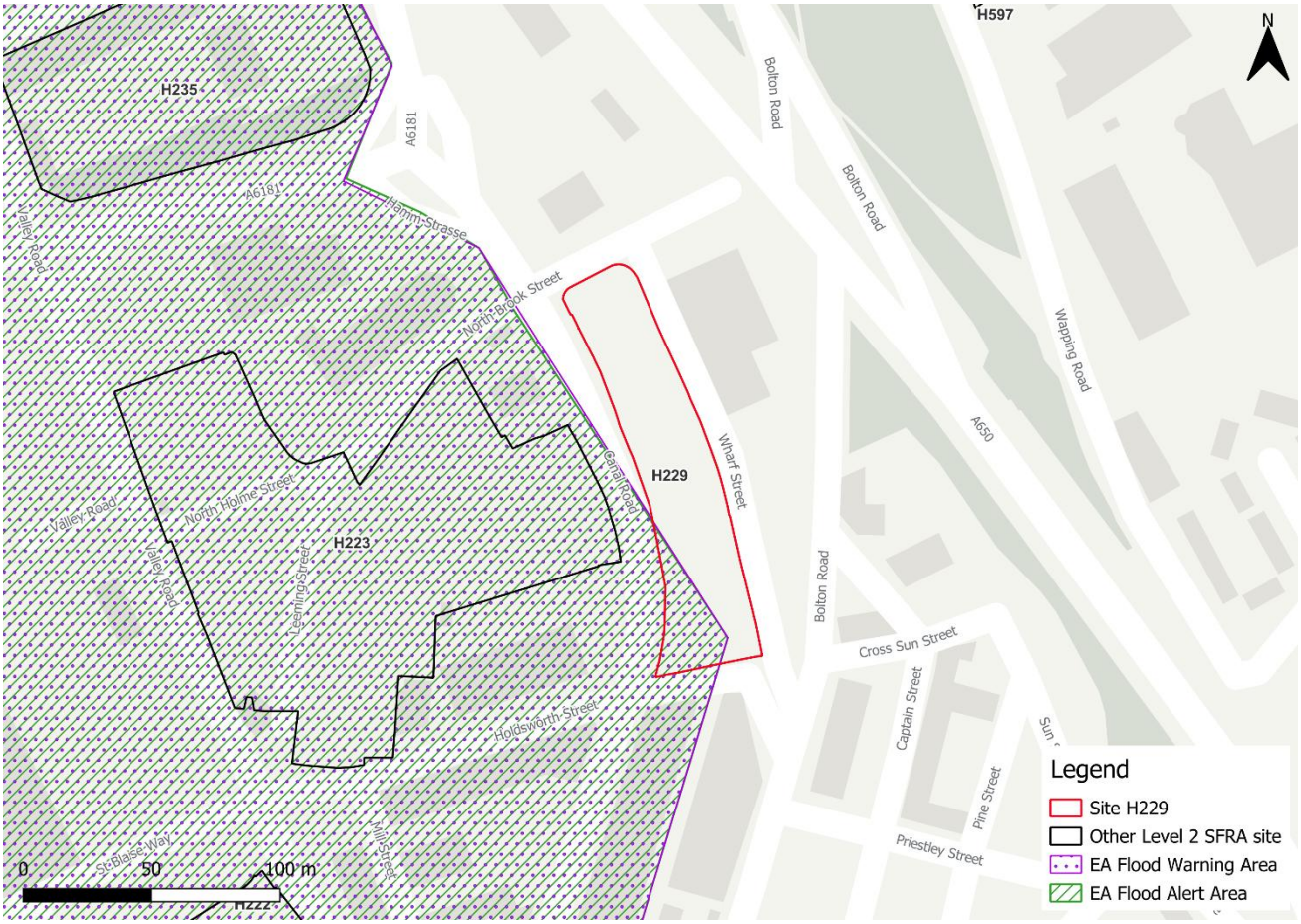


Figure 2-5: EA Flood Warning Areas and Flood Alert Areas

2.5.2 Access and escape routes

Based on available information, safe access and escape routes are likely to be achievable via Wharf Street to the east of the site (Figure 2-6).

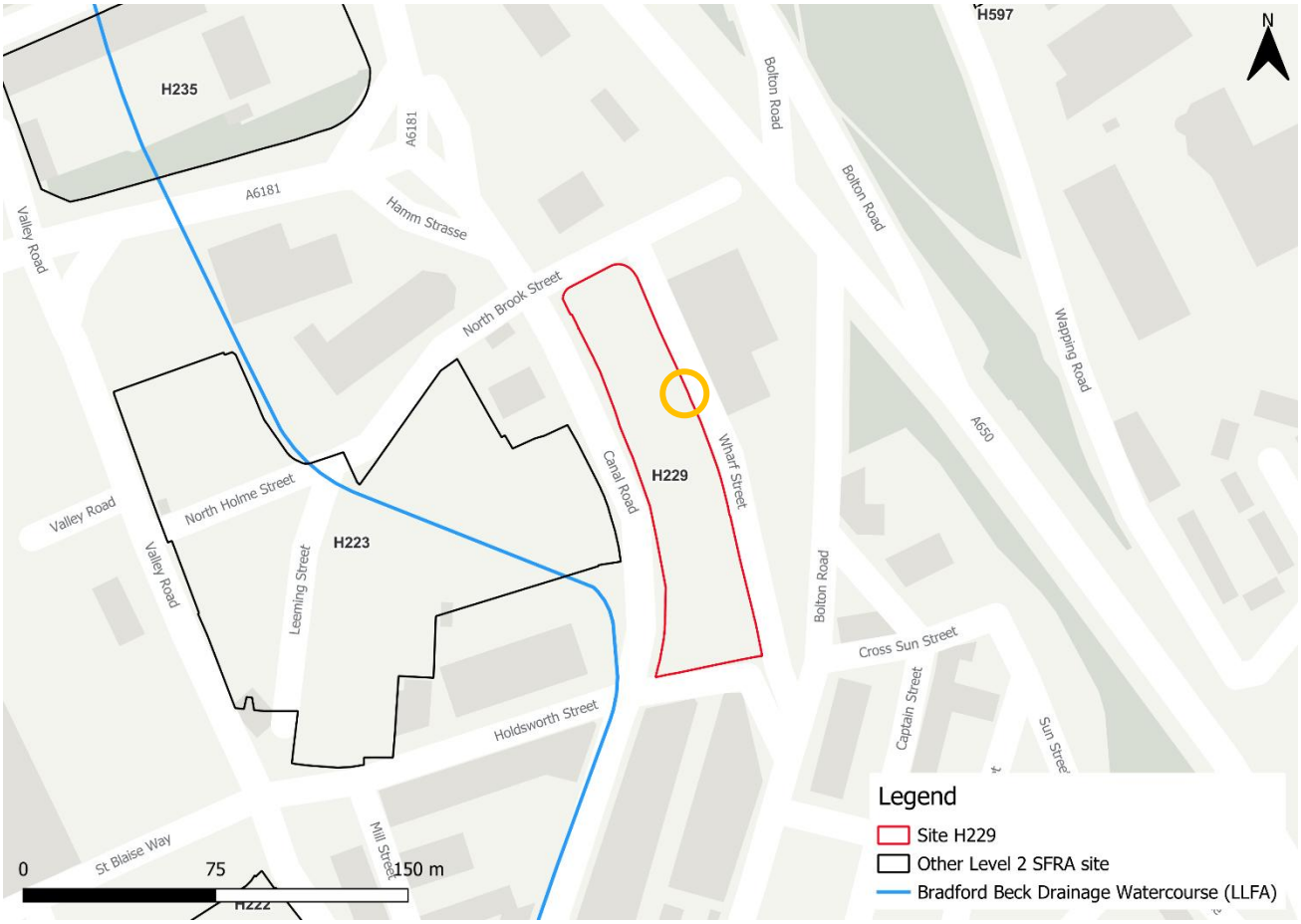


Figure 2-6: Potential access and escape routes

2.6 Observations, mitigation options, site suitability and sequential approach to development management - fluvial

- Observations:
  - The proposed development of the site would see a change in the risk classification from less vulnerable to more vulnerable, according to the NPPF.
  - Given the change in use and therefore vulnerability of the site, the LPA must consider whether the change of use is acceptable and whether the development can be designed to be safe, including for adequate emergency planning provision, accounting for the information provided in this Level 2 SFRA (para 014 FRCC-PPG).
  - The site is partially located within Flood Zone 2 of the EA's Flood Map for Planning, in the southeastern corner of the site. However, it is noted that the current Flood Zone 2 does not yet account for the latest Bradford Beck model outputs.
  - The majority of the site is located within Flood Zone 1, putting it at low risk of fluvial flooding. Ideally, all development would be directed to the area of the site within Flood Zone 1. The area shown to be within Flood Zone 2 could be used as a blue-green corridor offering multifunctional benefits.
  - The 1% AEP event with an allowance for climate change is what the EA considers to be the design event for a development to mitigate fluvial flood risk. Fluvial risk is not modelled to impact the site in the 1% AEP undefended central climate change event.
  - The site is partially impacted in the extreme 0.1% AEP undefended event plus the central allowance for climate change; however, this is confined to a small area along the western boundary of the site.
- Mitigation
  - EA flood warnings and alerts should continue to be in place to ensure early evacuation of site users before an extreme flood event occurs.
- Access and escape
  - Based on available information, safe access and escape routes will likely be available via Wharf Street to the east of the site.

3 Flood risk from surface water

3.1 Existing risk

At the time of writing, the EA's latest national Risk of Flooding from Surface Water (RoFSW) does not include depth and hazard information suitable for planning purposes. Therefore, this Level 2 SFRA considers the third generation RoFSW depth and hazard mapping in addition to the NaFRA2 extents, as agreed with the EA. Surface water depth and hazard should be confirmed at the site-specific FRA stage.

3.1.1 Risk of Flooding from Surface Water - NaFRA2 extents

Based on the EA's national scale RoFSW map (January 2026), surface water risk to the site is predominantly very low, as shown in Table 3-1.

Surface water risk in the high and medium risk events is confined to an area of ponding in the northwest of the site where elevations are low (Figure 3-1). In the low risk event, there is a small area of ponding present in the southwest of the site. Safe access and escape routes via Wharf Street remain to be achievable due to no modelled surface water depths and hazards along this route.

Table 3-1: Existing surface water flood risk based on percentage area at risk using the RoFSW map

Very low risk (% area)	Low risk (% area)	Medium risk (% area)	High risk (% area)
93	4	1	2

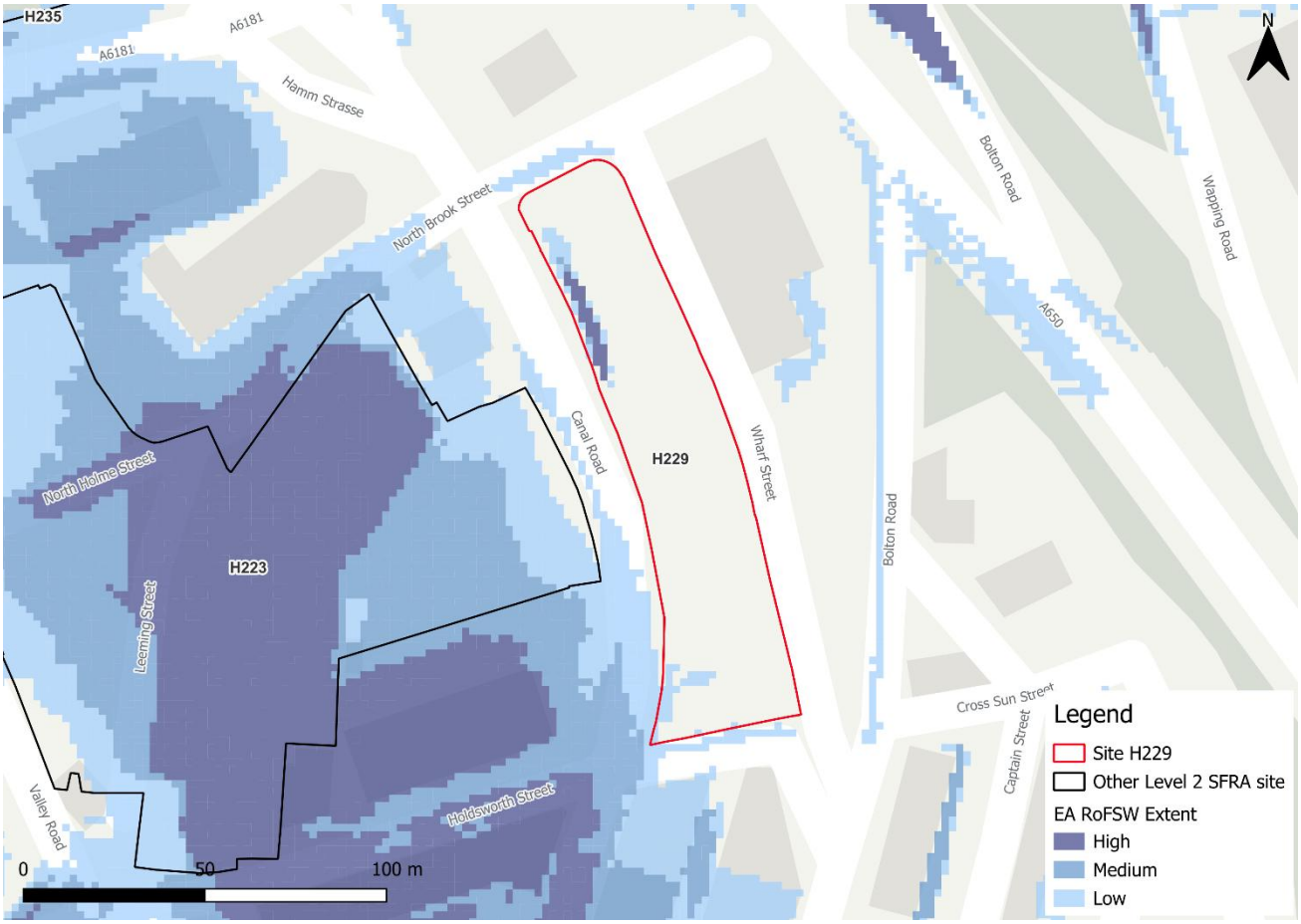


Figure 3-1: Surface water flood extents (NaFRA2 - Risk of Flooding from Surface Water map)

3.1.2 Risk of Flooding from Surface Water - third generation depths and hazards

Based on the EA's national scale third generation RoFSW map, there are no flood depths or hazards modelled to the site in the medium risk event.

There are therefore clear differences between the NaFRA2 RoFSW map and the third-generation depth and hazard mapping. The NaFRA2 RoFSW map does not map flooding less than 0.075m (7.5cm) in depth. Therefore, where the map may show no flooding, there may be shallow flooding up to a depth of 0.075m. In contrast, the third generation RoFSW does not map flooding with a hazard rating of less than 0.575. This could explain the differences observed between the NaFRA2 and third generation RoFSW. Assessment of surface water should be carried out at the site-specific FRA stage to robustly establish current and future surface water flood risk conditions.

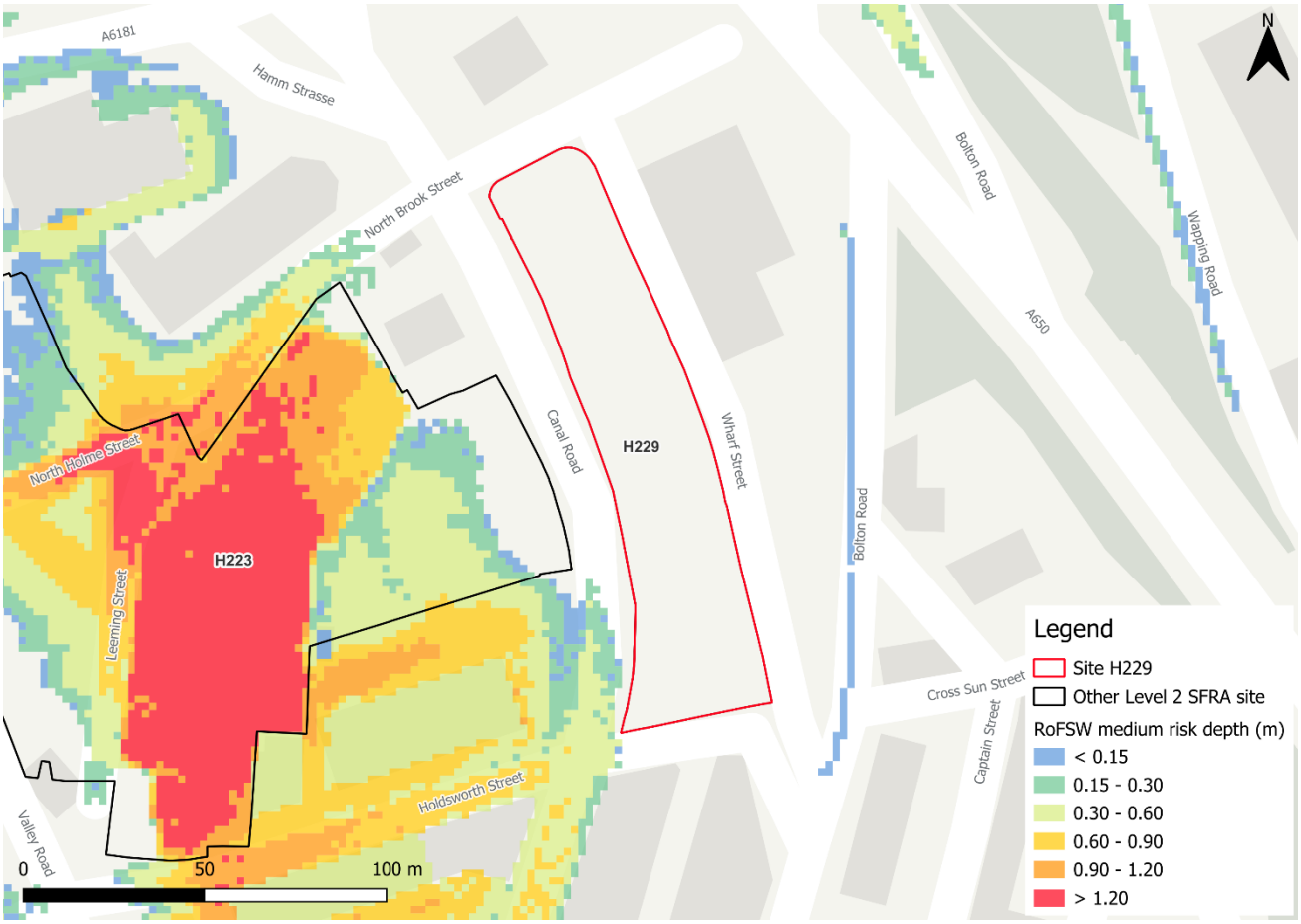


Figure 3-2: Medium-risk event surface water flood depths (Risk of Flooding from Surface Water map)

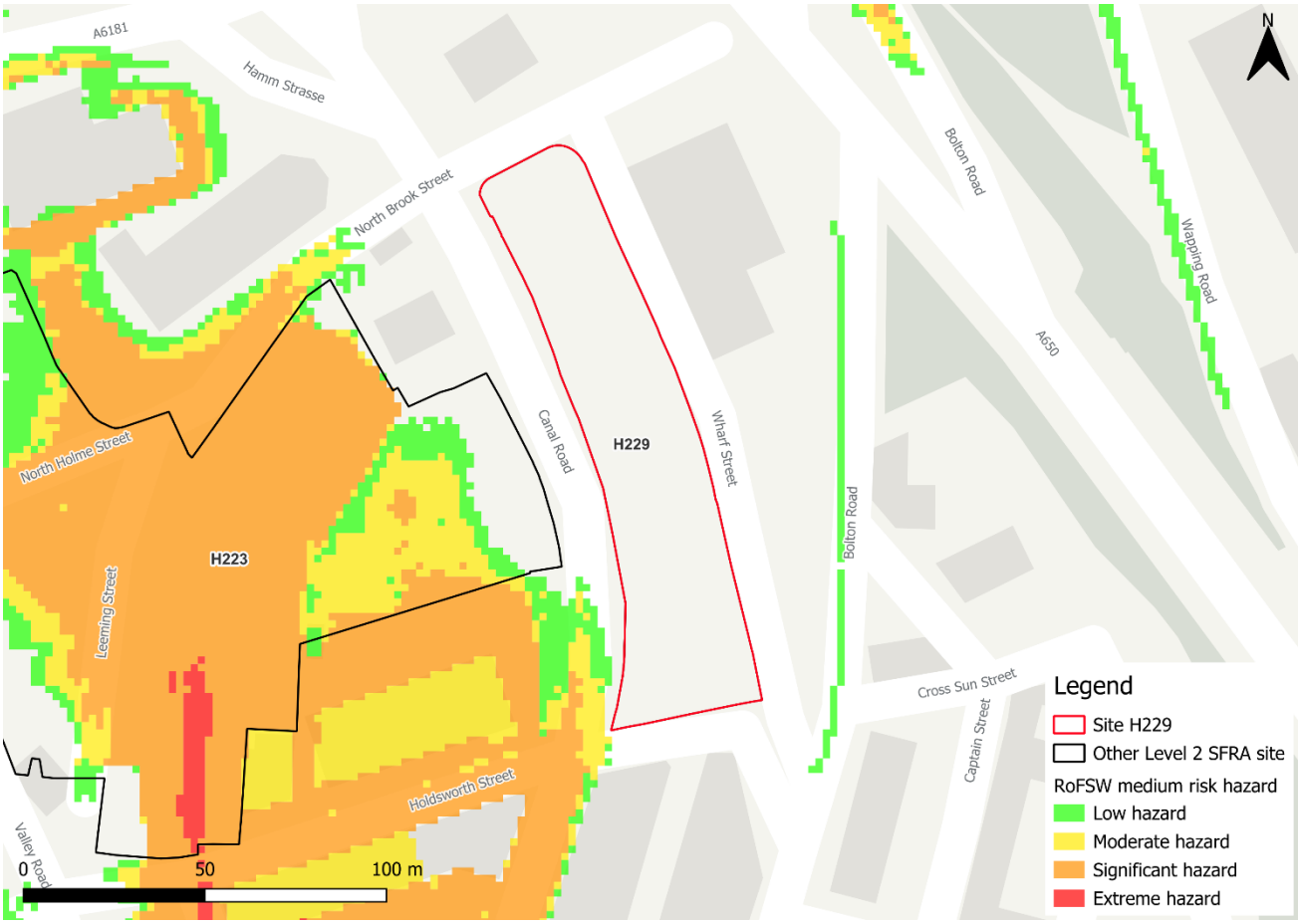


Figure 3-3: Medium-risk event surface water flood hazard[1] (Risk of Flooding from Surface Water map)

3.2 Impacts from climate change

At the time of writing, the available national surface water climate change mapping is unsuitable for consideration in development planning. This Level 2 SFRA considers the low-risk surface water event as a conservative proxy for the medium risk event plus climate change, as agreed with the EA. The impact of climate change on surface water flood risk should be considered at the site-specific FRA stage.

Using the low risk event as a proxy, the medium risk surface water event is likely to increase in extent within the site when accounting for climate change, increasing to include a small area of ponding in the south of the site (Figure 3-4). The third-generation map indicates a risk of flooding from surface water in the southwest of the site, with maximum flood depths between 0.30 and 0.60m (Figure 3-5) and hazard predominantly categorised as 'Moderate' (Figure 3-6).

1 Based on Section 7.5 Hazard rating. What is the Risk of Flooding from Surface Water map? Report version 2.0. April 2019. Environment Agency

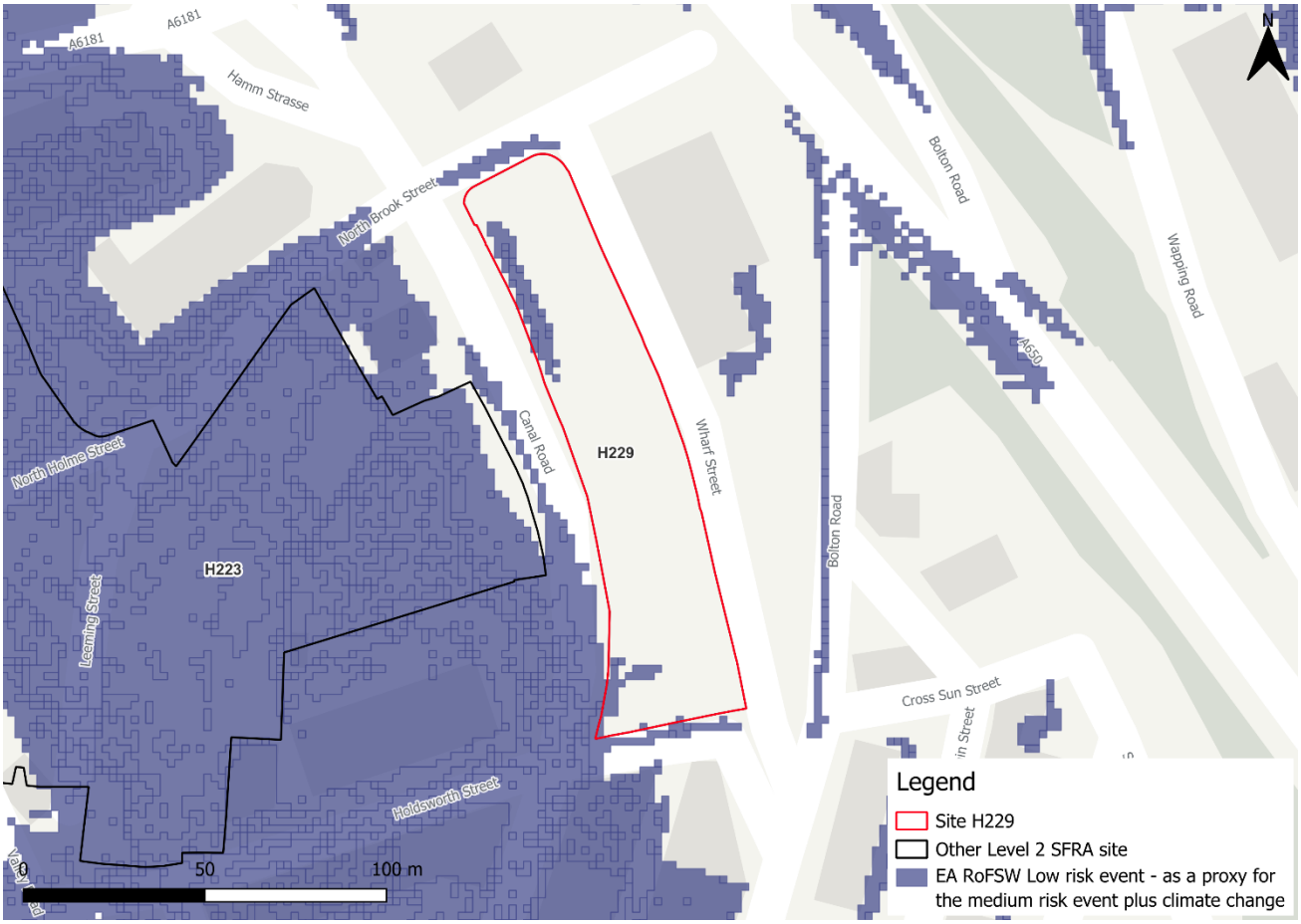


Figure 3-4: Low risk surface water flood extent, as a proxy for the medium risk event plus climate change (NaFRA2 - Risk of Flooding from Surface Water map)

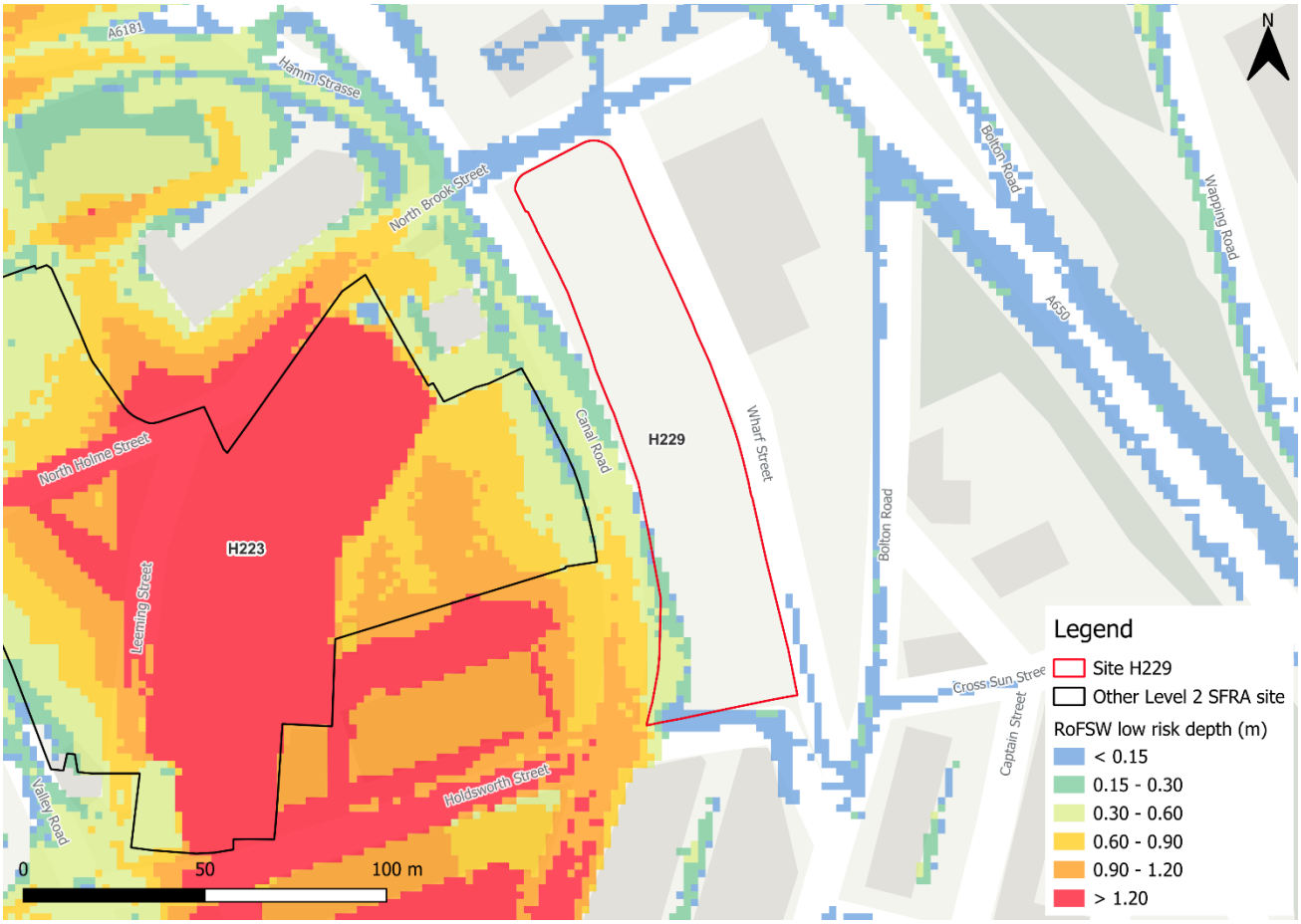


Figure 3-5: Low risk event surface water flood depths, as a proxy for the medium risk event plus climate change (Third generation - Risk of Flooding from Surface Water map)

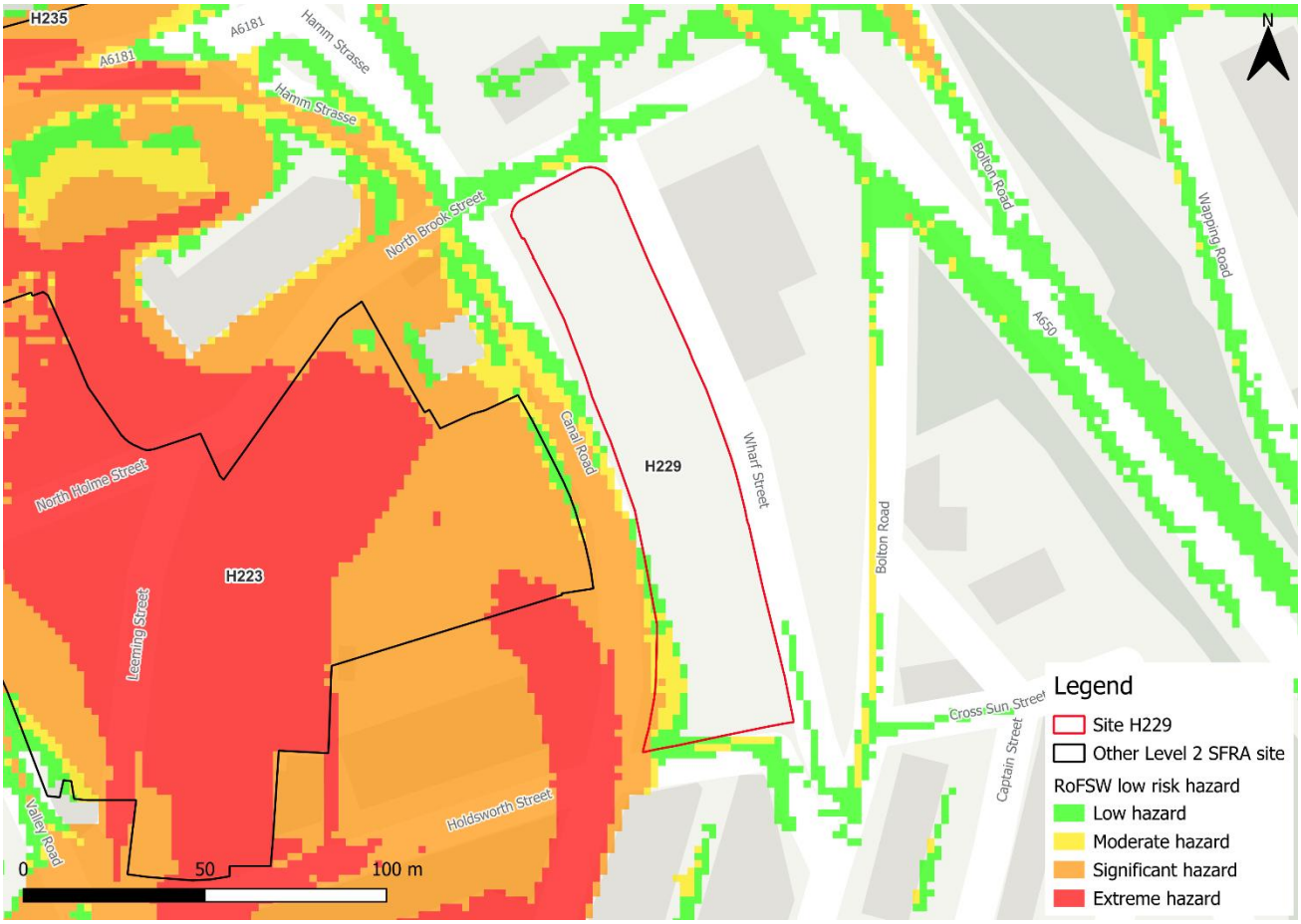


Figure 3-6: Low risk event surface water flood hazard, as a proxy for the medium risk event plus climate change (Third generation - Risk of Flooding from Surface Water map)

3.3 Observations, mitigation options and site suitability - surface water

- Current risk to the site is predominantly very low, with approximately 93% of the site being at very low risk. Surface water risk in the medium risk event is confined to the northwest of the site.
- The effects of climate change on surface water have not been modelled for this SFRA, however the low risk surface water event has been used as a proxy for the medium risk event plus climate change. In this event, there is surface water flood risk modelled to the southwest of the site.
- Topographic low spots should be considered and included in site design and ideally left in place to flood naturally when required.
- The drainage strategy must ensure there is no increase in surface water flood risk elsewhere as a result of new development. Existing brownfield rates will likely apply, though the developer should consult local LLFA guidance and the National SuDS guidance.
- Assessment of the current drainage system in place should be carried out to ascertain any current capacity issues and whether the current system could accommodate the proposed residential development or whether further capacity will be required.

- The RoFSW map is not suitable for identifying whether an individual property will flood and is therefore indicative. The RoFSW map is not appropriate to act as the sole evidence for any specific planning or regulatory decision or assessment of risk in relation to flooding at any scale without further supporting studies or evidence.

4 Risk from groundwater

Risk of groundwater emergence is assessed in this SFRA using JBA's 5m Groundwater Emergence Map. This dataset is recommended for use by the EA in the SFRA Good Practice Guide[2]. Figure 4-1 shows the map covering this site and the surrounding areas and Table 4-1 explains the risk classifications.

Within the majority of the site, there is no risk of groundwater emergence. This is reflected in the geology of the area being a combination of mudstone, siltstone and sandstone (Figure 1-3), contributing to potentially reduced rates of infiltration and low water tables. Infiltration SuDS may therefore be an appropriate option at this site as there is a lower risk of groundwater emergence. However, the underlying bedrock geology being less permeable means that the type of infiltration SuDS needs to be considered further through the drainage strategy.

There is a small area within the southeast of the site where groundwater may emerge at significant rates and has the capacity to flow overland and / or pond within any topographic low spots. In this area, ground investigations will be required through the site-specific FRA to ascertain groundwater levels and conditions.

2 Strategic flood risk assessment good practice guide. ADEPT. December 2021.

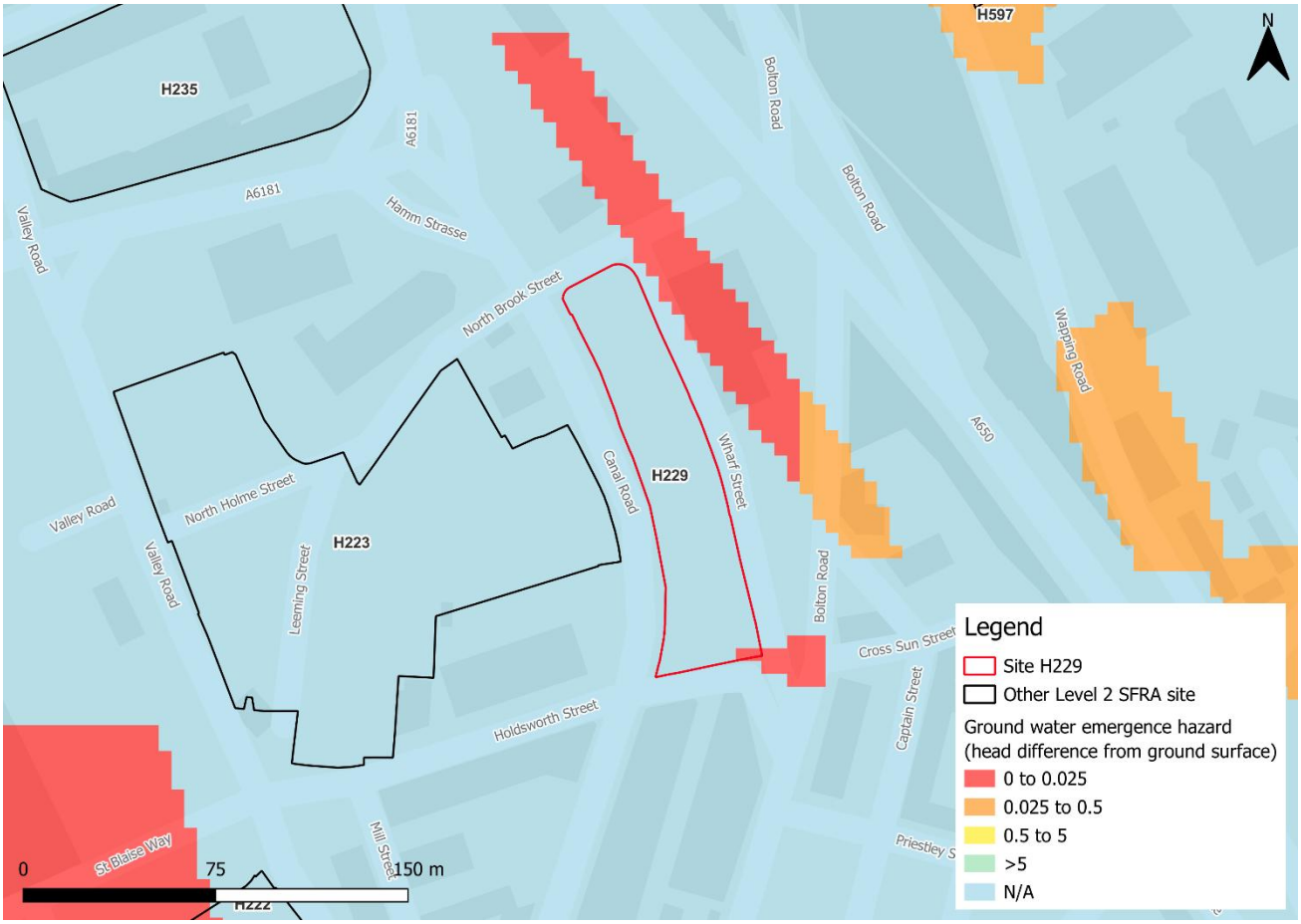


Figure 4-1: JBA 5m Groundwater Emergence Map

Table 4-1: Groundwater Hazard Classification

Groundwater head difference (m)*	Class label
0 to 0.025	Groundwater levels are either at very near (within 0.025m of) the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
0.025 to 0.5	Groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
0.5 to 5	Groundwater levels are between 0.5m and 5m below the ground surface in the 100-year return period flood event There is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.
>5	Groundwater levels are at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater is not likely.
N/A	No risk. This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.
*Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.	

5 Residual risk

Although a site may be afforded some protection from defences and / or drainage infrastructure, there is always a residual risk of flooding from asset failure i.e. defence breaches, or blockages of culverts or drainage assets. Residual risk at this site comes from the potential blockage of the structure underneath the site to its west.

5.1 Potential blockage

A blockage of the culvert to the west of the site may cause water in the channel to back up and cause flooding to the site, depending on the severity of the blockage and the magnitude of the flood event. Culvert course and condition surveys may be required, including for consultation with the culvert owner.

The Bradford Beck 2026 model includes a scenario in which all culverts within the model are blocked by 50%. Figure 5-1 shows the modelled flood depths for this scenario. There is a small increase in the extent of flooding caused by a 50% blockage to the structure. This flood extent reaches the boundary of the site in its southwest corner.

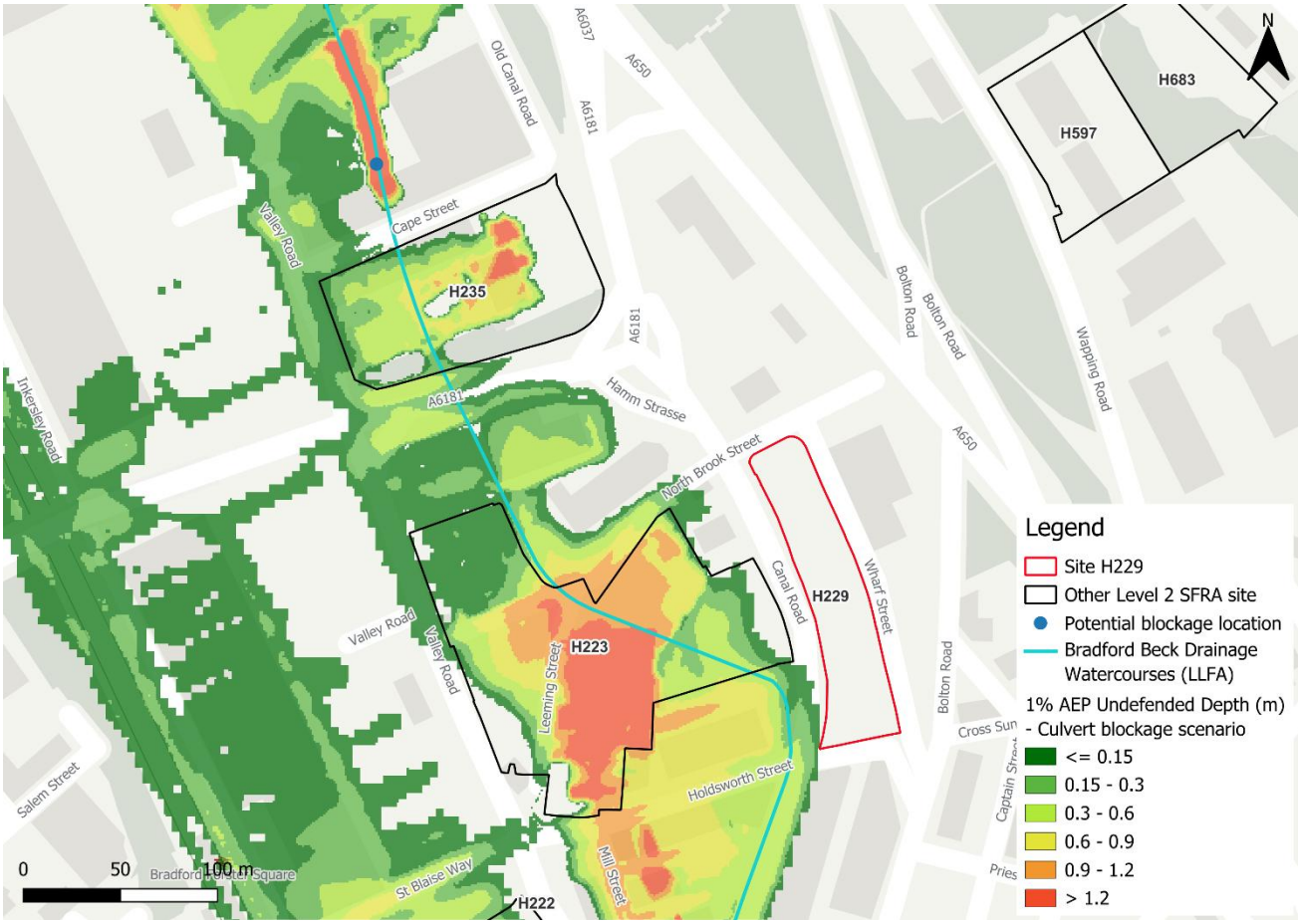


Figure 5-1: Flood depths for 1% AEP undefended flood event 50% culvert blockage scenario - structure underneath the site to its west.

5.2 Flood risk from reservoirs

The EA's Reservoir Flood Maps (RFM) (2021) show where water may go in the unlikely event of a reservoir or dam failure. Figure 5-2 shows the RFM in a 'dry day' and 'wet day' scenario. A 'dry day' scenario assumes that the water level in the reservoir is the same as the spillway level or the underside of the roof for a service reservoir and the watercourses upstream and downstream of the reservoir are at a normal level. A 'wet day' scenario assumes a worst-case scenario where a reservoir releases water held on a 'wet day' when local rivers have already overflowed their banks.

The site is potentially at risk from four reservoirs. All four reservoirs are located within Bradford. Of the four reservoirs, two are operated by the City of Bradford Metropolitan District Council, and two are operated by Yorkshire Water Services Ltd.

The EA's SFRA guidance states that where a proposed development site is at flood risk from a reservoir, then an assessment into whether the reservoir design or maintenance schedule needs improving should be carried out. Expert advice may be required from an all-reservoirs panel engineer. The Council should consult the relevant reservoir undertaker to ascertain whether the proposed development could affect the reservoir's risk designation, its design category or how it is operated. The Council, as category 1 responders, can access more detailed information about reservoir risk and reservoir owners using the Resilience Direct system.

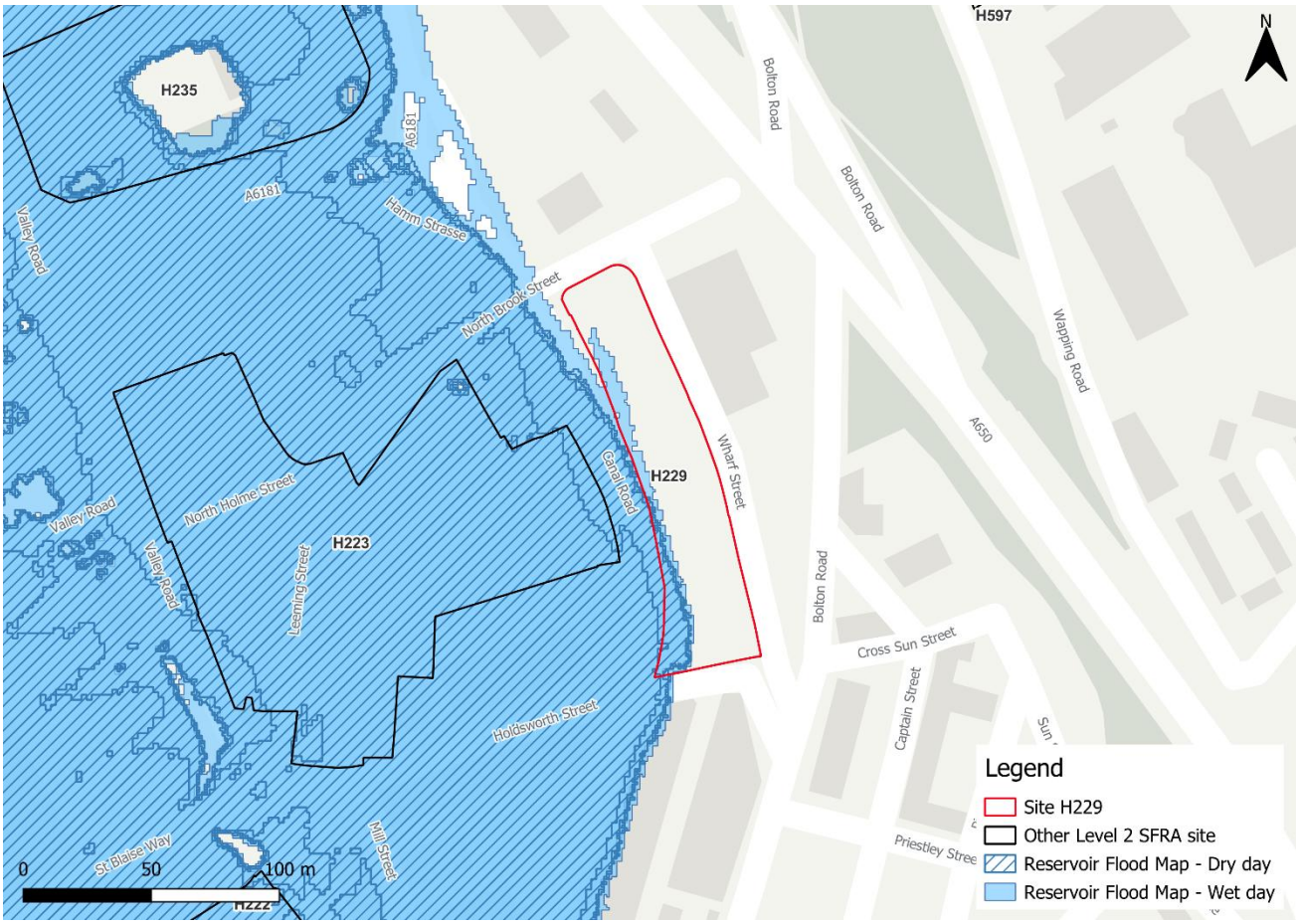


Figure 5-2: Flood risk from reservoirs

5.3 Observations, mitigation options and site suitability - residual risk

- The site is at potential residual risk from a blockage of the culvert to the west of the site. The modelled 50% culvert blockage scenario indicates that flood extents may reach the southwestern boundary of the site. The site-specific FRA could consider modelling a higher blockage proportion to understand whether there would be any additional risk to the site.
- Areas adjacent to culverts and bridges are at particular risk from the rapid onset of fast flowing and deep flooding, with little or no warning if structures become blocked. Emergency plans must be in place for such areas and safe access and escape routes must be in place for the lifetime of development. Resistant and resilience measures may also need to be put in place to manage residual flood risk when avoidance measures have been exhausted.
- The LPA should use the information on residual risk in this Level 2 SFRA to state in the local plan strategic policies a preferred mitigation strategy for ensuring development will be safe throughout its lifetime in relation to urban form, risk management and where flood mitigation measures are likely to have wider sustainable design implications (para 042, FRCC-PPG).
- The site is at potential residual risk from a breach of four reservoirs. All four reservoirs impact the site in the 'dry day' flood extent. However, only Upper Chellow and Lower Chellow, both located in Bradford, are modelled to impact the site based on the 'wet day' flood extent, which represents a prediction of the credible worst case scenario, therefore it is unlikely that such an extreme flood event would occur.
- Given the potential reservoir risk to the site, developers should consider[3]:
    - Consulting with the local resilience forum for advice on emergency planning,
    - Consulting with relevant reservoir owners to understand the impact development may have on their reservoirs, and
    - Using this Level 2 SFRA to understand whether any proposed development will be safe throughout its lifetime.

3 Reservoir flood maps: when and how to use them | Environment Agency | 2021

6 Overall site assessment

6.1 Can part b) of the exception test be passed?

This site is not required to pass part b) of the exception test[4] as it is not located within Flood Zone 3a, however it must still be proven that the development can be safe for its lifetime, which is 100 years for residential development.

6.2 Recommendations summary

Based on the evidence presented in the Level 1 SFRA (2023) and this Level 2 SFRA:

- It should be appropriate to develop this site for more vulnerable purposes given its location largely within Flood Zone 1 and nominal surface water flood risk.
- Ideally, all development would be directed to the area of the site within Flood Zone 1.
- The Flood Map for Planning requires updating with the latest modelling for Bradford Beck.

6.3 Site-specific FRA requirements and further work

At the planning application stage, the following should be considered:

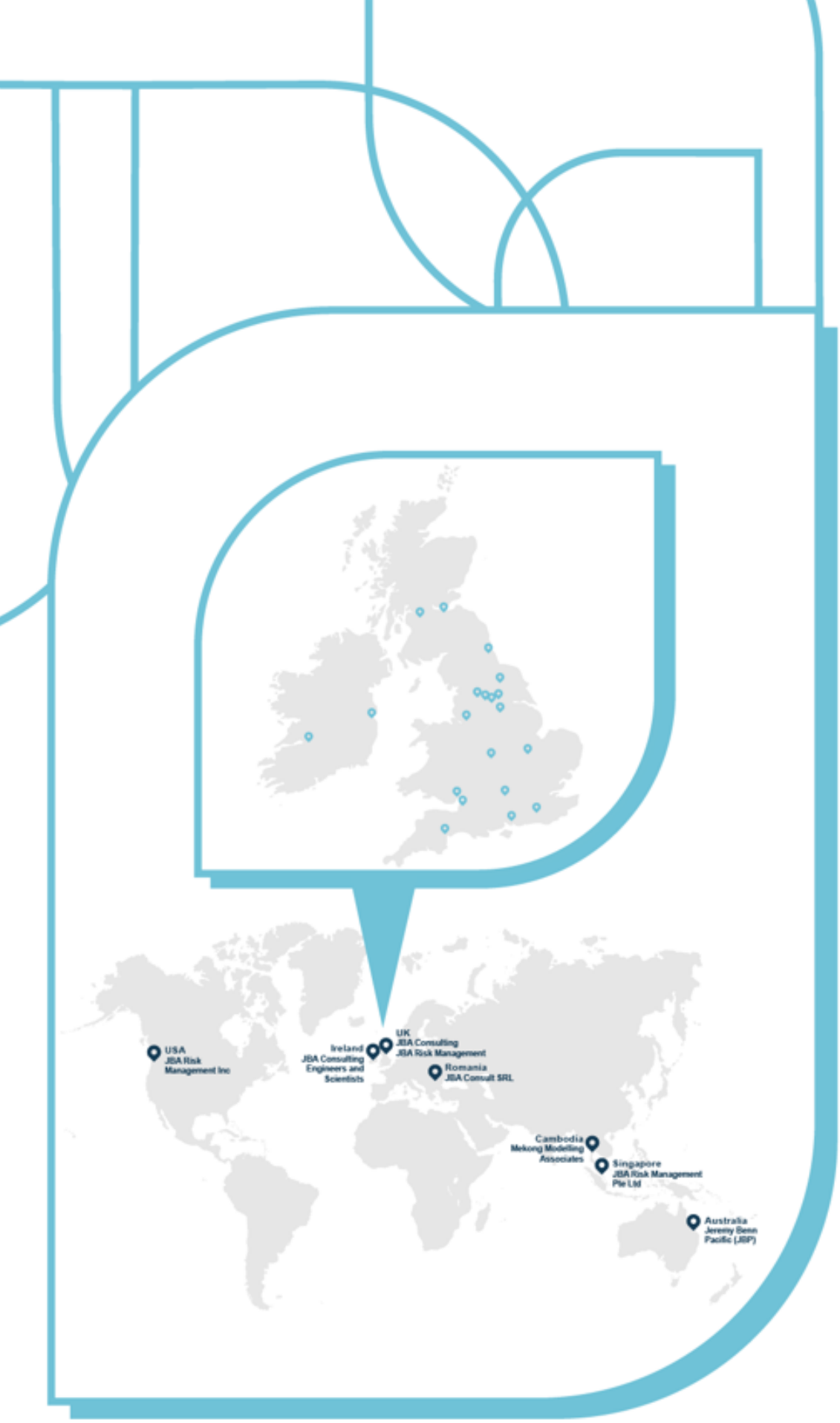
- Further modelling to understand the impacts of climate change on surface water flood risk to the site.
- A condition assessment of the culvert beneath the west of the site.
- Consultation with the relevant reservoir owners to understand the impact of development on reservoir risk designation.
- Any FRA should be carried out in line with the latest versions of the NPPF; FRCC-PPG; EA guidance; the CBMDC Local Plan and national and local SuDS policy and guidelines.
- Throughout the FRA process, consultation should be carried out with the following, where applicable, the local planning authority; the lead local flood authority; emergency planning officers; the Environment Agency; Yorkshire Water; the highways authorities; and the emergency services.

4 Para 178 National Planning Policy Framework 2024

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Bradford Level 2 Strategic Flood Risk Assessment - Site H231

Final Draft

July 2026

Prepared for:

City of BRADFORD METROPOLITAN DISTRICT COUNCIL

www.jbaconsulting.com

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Contract

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This report describes work commissioned by City of Bradford Metropolitan District Council (CBMDC) by an instruction dated 19 July 2024. The Client's representative for the contract was Jonathan Dicken of CBMDC. Georgina Williams of JBA Consulting carried out this work.

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1 Background

This is a Level 2 Strategic Flood Risk Assessment (SFRA) site screening report for the City of Bradford Metropolitan District Council (CBMDC) Local Plan Site H231. The content of this Level 2 SFRA site screening report assumes the reader has already consulted the 'CBMDC Level 1 SFRA' (2023) and read the 'CBMDC Level 2 SFRA Main Report' (2026) and is therefore familiar with the terminology used in this report.

1.1 Site H231

- Location: Land and buildings east of Grattan Road
- Existing site use: Brownfield commercial
- Existing site use vulnerability: Less vulnerable
- Proposed site use: Housing
- Proposed site use vulnerability: More vulnerable
- Site area: 0.2 hectares
- Proposed development impermeable area: 0.2 hectares
- Watercourse: Bradford Beck
- CBMDC river model: Bradford Beck 2026
- Summary of requirements from scoping stage:
    - Level 1 SFRA recommendation was for withdrawal from allocation or more detailed assessment through Level 2 SFRA
    - Assessment of modelled fluvial flood depths, velocities and hazards
    - Assessment of surface water flood depths and hazards based on the EA's national Risk of Flooding from Surface Water dataset
    - Assessment of all other sources of flood risk



Figure 1-1: Existing site location boundary

There are areas of higher elevation within the north of the site, sloping towards the south (Figure 1-2).

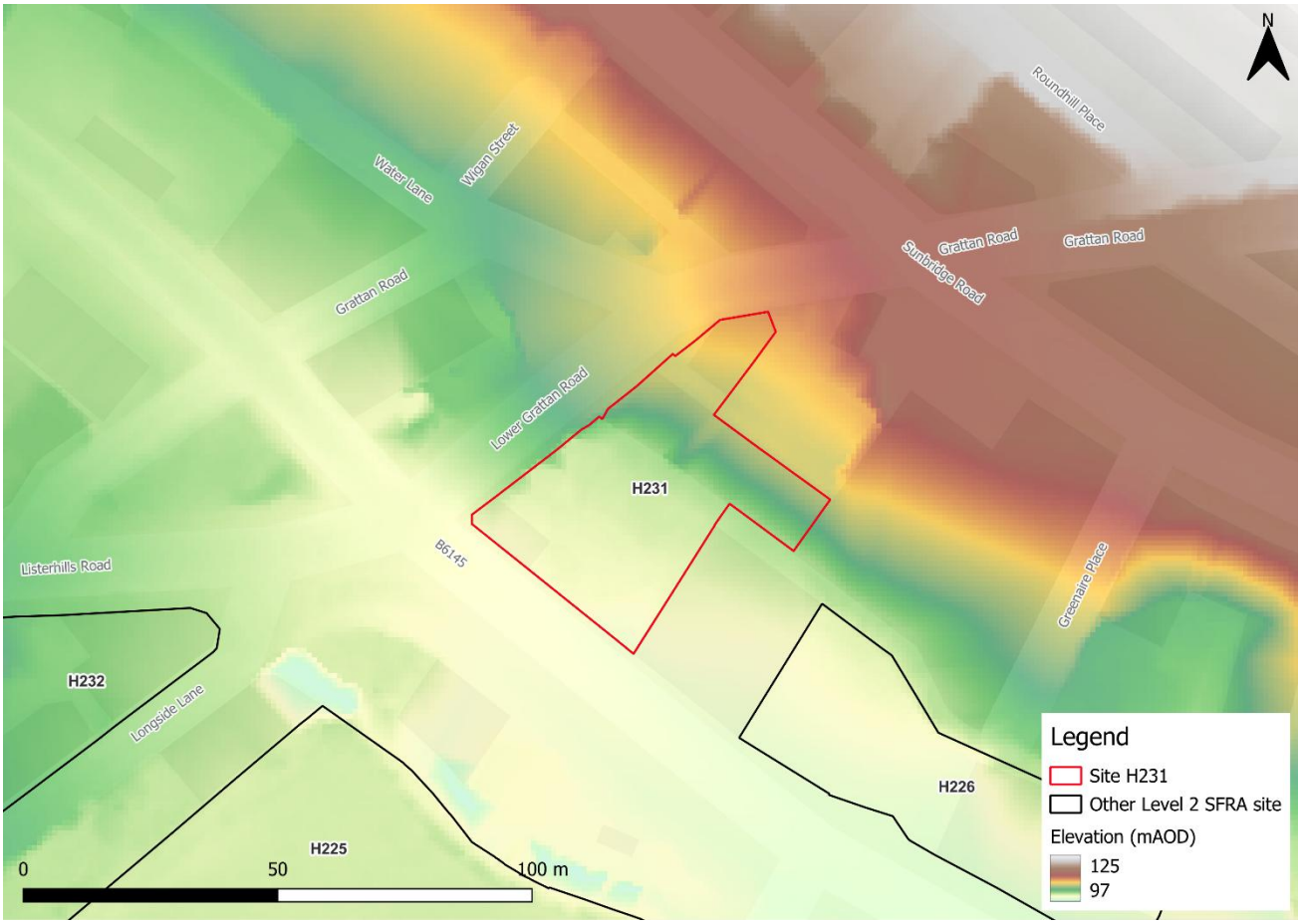


Figure 1-2: Topography

The underlying bedrock within the site is defined as 'Pennine Lower Coal Measures Formation', which comprises mudstone, siltstone, sandstone, coal, ironstone and ferricrete (Figure 1-3). This is overlain with superficial deposits of till. Mudstone, siltstone, coal, ironstone and ferricrete typically have low permeability, however this can be highly variable. Sandstone has a higher permeability.



Figure 1-3: Soils and geology

2 Flood risk from rivers

2.1 Existing risk

2.1.1 Flood Map for Planning and functional floodplain

Based on the EA's Flood Map for Planning (January 2026) and Flood Zone 3b (functional floodplain), as updated in this Level 2 SFRA, the percentage areas of the site within each fluvial flood zone are stated in Table 2-1 and can be viewed on Figure 2-1. This version of the Flood Map for Planning does not consider flood defence infrastructure (Section 2.3).

Fluvial flood risk to the site comes from Bradford Beck to the south of the site. The southern boundary of the site is within Flood Zone 2 and therefore at medium risk.

Table 2-1: Existing fluvial flood risk based on percentage area of site at risk

Flood Zone 1 (% area)	Flood Zone 2 (% area)	Flood Zone 3a (% area)	Flood Zone 3b (% area)
95	5	0	0



Figure 2-1: Existing risk from rivers to the site

2.1.2 Bradford Beck 2026 model outputs - present day

Figure 2-2 shows the modelled flood depths for the 0.1% AEP undefended event. Modelled risk to the site is less than that shown by Flood Zone 2, however it is noted that the Flood Map for Planning has not been updated to account for the latest Bradford Beck model outputs.



Figure 2-2: Flood depths for 0.1% AEP undefended flood event

2.2 Impacts from climate change

The EA's SFRA guidance states that SFRAs should assess the central allowance for less vulnerable, more vulnerable, highly vulnerable and water compatible development (Table 2-2). The impacts of climate change on flood risk from the Bradford Beck 2026 model have been modelled without flood defence infrastructure in place. As documented in Section 2.3.1, there are no formal engineered defences that would benefit the site.

Table 2-2: Modelled climate change allowances for peak river flows for the Aire and Calder Management Catchment

Return period (AEP event)	Central allowance 2080s (% increase)	Higher central allowance 2080s (% increase)	Upper end allowance 2080s (% increase)
3.3% (functional floodplain)	23%	31%	51%
1%	23%	31%	51%
0.1%	23%	31%	51%

2.2.1 Bradford Beck 2026 model outputs - present day

Figure 2-3 shows the onsite model flood depths for the 0.1% AEP undefended event plus the central climate change allowance. This event impacts the southeastern boundary of the site. Greatest flood depths are shown to be shallow at < 0.15 m. Maximum velocities within the site are between 0.5 and 1 m^3/s (Figure 2-4), with areas of hazard categorised as 'very low' (Figure 2-5). Safe access and escape routes would likely be achievable via Lower Grattan Road to the west of the site.



Figure 2-3: Flood depths for 0.1% AEP undefended flood event +23% (central climate change allowance)

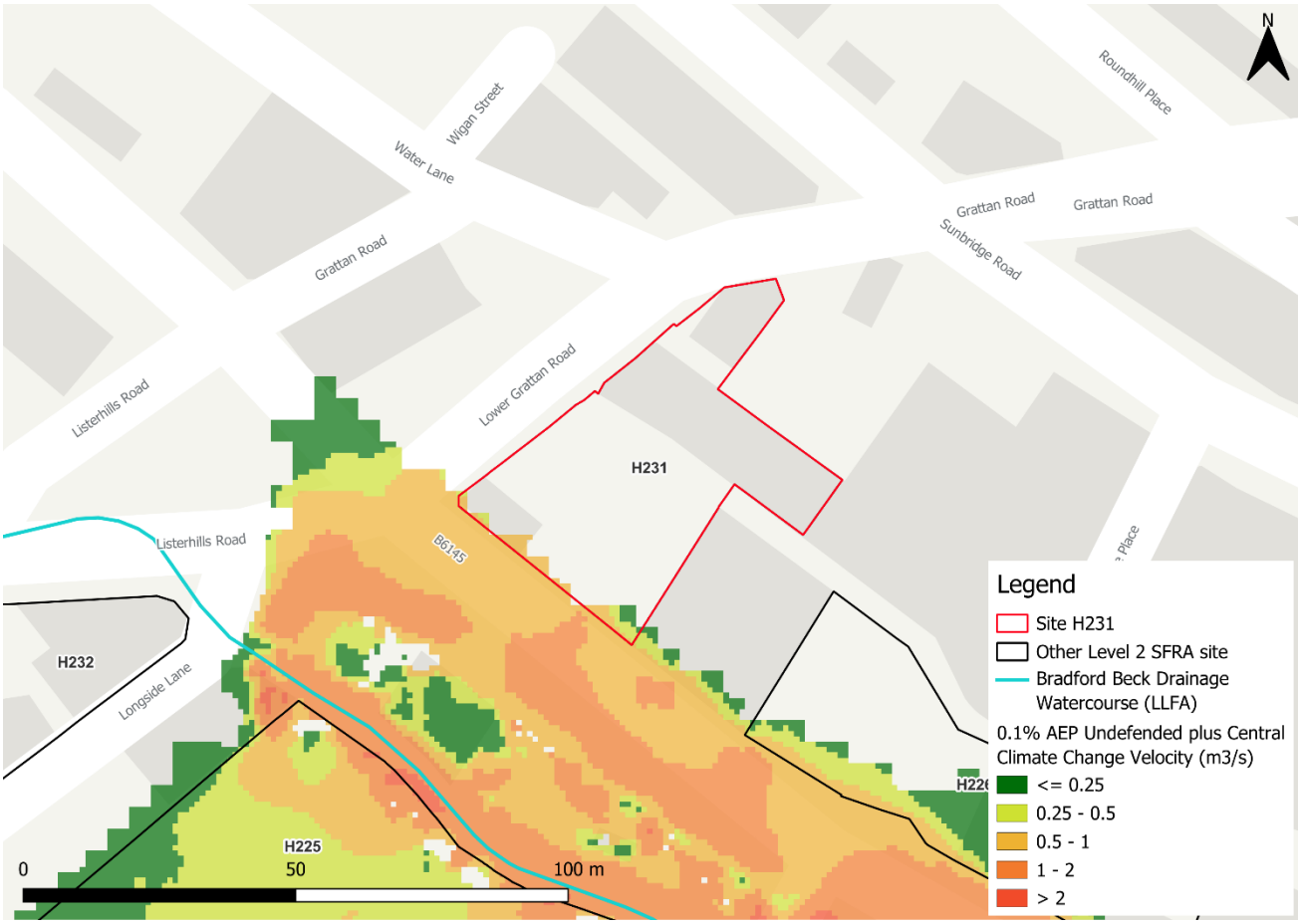


Figure 2-4: Flood velocities for 0.1% AEP undefended flood event +23% (central climate change allowance)

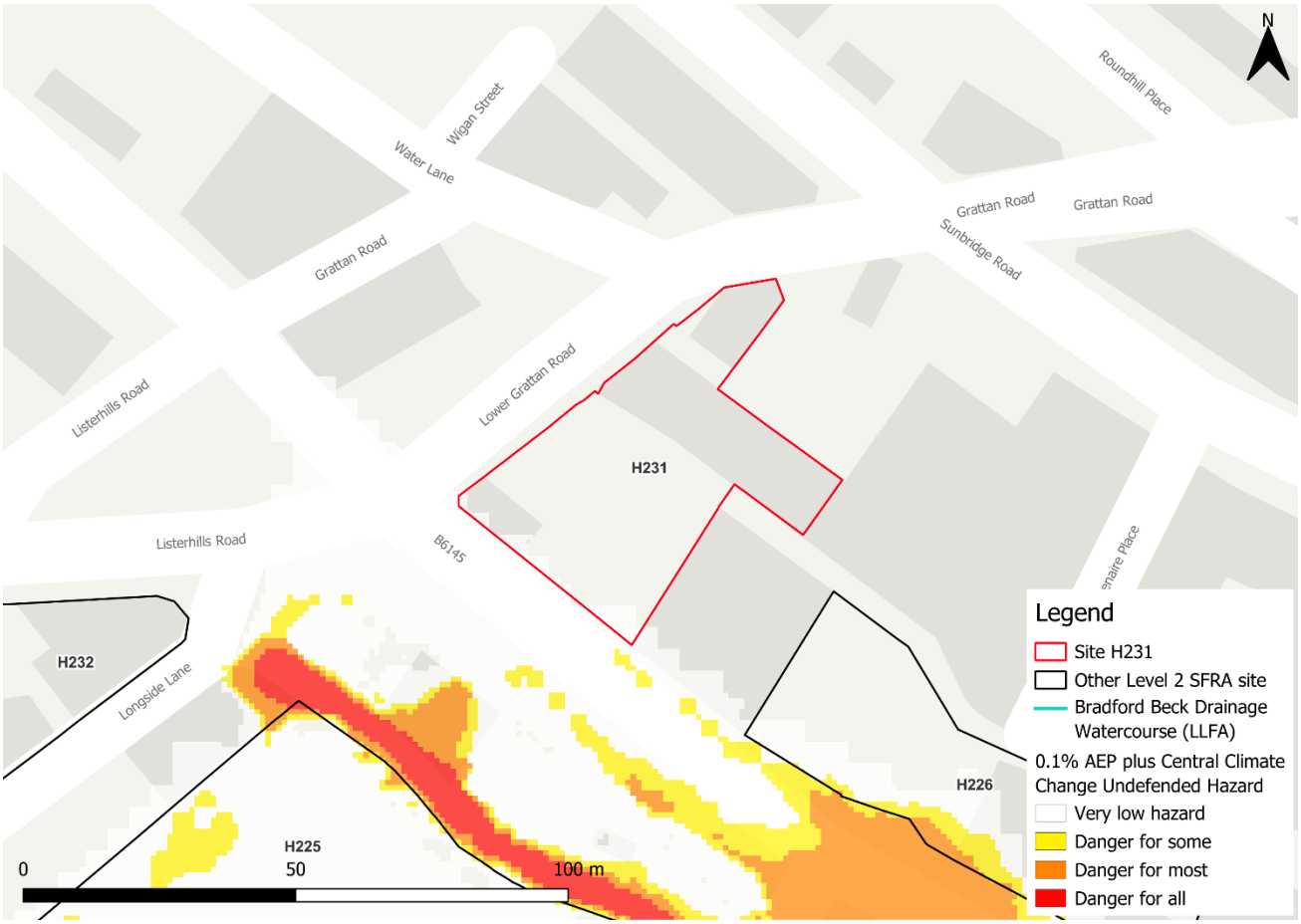


Figure 2-5: Flood hazard for 0.1% AEP undefended flood event +23% (central climate change allowance)

2.2.2 Flood Map for Planning - Climate Change

Climate change data in this area is unavailable from the EA's Flood Map for Planning plus Climate Change (2070-2125) dataset, as shown in Figure 2-6.

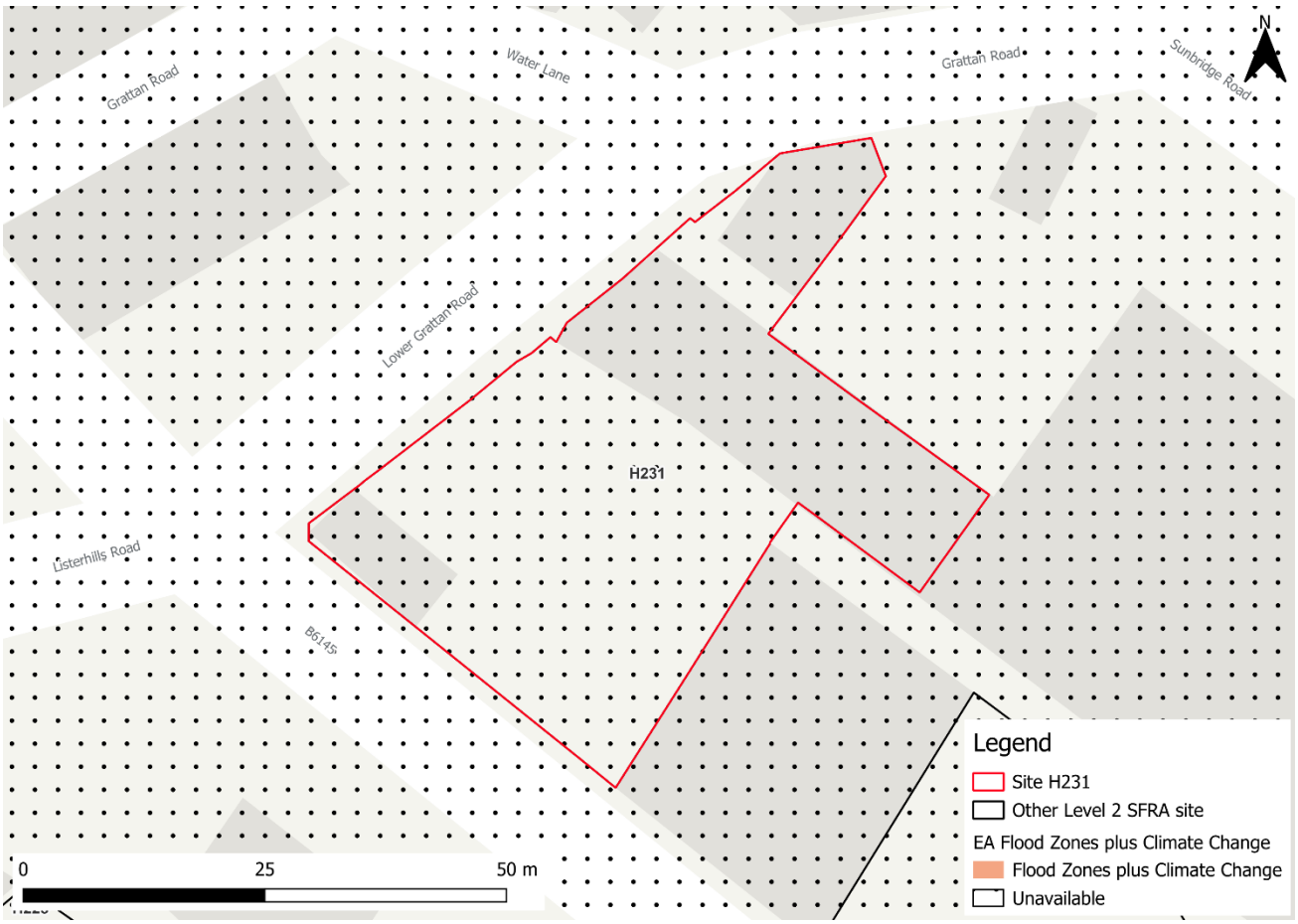


Figure 2-6: EA Flood Zones plus Climate Change

2.3 Flood risk management

2.3.1 Flood defences

The site does not benefit from any formal engineered flood defences, according to the EA's spatial flood defences dataset.

2.3.2 Working with Natural Processes

The EA's Working with Natural Processes (WwNP) dataset has been interrogated to identify opportunities for Natural Flood Management (NFM) to reduce flood risk to the site and surrounding areas. There are no applicable areas that could benefit the site.

2.4 Historic flood incidents

The EA's Historic Flood Map (HFM) and Recorded Flood Outlines (RFO) datasets have been considered. There are no recorded historic flood events at the site.

2.5 Emergency planning

2.5.1 Flood warnings

The EA operates a Flood Warning Service for properties located within a Flood Warning Area (FWA) for when a flood event is expected to occur. An area in the south of site is located within a FWA, namely 123FWF785 - Bradford Beck and tributaries at Bradford.

Flood alerts may be issued before a flood warning for properties located within a Flood Alert Area (FAA) to provide advance notice of the possibility of flooding. A flood alert may be issued when there is less confidence that flooding will occur in a FWA. An area in the south of site is also located within a FAA, namely 123WAF961 - Middle River Aire catchment.

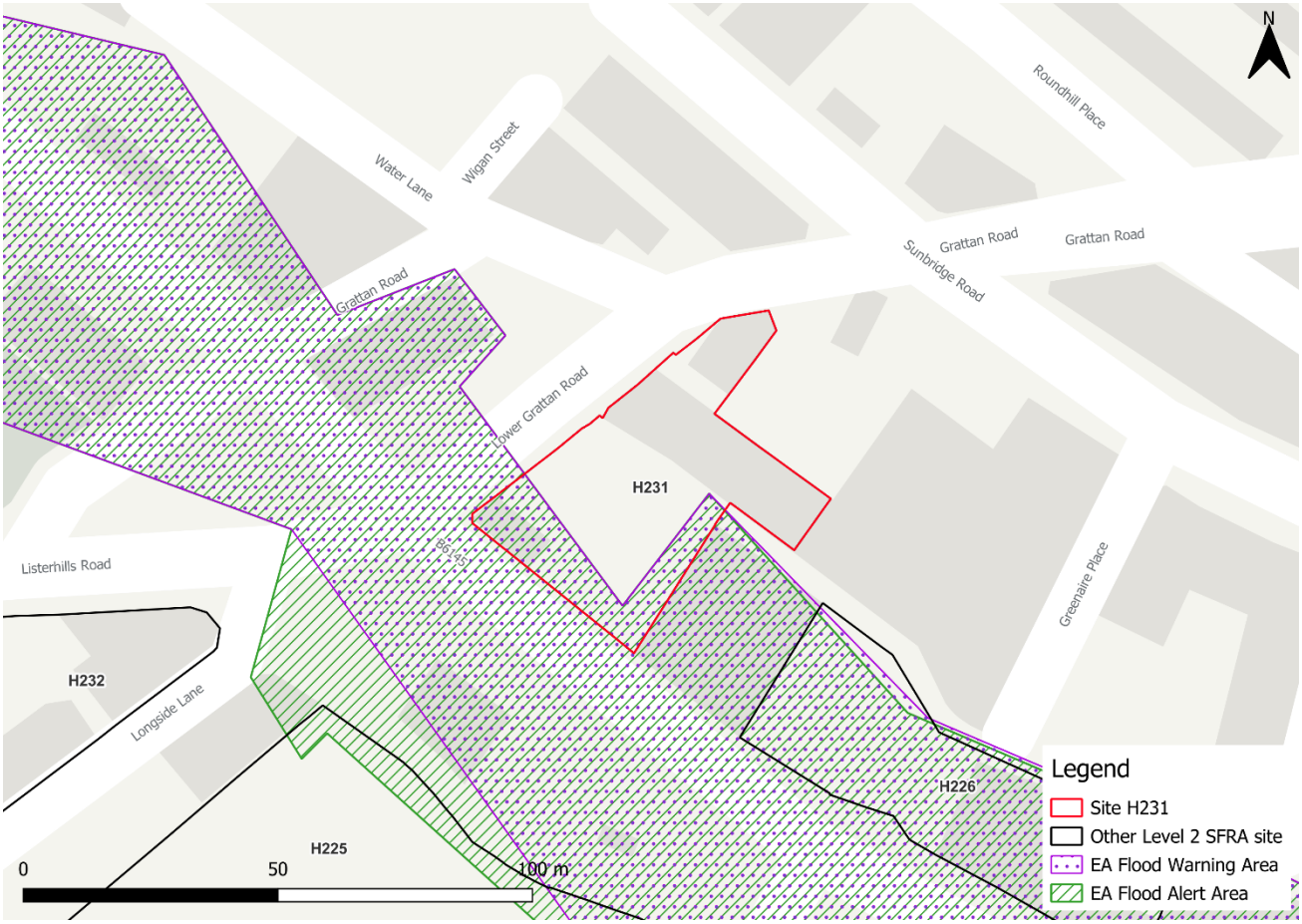


Figure 2-7: EA Flood Warning Areas and Flood Alert Areas

2.5.2 Access and escape routes

Based on available information, safe access and escape routes would likely be achievable via Lower Grattan Road to the west of the site (Figure 2-8).



Figure 2-8: Potential access and escape routes

2.6 Observations, mitigation options, site suitability and sequential approach to development management - fluvial

- Observations:
  - The proposed development of the site would see a change in the risk classification from less vulnerable to more vulnerable, according to the NPPF.
  - Given the change in use and therefore vulnerability of the site, the LPA must consider whether the change of use is acceptable and whether the development can be designed to be safe, including for adequate emergency planning provision, accounting for the information provided in this Level 2 SFRA (para 014 FRCC-PPG).
  - The majority of the site is located within Flood Zone 1. Development should be directed to the area of the site within Flood Zone 1.
  - There is a small proportion within the south of the site located within Flood Zone 2. However, the Flood Map for Planning has not been updated with the Bradford Beck 2026 model outputs. The latest modelling shows that the site is not at present day risk from Bradford Beck in the 0.1% AEP undefended event.

- The southern boundary of the site is situated within the extreme 0.1% AEP undefended event plus the central climate change allowance, however depths in this area are very low.

- Mitigation:
  - EA flood alerts should continue to be in place to ensure early evacuation of site users before an extreme flood event occurs.
- Access and escape:
  - Safe access and escape routes would likely be achievable via Lower Grattan Road to the west of the site.

3 Flood risk from surface water

3.1 Existing risk

At the time of writing, the EA's latest national Risk of Flooding from Surface Water (RoFSW) does not include depth and hazard information suitable for planning purposes. Therefore, this Level 2 SFRA considers the third generation RoFSW depth and hazard mapping in addition to the NaFRA2 extents, as agreed with the EA. Surface water depth and hazard should be confirmed at the site-specific FRA stage.

3.1.1 Risk of Flooding from Surface Water - NaFRA2 extents

Based on the EA's national scale RoFSW map (January 2026), surface water risk to the site is predominantly low, as shown in Table 3-1.

In the high and medium risk events, surface water risk is confined to a flow path through the north of the site and an area of ponding along the southern site boundary. In the low risk event, surface water risk is clearly constrained by the existing development onsite. Safe access and escape routes should be achievable via Lower Grattan Road to the west of the site.

Table 3-1: Existing surface water flood risk based on percentage area at risk using the RoFSW map

Very low risk (% area)	Low risk (% area)	Medium risk (% area)	High risk (% area)
50	39	7	4

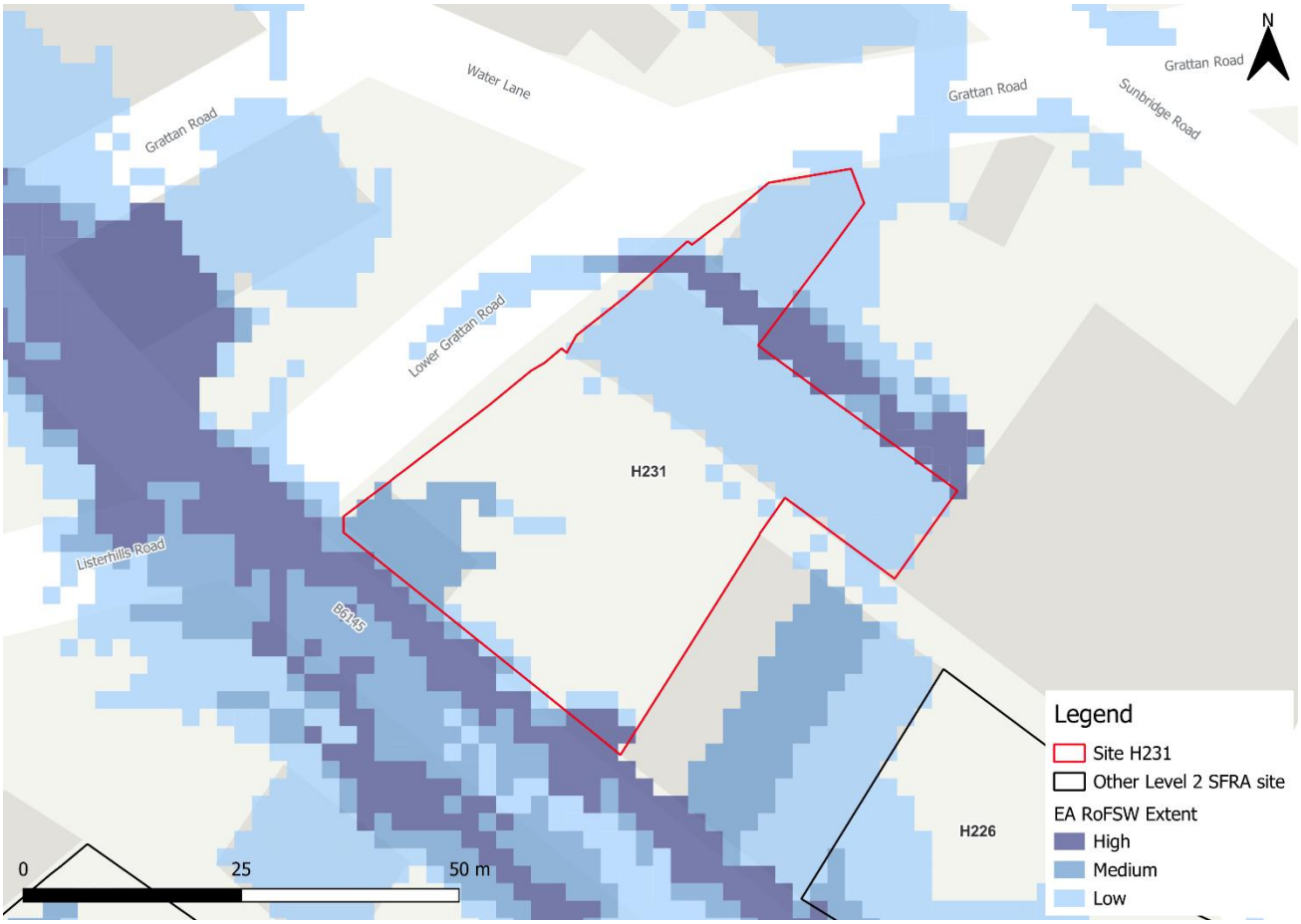


Figure 3-1: Surface water flood extents (NaFRA2 - Risk of Flooding from Surface Water map)

3.1.2 Risk of Flooding from Surface Water - third generation depths and hazards

Based on the EA's national scale third generation RoFSW map, the greatest flood depths within the site in the medium risk event are between 0.3 and 0.6 m (Figure 3-2), with areas of hazard categorised as 'significant' (Figure 3-3). Safe access and escape routes would likely be achievable via Lower Grattan Road to the west of the site given the low modelled flood depths along this route.

There are differences between the NaFRA2 RoFSW map and the third-generation depth and hazard mapping. The NaFRA2 RoFSW map does not include most watercourse channels. Additionally, the NaFRA2 RoFSW map does not map flooding less than 0.075m (7.5cm) in depth. Therefore, where the map may show no flooding, there may be shallow flooding up to a depth of 0.075m. In contrast, the third generation RoFSW does not map flooding with a hazard rating of less than 0.575. This could explain the differences observed between the NaFRA2 and third generation RoFSW. Assessment of surface water should be carried out at the site-specific FRA stage to robustly establish current and future surface water flood risk conditions.

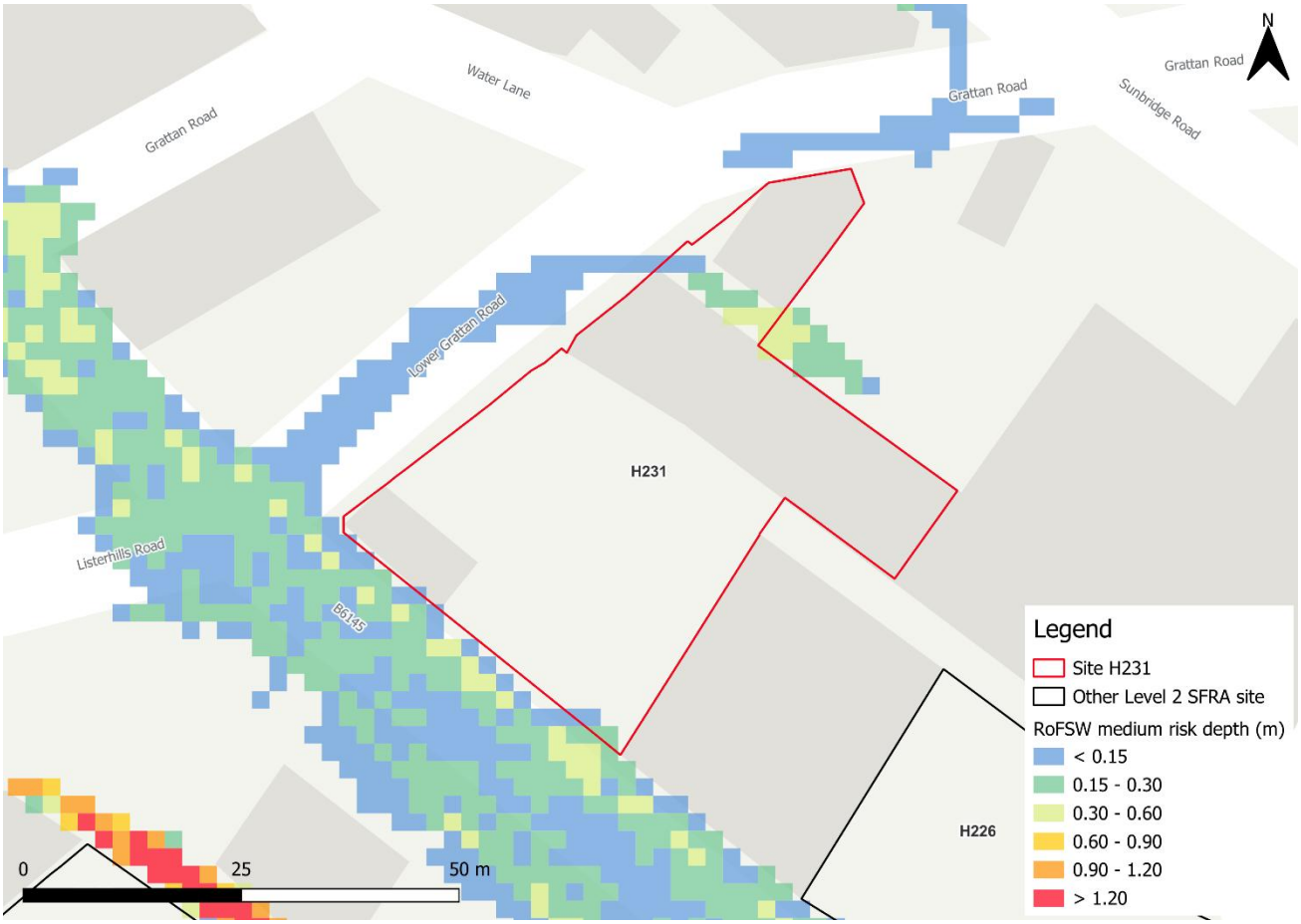


Figure 3-2: Medium risk event surface water flood depths (Risk of Flooding from Surface Water map)

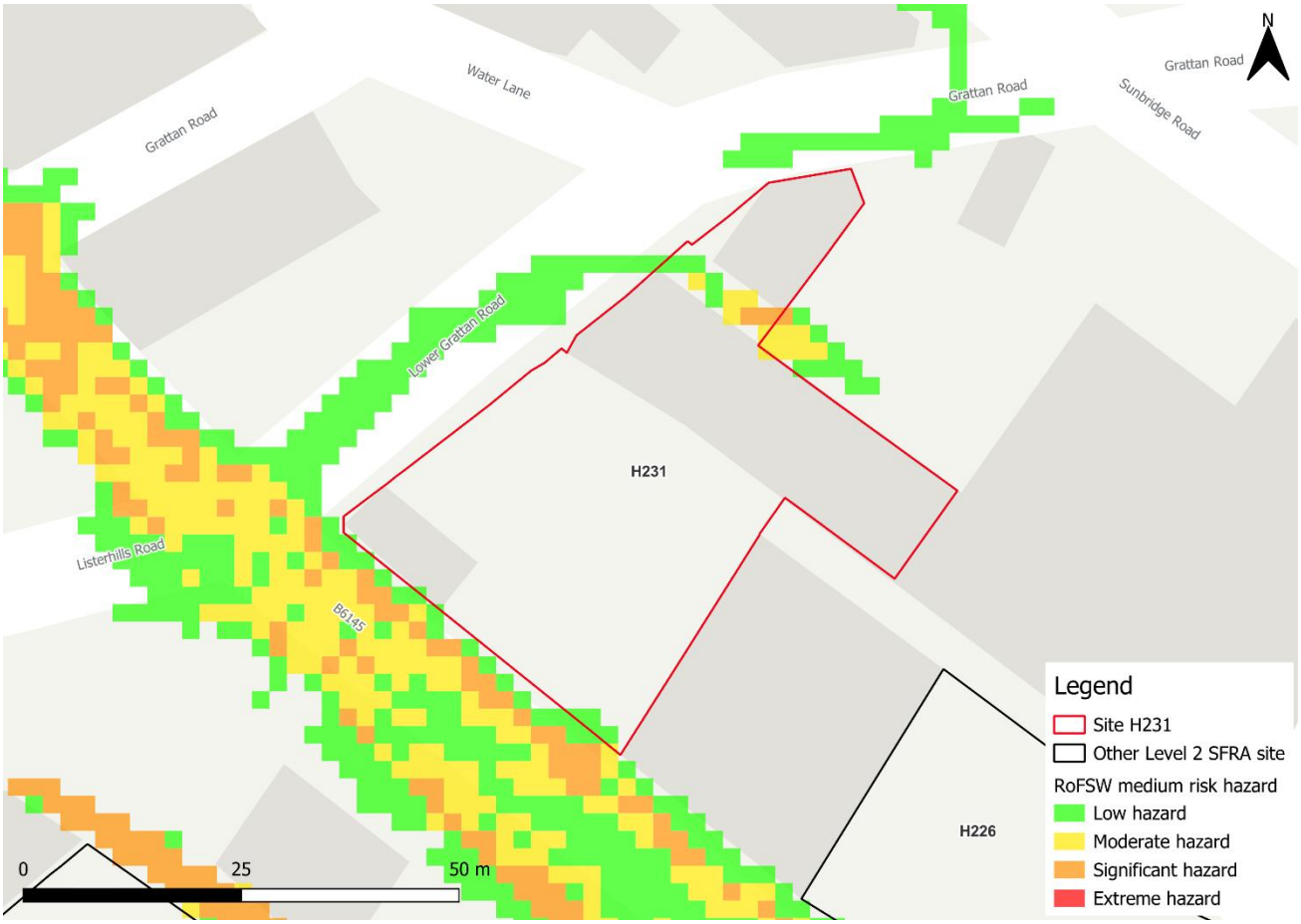


Figure 3-3: Medium risk event surface water flood hazard[1] (Risk of Flooding from Surface Water map)

3.2 Impacts from climate change

At the time of writing, the available national surface water climate change mapping is unsuitable for consideration in development planning. This Level 2 SFRA considers the low risk surface water event as a conservative proxy for the medium risk event plus climate change, as agreed with the EA. The impact of climate change on surface water flood risk should be considered at the site-specific FRA stage.

Using the low risk event as a proxy, the medium risk surface water event is likely to increase significantly in extent when accounting for climate change (Figure 3-4). The third generation mapping indicates maximum flood depths are modelled to increase to between 0.6 and 0.9 m (Figure 3-5), with areas of hazard categorised as 'significant' (Figure 3-6). Safe access and escape routes should remain achievable via Lower Grattan Road to the west of the site, given the low modelled flood depths along this route.

1 Based on Section 7.5 Hazard rating. What is the Risk of Flooding from Surface Water map? Report version 2.0. April 2019. Environment Agency

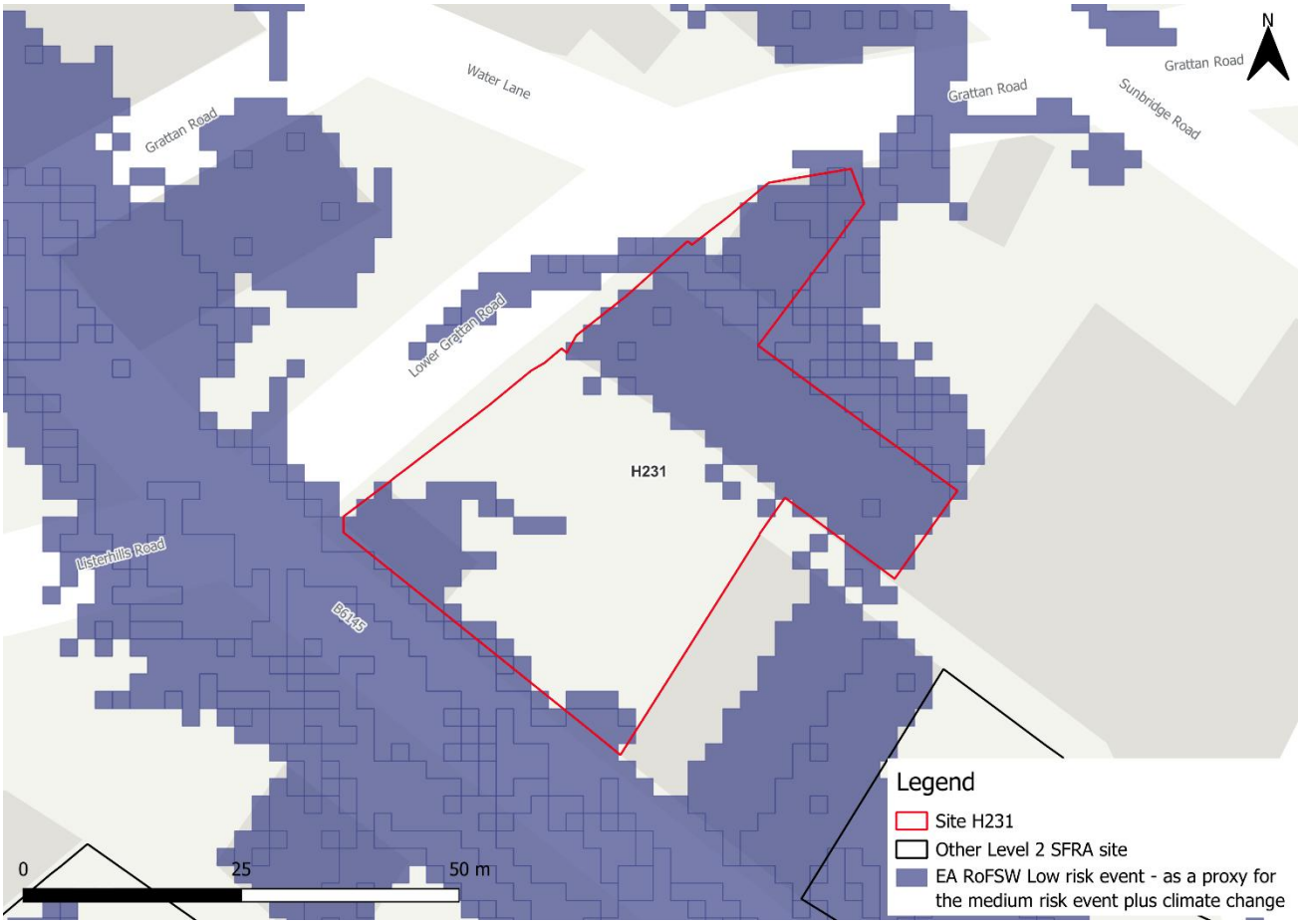


Figure 3-4: Low risk event surface water flood extent, as a proxy for the medium risk event plus climate change (NaFRA2 - Risk of Flooding from Surface Water map)

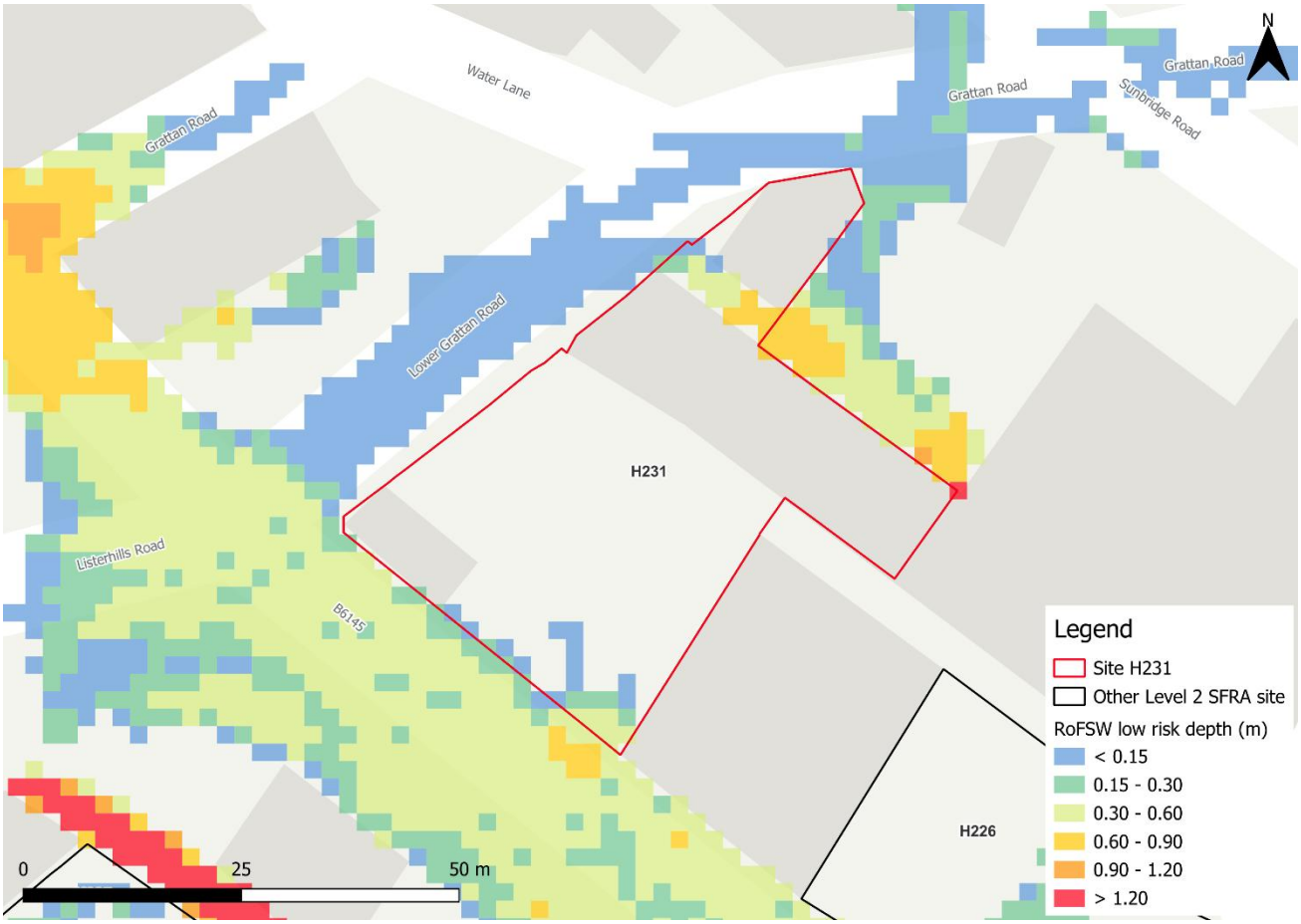


Figure 3-5: Low risk event surface water flood depths, as a proxy for the medium risk event plus climate change (Third generation - Risk of Flooding from Surface Water map)

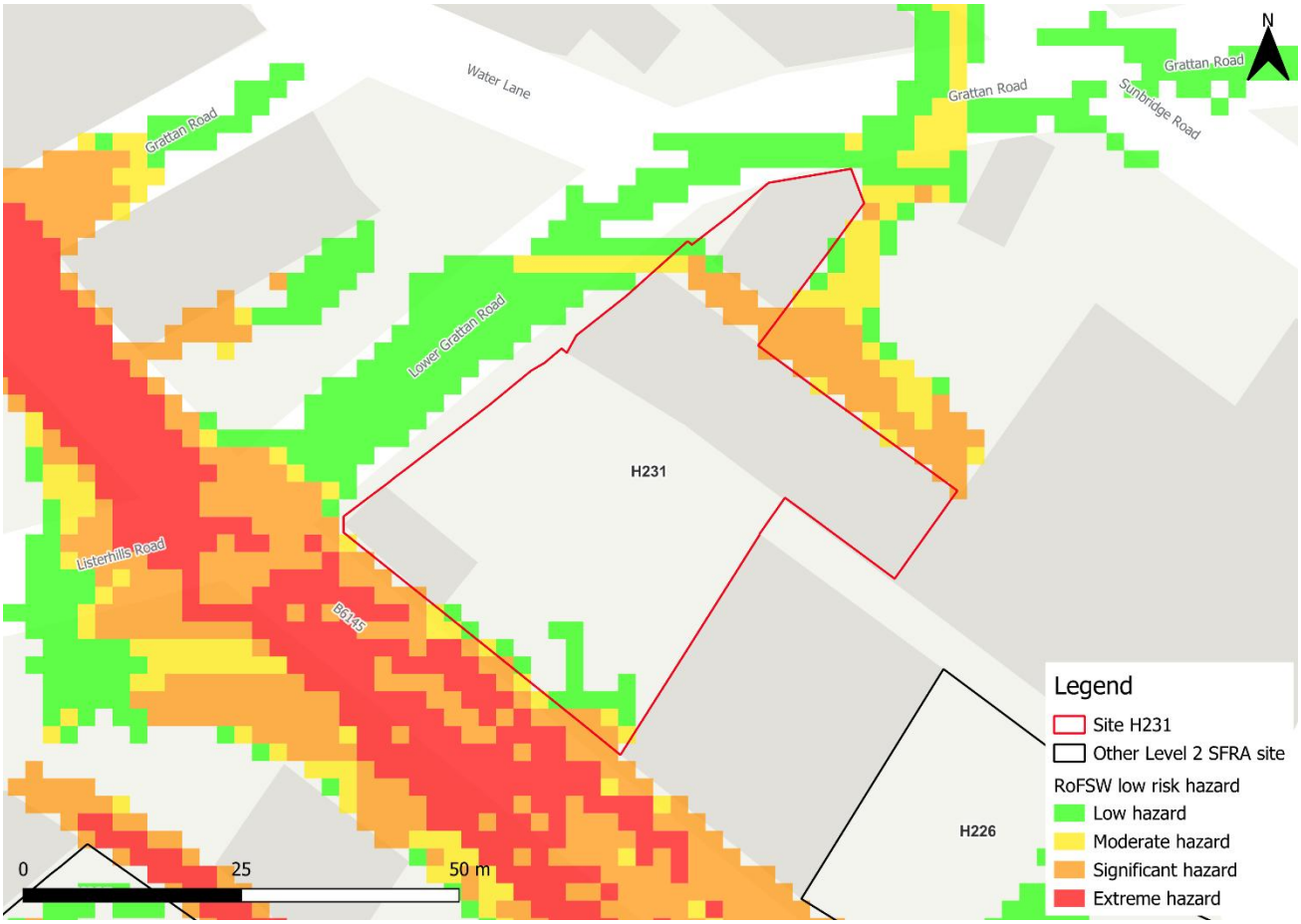


Figure 3-6: Low risk event surface water flood hazard, as a proxy for the medium risk event plus climate change (Third generation - Risk of Flooding from Surface Water map)

3.3 Observations, mitigation options and site suitability - surface water

- Current risk to the site is predominantly very low with 39% of the site being at low surface water flood risk. Surface water risk in the high and medium risk events is confined to a flow path through the north of the site and an area of ponding along the southern site boundary.
- The effects of climate change on surface water have not been modelled for this SFRA; however, the low risk surface water event has been used as a proxy for the medium risk event plus climate change. In this event, there is a significant additional area of ponding within the north of the site. Surface water risk in this event is constrained by the existing development present onsite.
- It is assumed that the existing buildings present onsite are to be demolished prior to new development. Any change in site layout where current buildings are to be demolished and changes to road layouts will require detailed surface water modelling to ascertain flow routes and low-lying areas.
- Topographic low spots and flow paths should be considered and included in site design and ideally left in place to flood naturally when required.
- Safe access and escape routes should be possible via Lower Grattan Road to the west of the site.

- The drainage strategy must ensure there is no increase in surface water flood risk elsewhere as a result of new development. Existing brownfield rates will likely apply, though the developer should consult local LLFA guidance and the National SuDS guidance. The drainage strategy should also demonstrate how the surface water flood risk currently constrained by the existing development present onsite, will be retained onsite.
- Assessment of the current drainage system in place should be carried out to ascertain any current capacity issues and whether the current system could accommodate the proposed residential development or whether further capacity will be required.
- The RoFSW map is not suitable for identifying whether an individual property will flood and is therefore indicative. The RoFSW map is not appropriate to act as the sole evidence for any specific planning or regulatory decision or assessment of risk in relation to flooding at any scale without further supporting studies or evidence.

4 Risk from groundwater

Risk of groundwater emergence is assessed in this SFRA using JBA's 5m Groundwater Emergence Map. This dataset is recommended for use by the EA in the SFRA Good Practice Guide[2]. Figure 4-1 shows the map covering this site and the surrounding areas and Table 4-1 explains the risk classifications.

The entire site is located within an area where there is no risk of groundwater emergence. Groundwater conditions may therefore be suited to infiltration SuDS, however the bedrock geology of the site indicates the permeability may be low (Figure 1-3). Therefore, the type of infiltration SuDS needs to be considered further through the drainage strategy.



Figure 4-1: JBA 5m Groundwater Emergence Map

2 Strategic flood risk assessment good practice guide. ADEPT. December 2021.

Table 4-1: Groundwater Hazard Classification

Groundwater head difference (m)*	Class label
0 to 0.025	Groundwater levels are either at very near (within 0.025m of) the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
0.025 to 0.5	Groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
0.5 to 5	Groundwater levels are between 0.5m and 5m below the ground surface in the 100-year return period flood event There is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.
>5	Groundwater levels are at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater is not likely.
N/A	No risk. This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.
*Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.	

5 Residual risk

Although a site may be afforded some protection from defences and / or drainage infrastructure, there is always a residual risk of flooding from asset failure i.e. defence breaches, or blockages of culverts or drainage assets. Potential residual risk at this site comes from the potential blockage or structural failure of the culvert beneath Tumbling Hill Street to the south of the site.

5.1 Potential blockage

A blockage or failure of the structure beneath Tumbling Hill Street may cause water in the channel to back up and cause flooding to the site, depending on the severity of the blockage and the magnitude of the flood event. Culvert course and condition surveys may be required, including for consultation with the culvert owner.

The Bradford Beck 2026 model includes for a scenario in which all culverts within the model are blocked by 50%. Figure 5-1 shows the modelled flood depths for this scenario. There is no modelled risk to the site when considering a 50% blockage of the structure. However, there may be a greater residual risk posed to the site if a higher blockage proportion was modelled, including a structural failure of the asset. This should be modelled as part of the site-specific FRA.



Figure 5-1: Flood depths for 1% AEP undefended flood event 50% culvert blockage scenario - structure beneath Tumbling Hill Street

5.2 Flood risk from reservoirs

The EA's Reservoir Flood Maps (RFM) (2021) show where water may go in the unlikely event of a reservoir or dam failure. Figure 5-2 shows the RFM in a 'dry day' and 'wet day' scenario. A 'dry day' scenario assumes that the water level in the reservoir is the same as the spillway level or the underside of the roof for a service reservoir and the watercourses upstream and downstream of the reservoir are at a normal level. A 'wet day' scenario assumes a worst-case scenario where a reservoir releases water held on a 'wet day' when local rivers have already overflowed their banks.

The site is potentially at risk from four reservoirs located in Bradford. Of these four reservoirs, two are operated by Yorkshire Water Services Ltd whilst two are operated by the City of Bradford Metropolitan District Council.

The EA's SFRA guidance states that where a proposed development site is at flood risk from a reservoir, then an assessment into whether the reservoir design or maintenance schedule needs improving should be carried out. Expert advice may be required from an all-reservoirs panel engineer. The Council should consult the relevant reservoir undertaker to ascertain whether the proposed development could affect the reservoir's risk designation, its design category or how it is operated. The Council, as category 1 responders, can

access more detailed information about reservoir risk and reservoir owners using the Resilience Direct system.

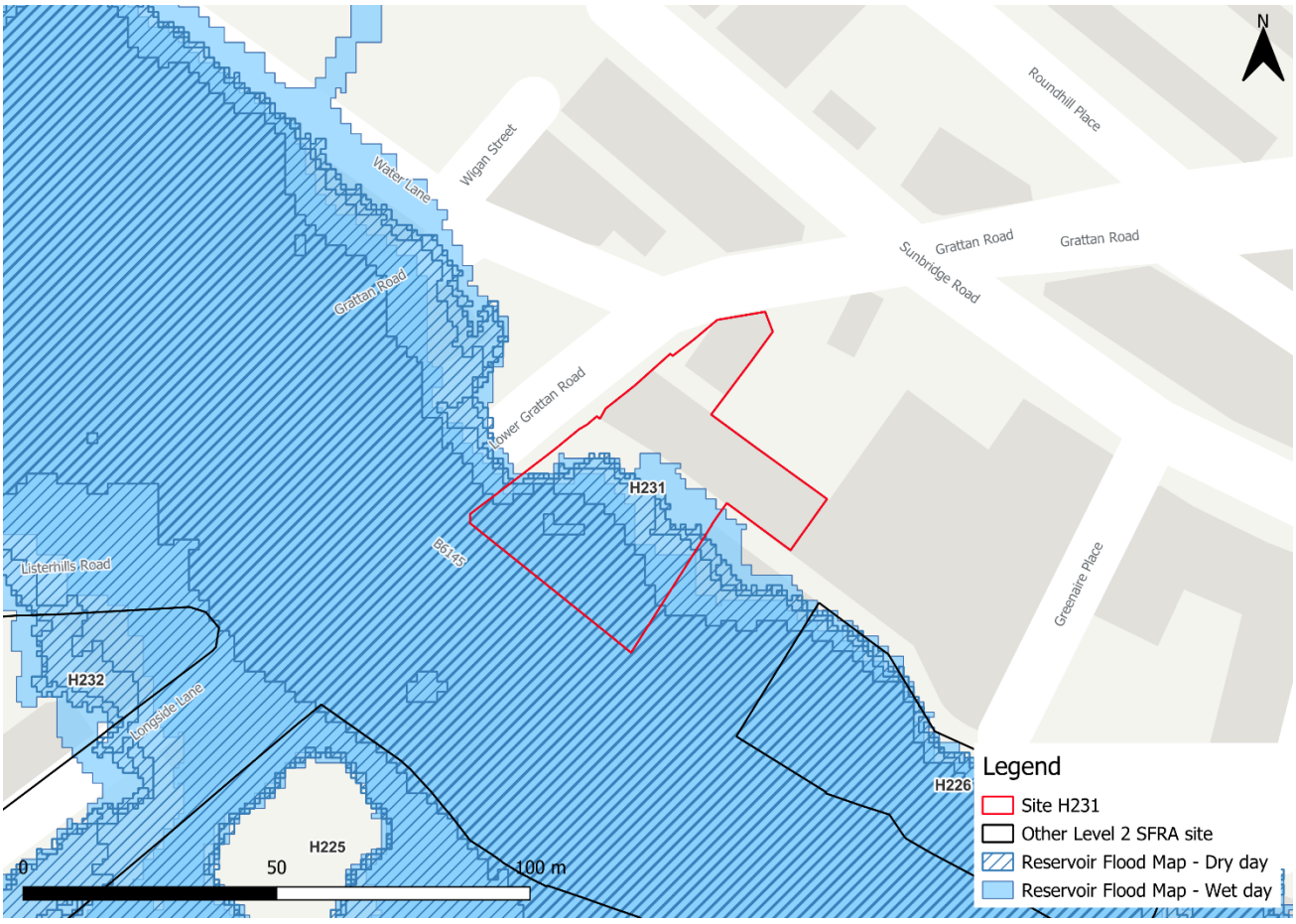


Figure 5-2: Flood risk from reservoirs

5.3 Observations, mitigation options and site suitability - residual risk

- The site is at potential residual risk from a structural failure or 100% blockage of the culvert beneath Tumbling Hill Street to the south of the site. The available modelled 50% culvert blockage scenario indicates that there is unlikely to be significant additional impacts to the site. The site-specific FRA could consider modelling a higher blockage proportion to understand whether there would be any additional risk to the site.
- Areas adjacent to culverts and bridges are at particular risk from the rapid onset of fast flowing and deep flooding, with little or no warning if structures become blocked. Emergency plans must be in place for such areas and safe access and escape routes must be in place for the lifetime of development. Resistance and resilience measures may also need to be put in place to manage residual flood risk when avoidance measures have been exhausted.
- The LPA should use the information on residual risk in this Level 2 SFRA to state in the local plan strategic policies a preferred mitigation strategy for ensuring development will be safe throughout its lifetime in relation to urban form, risk

management and where flood mitigation measures are likely to have wider sustainable design implications (para 042, FRCC-PPG).

- The site is at potential residual risk from a breach of four reservoirs. All four reservoirs impact the site in the 'dry day' flood extent. However, only Upper Chellow and Lower Chellow are modelled to impact the site based on the 'wet day' flood extent, which represents a prediction of the credible worst case scenario, therefore it's unlikely that any actual flood would be this large.
- Given the potential reservoir risk to the site, developers should consider[3]:
  - Consulting with the local resilience forum for advice on emergency planning,
  - Consulting with relevant reservoir owners to understand the impact development may have on their reservoirs, and
  - Using this Level 2 SFRA to understand whether any proposed development will be safe throughout its lifetime.

3 Reservoir flood maps: when and how to use them | Environment Agency | 2021

6 Overall site assessment

6.1 Can part b) of the exception test be passed?

This site is not required to pass part b) of the exception test[4] as it is located within Flood Zone 1, however it must still be proven that the development can be safe for its lifetime, which is generally considered to be 100 years for residential development.

6.2 Recommendations summary

Based on the evidence presented in the Level 1 SFRA (2023) and this Level 2 SFRA:

- It should be appropriate to develop this site for more vulnerable purposes given its location largely within Flood Zone 1 and low surface water flood risk.
- The impact of climate change on surface water should be modelled at the site-specific FRA stage to understand how surface water flood risk may affect the site and proposed access and escape routes in the future.
- A detailed drainage strategy will be required at the planning application stage for any new development. This should demonstrate that there will be no increase in surface water flood risk offsite as a result of the demolition of the existing buildings on site and the new development.

6.3 Site-specific FRA requirements and further work

At the planning application stage, the following should be considered:

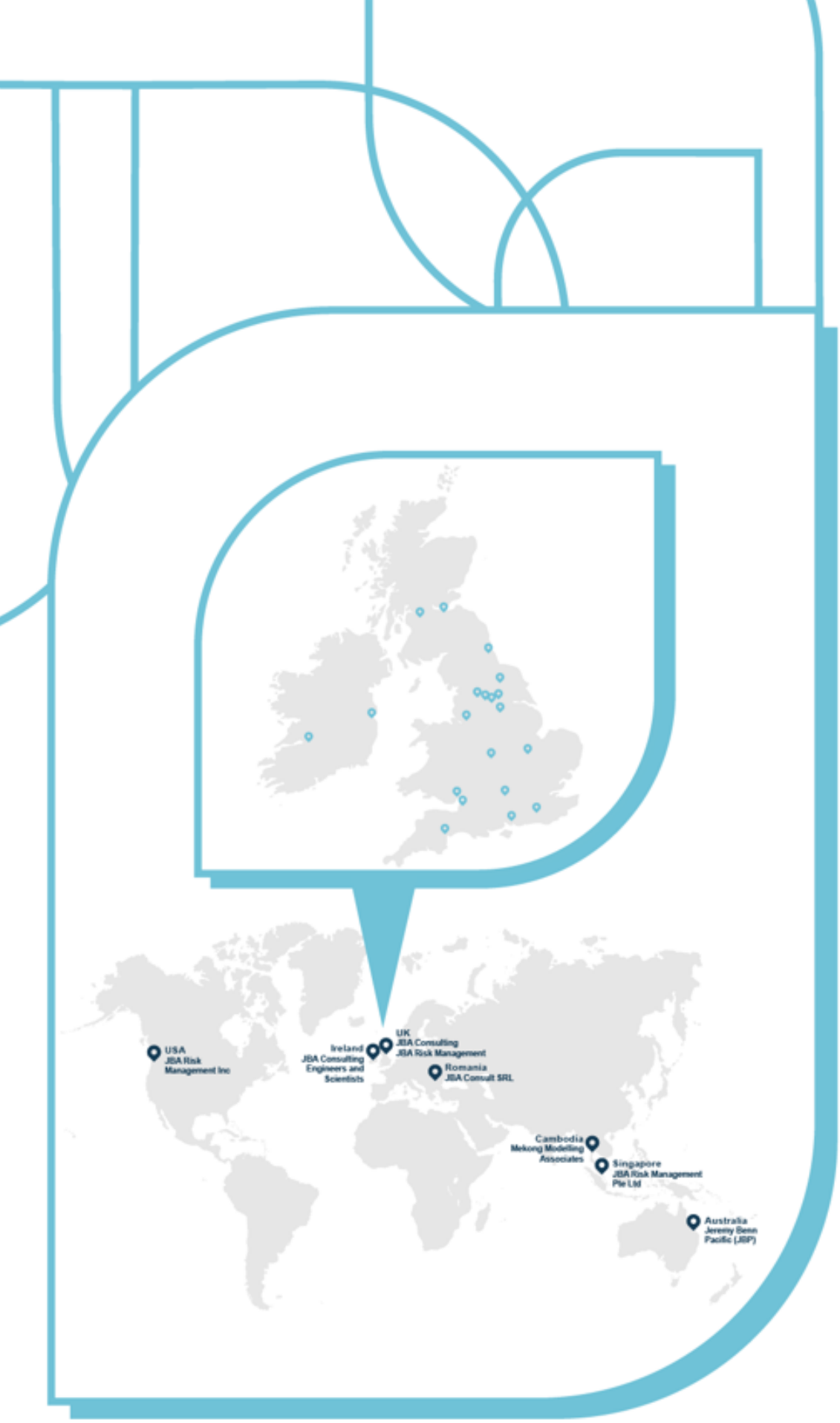
- Further modelling to understand the impacts of climate change on surface water flood risk to the site.
- Further modelling to understand the impacts of an 100% blockage scenario of the Tumbling Hill Street culvert to the south of the site.
- A condition assessment of the culvert beneath Tumbling Hill Street.
- Consultation with the relevant reservoir owners to understand the impact of development on reservoir risk designation.
- Any FRA should be carried out in line with the latest versions of the NPPF; FRCC-PPG; EA guidance; the CBMDC Local Plan and national and local SuDS policy and guidelines.
- Throughout the FRA process, consultation should be carried out with the following, where applicable, the local planning authority; the lead local flood authority; emergency planning officers; the Environment Agency; Yorkshire Water; the highways authorities; and the emergency services.

4 Para 178 National Planning Policy Framework 2024

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Bradford Level 2 Strategic Flood Risk Assessment - Site H232

Final Draft

July 2026

Prepared for:

City of BRADFORD METROPOLITAN DISTRICT COUNCIL

www.jbaconsulting.com

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Contract

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This report describes work commissioned by City of Bradford Metropolitan District Council (CBMDC) by an instruction dated 19 July 2024. The Client's representative for the contract was Jonathan Dicken of CBMDC. Georgina Williams of JBA Consulting carried out this work.

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1 Background

This is a Level 2 Strategic Flood Risk Assessment (SFRA) site screening report for the City of Bradford Metropolitan District Council (CBMDC) Local Plan Site H232. The content of this Level 2 SFRA site screening report assumes the reader has already consulted the 'CBMDC Level 1 SFRA' (2023) and read the 'CBMDC Level 2 SFRA Main Report' (2026) and is therefore familiar with the terminology used in this report.

1.1 Site H232

- Location: Listerhills Road
- Existing site use: Mixed use; commercial and residential
- Existing site use vulnerability: More vulnerable
- Proposed site use: Residential
- Proposed site use vulnerability: More vulnerable
- Site area: 1.3 hectares
- Proposed development impermeable area: 1.19 hectares
- Watercourse: Bradford Beck
- CBMDC river model: Bradford Beck 2026
- Summary of requirements from scoping stage:
    - Level 1 SFRA recommendation was for withdrawal from allocation or more detailed assessment through Level 2 SFRA
    - Assessment of modelled fluvial flood depths, velocities and hazards
    - Assessment of all other sources of flood risk



Figure 1-1: Existing site location boundary

The topography of the site is varied, with higher elevation in the west of the site which steeply slopes down towards Bradford Beck in the east (Figure 1-2). The area adjacent to Bradford Beck in the east of the site is approximately 11m lower in elevation than the western areas of the site.

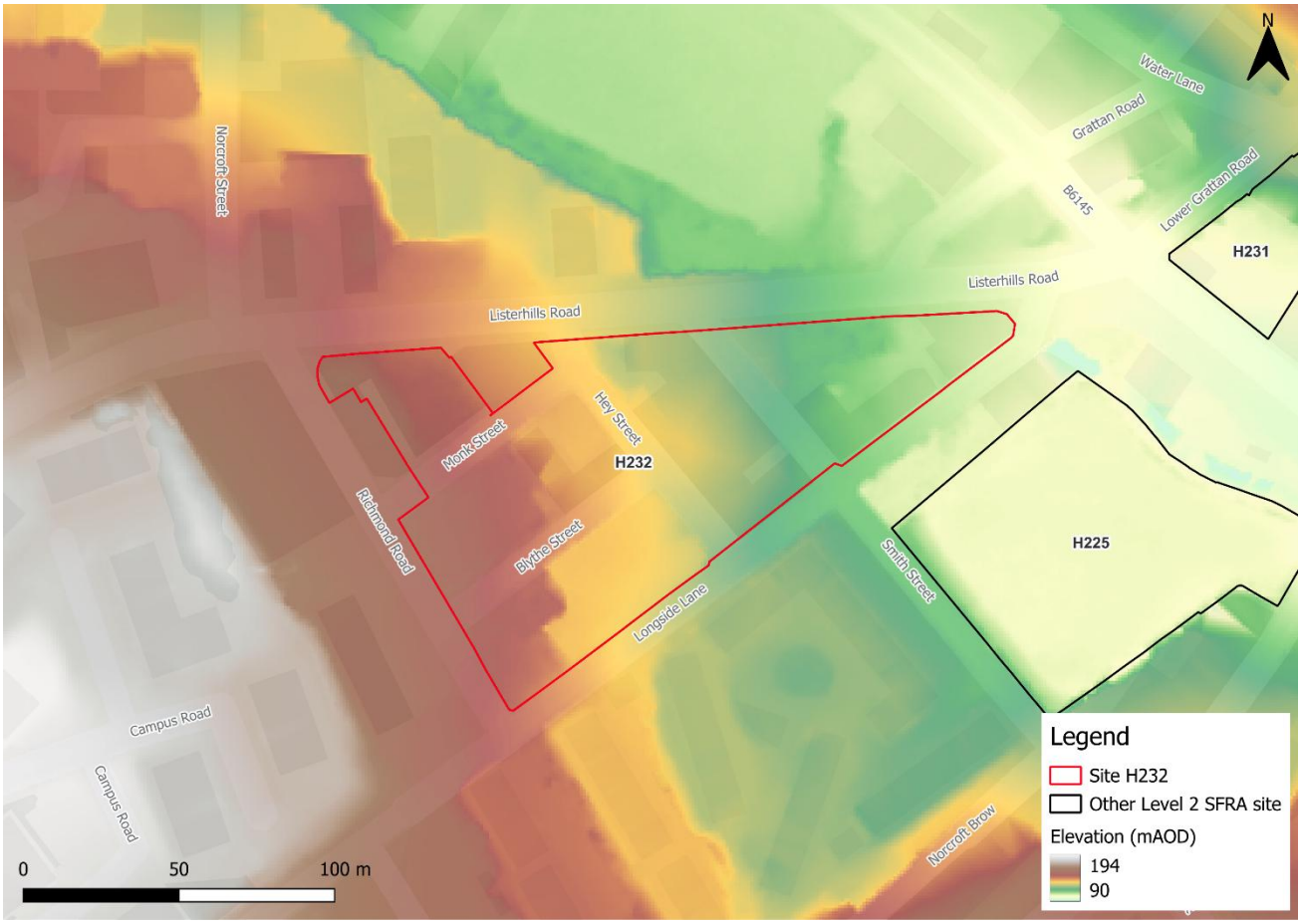


Figure 1-2: Topography

The underlying bedrock within the site is defined as 'Pennine Lower Coal Measures Formation', which comprises mudstone, siltstone, sandstone, coal, ironstone and ferricrete (Figure 1-3). This is overlain with superficial deposits of till. Mudstone, siltstone, coal, ironstone and ferricrete typically have low permeability, however this can be highly variable. Sandstone has a higher permeability.



Figure 1-3: Soils and geology

2 Flood risk from rivers

2.1 Existing risk

2.1.1 Flood Map for Planning and functional floodplain

Based on the EA's Flood Map for Planning (January 2026) and Flood Zone 3b (functional floodplain), as updated in this Level 2 SFRA, the percentage areas of the site within each fluvial flood zone are stated in Table 2-1 and can be viewed on Figure 2-1. This version of the Flood Map for Planning does not consider flood defence infrastructure (Section 2.3).

Fluvial flood risk to the site comes from Bradford Beck which is culverted to the east of the site. A small area of functional floodplain is present in the eastern corner of the site. However, this is based on an 8m buffered polygon of the Bradford Beck channel to indicate the potential presence of the watercourse beneath the site. The mapped watercourse location my not represent the actual location of the culverted channel. Noting that, functional floodplain policy applies to the path of the culvert beneath the site and not the mapped functional floodplain, where these differ. The path of the culverted channel should be confirmed through a survey as part of the site-specific FRA. The majority of the site is located within Flood Zone 1 and is therefore at low risk of fluvial flooding.

Table 2-1: Existing fluvial flood risk based on percentage area of site at risk

Flood Zone 1 (% area)	Flood Zone 2 (% area)	Flood Zone 3a (% area)	Flood Zone 3b (% area)
99	0	0	1

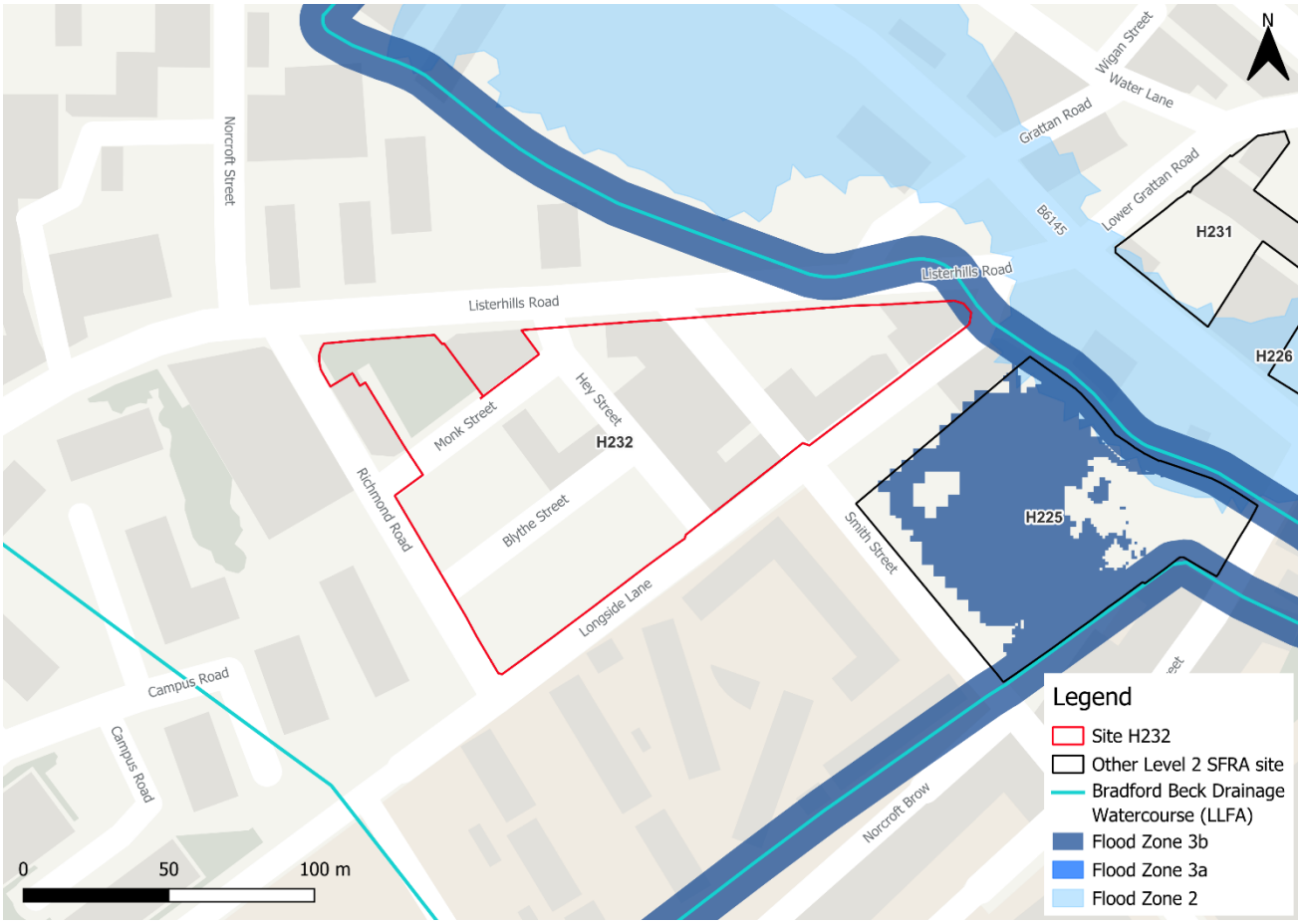


Figure 2-1: Existing risk from rivers to the site

2.1.2 Bradford Beck 2026 model outputs

The Bradford Beck 2026 model does not show the site to be at risk of fluvial flooding during the present day 1% AEP undefended event (Figure 2-2).



Figure 2-2: Flood depths for 1% AEP undefended flood event

2.2 Impacts from climate change

The EA's SFRA guidance states that SFRAs should assess the central allowance for less vulnerable, more vulnerable, highly vulnerable and water compatible development (Table 2-2). The impacts of climate change on flood risk from the Bradford Beck 2026 model have been modelled without flood defence infrastructure in place. As documented in Section 2.3.1, there are no formal engineered flood defences that would benefit the site.

Table 2-2: Modelled climate change allowances for peak river flows for the Aire and Calder Management Catchment

Return period (AEP event)	Central allowance 2080s (% increase)	Higher central allowance 2080s (% increase)	Upper end allowance 2080s (% increase)
3.3% (functional floodplain)	23%	31%	51%
1%	23%	31%	51%

2.2.1 Bradford Beck 2026 model outputs - climate change

Figure 2-3 shows the onsite modelled flood depths for the 1% AEP undefended event +23% for climate change. The Bradford Beck 2026 model shows that the site is not at risk of flooding during the climate change event.



Figure 2-3: Flood depths for 1% AEP undefended flood event +23% (central climate change allowance)

2.2.2 Flood Map for Planning - Climate Change

Climate change data in this area is unavailable from the EA's Flood Map for Planning plus Climate Change (2070-2125) dataset, as shown in Figure 2-4.

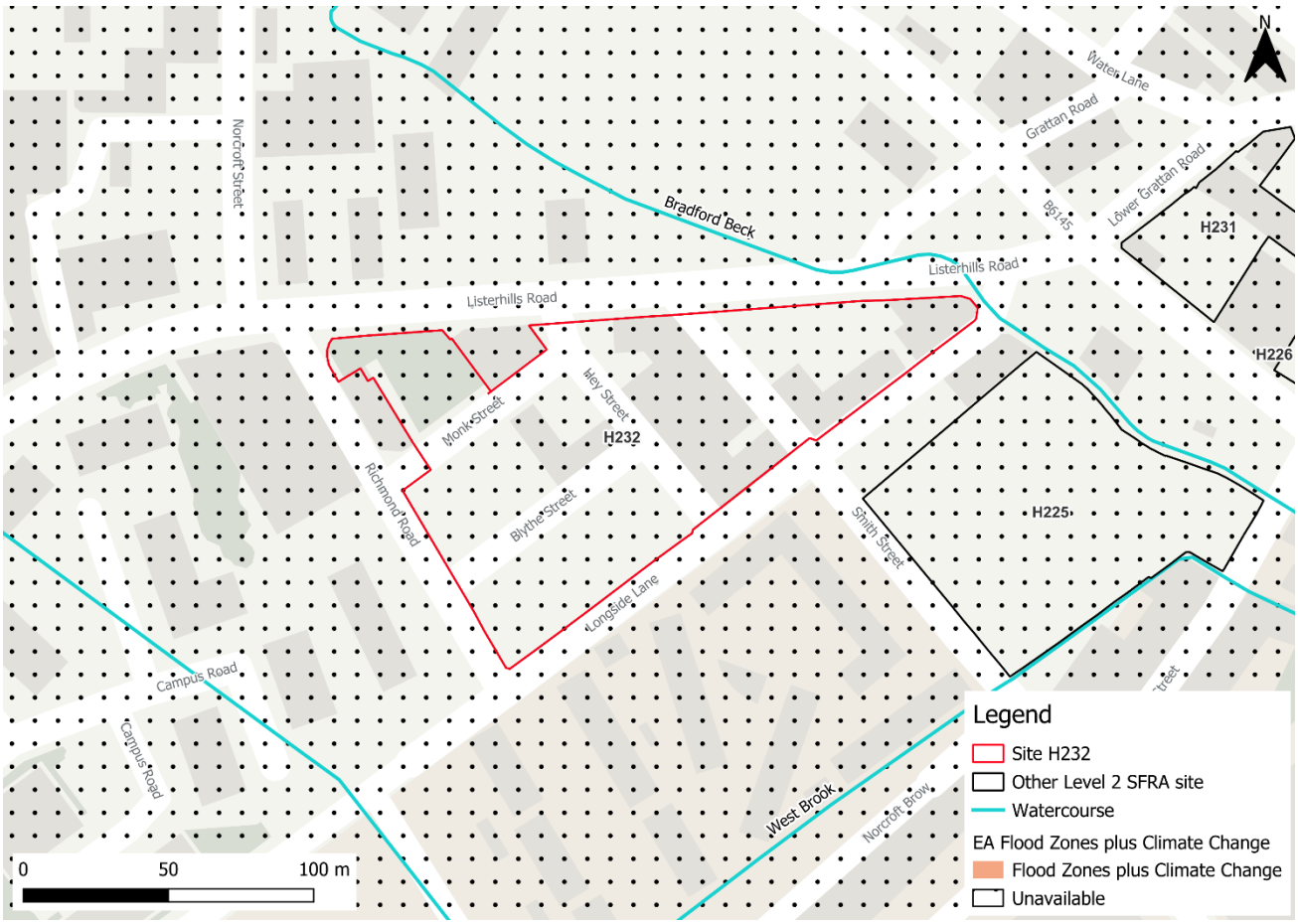


Figure 2-4: EA Flood Zones plus Climate Change

2.3 Flood risk management

2.3.1 Flood defences

The site does not benefit from any formal engineered flood defences, according to the EA's spatial flood defences dataset.

2.3.2 Working with Natural Processes

The EA's Working with Natural Processes (WwNP) dataset has been interrogated to identify opportunities for Natural Flood Management (NFM) to reduce flood risk to the site and surrounding areas. There are no applicable areas that could benefit the site.

2.4 Historic flood incidents

The EA's Historic Flood Map (HFM) and Recorded Flood Outlines (RFO) datasets have been considered. There are no recorded historic flood incidents within the vicinity of the site.

2.5 Flood warning and access and escape routes

The EA operates a Flood Warning Service for properties located within a Flood Warning Area (FWA) for when a flood event is expected to occur. The site is not located within a FWA, though an FWA, namely 123FWF785 - Bradford Beck and tributaries at Bradford, is located adjacent to the east of the site (Figure 2-5).

Flood alerts may be issued before a flood warning for properties located within a Flood Alert Area (FAA) to provide advance notice of the possibility of flooding. A flood alert may be issued when there is less confidence that flooding will occur in a FWA. This site is not located within a FAA, though an FAA, namely 123WAF961 - Middle River Aire catchment, is located adjacent to the east of the site (Figure 2-5).



Figure 2-5: EA Flood Warning and Flood Alert areas

2.5.1 Access and escape routes

Based on available information, safe access and escape routes would likely be achievable via Listerhills Road to the north of the site, travelling west (Figure 2-6).



Figure 2-6: Potential access and escape routes

2.6 Observations, mitigation options, site suitability and sequential approach to development management - fluvial

- Observations:
  - Given the proposed vulnerability of the site, the FRA must show that the development can be designed to be safe and that there is adequate emergency planning provision (para 014 FRCC-PPG).
  - The majority of the site is located within Flood Zone 1, putting it at low risk of fluvial flooding. Development should be directed to the area of the site within Flood Zone 1.
  - A small area in the east of the site is modelled to be within the functional floodplain, representing the culverted Bradford Beck watercourse beneath the site. Consideration should be given as to whether de-culverting and daylighting this section of culvert is feasible, supported by detailed modelling.
  - If Bradford Beck remains culverted, there should be no development above the culvert. The location and course of the culvert should be confirmed through a survey.
  - The 1% AEP event with an allowance for climate change is what the EA considers to be the design event for a development to mitigate fluvial flood

risk. Fluvial risk is not modelled to impact the site in the 1% AEP undefended +23% climate change event.

- Mitigation:
  - EA flood warnings and alerts should continue to be in place to ensure early evacuation of site users before an extreme flood event occurs.
- Access and escape:
  - Safe access and escape routes would likely be achievable during a fluvial flood event via Listerhills Road to the north of the site.

3 Flood risk from surface water

3.1 Existing risk

At the time of writing, the EA's latest national Risk of Flooding from Surface Water (RoFSW) does not include depth and hazard information suitable for planning purposes. Therefore, this Level 2 SFRA considers the third generation RoFSW depth and hazard mapping in addition to the NaFRA2 extents, as agreed with the EA. Surface water depth and hazard should be confirmed at the site-specific FRA stage.

3.1.1 Risk of Flooding from Surface Water - NaFRA2 extents

Based on the EA's national scale RoFSW map (January 2026), surface water risk to the site is predominantly very low, as shown in Table 3-1.

Surface water risk in the medium and low risk events is confined to a small area of ponding in the east of the site (Figure 3-1). Where demolition is proposed, a surface water drainage strategy, proportionate to the risk, will be required to show that surface water flood risk can be managed onsite.

Table 3-1: Existing surface water flood risk based on percentage area at risk using the RoFSW map

Very low risk (% area)	Low risk (% area)	Medium risk (% area)	High risk (% area)
98	1	1	0

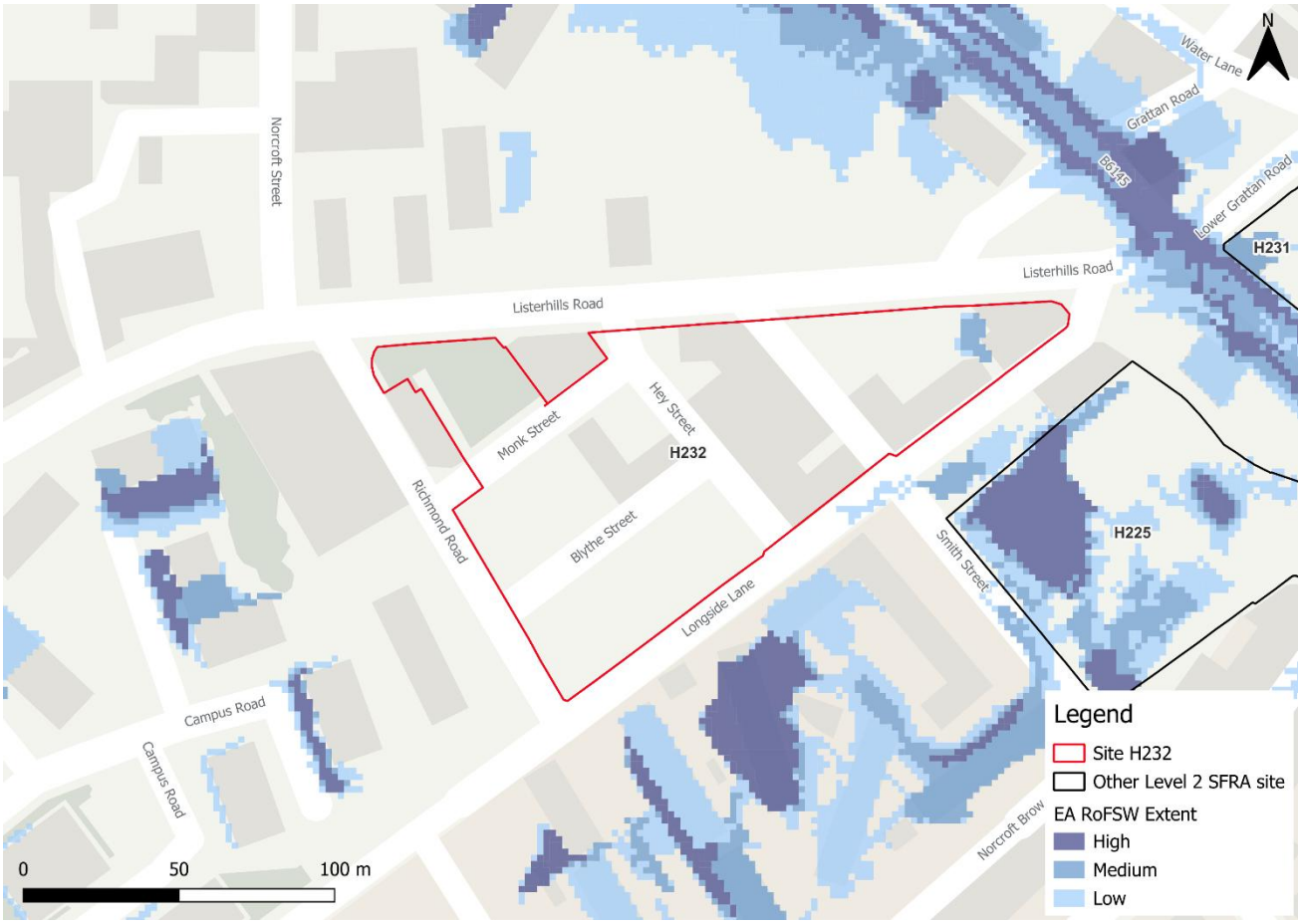


Figure 3-1: Surface water flood extents (NaFRA2 - Risk of Flooding from Surface Water map)

3.1.2 Risk of Flooding from Surface Water - third generation depths and hazards

Based on the EA's national scale third generation RoFSW map, there are no flood depths or hazards modelled to the site in the medium risk event.

There are therefore differences between the NaFRA2 RoFSW map and the third-generation depth and hazard mapping. The NaFRA2 RoFSW map does not map flooding less than 0.075m (7.5cm) in depth. Therefore, where the map may show no flooding, there may be shallow flooding up to a depth of 0.075m. In contrast, the third generation RoFSW does not map flooding with a hazard rating of less than 0.575. This could explain the differences observed between the NaFRA2 and third generation RoFSW. Assessment of surface water should be carried out at the site-specific FRA stage to robustly establish current and future surface water flood risk conditions.



Figure 3-2: Medium risk event surface water flood depths (Risk of Flooding from Surface Water map)

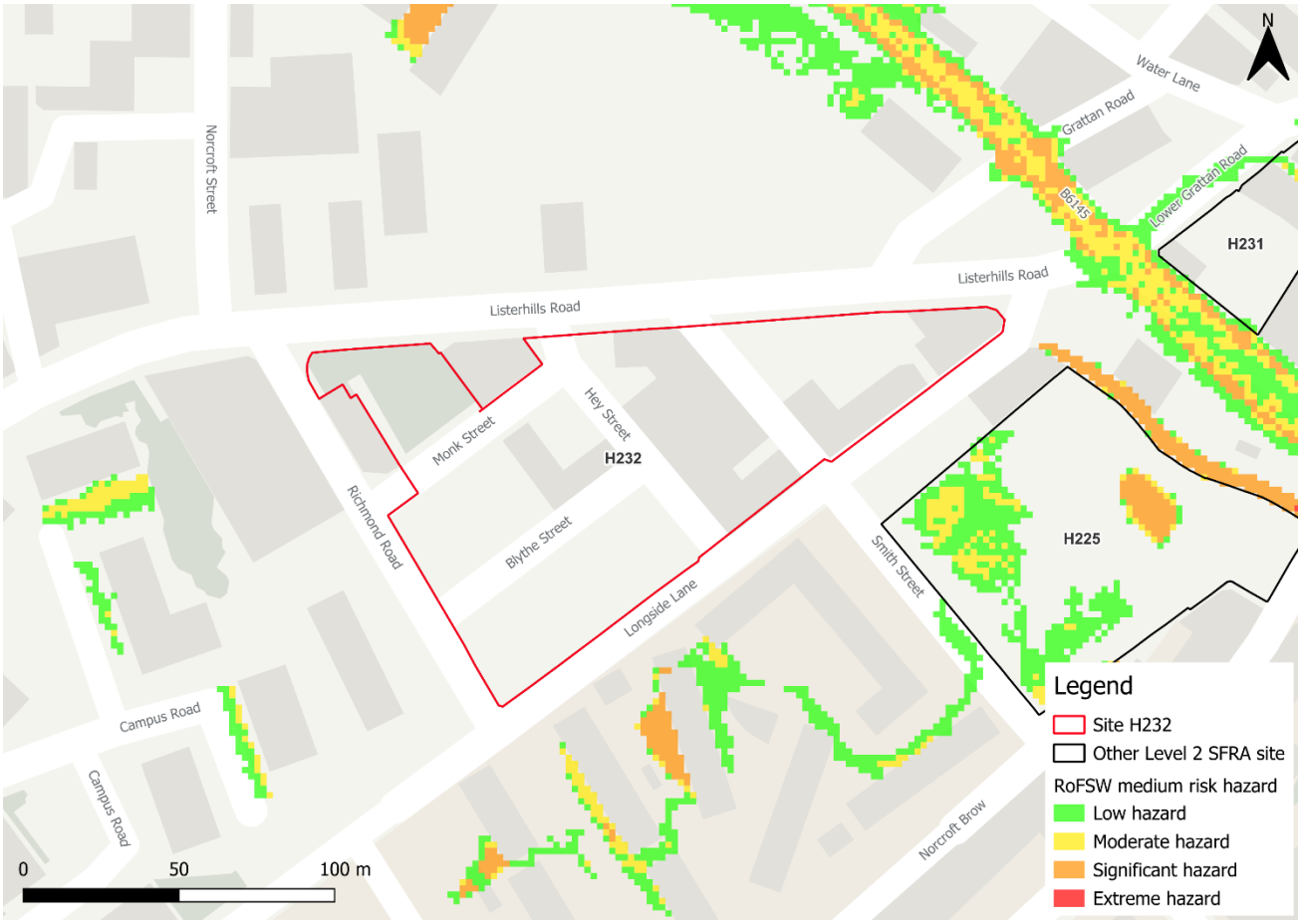


Figure 3-3: Medium risk event surface water flood hazard[1] (Risk of Flooding from Surface Water map)

3.2 Impacts from climate change

At the time of writing, the available national surface water climate change mapping is unsuitable for consideration in development planning. This Level 2 SFRA considers the low risk surface water event as a conservative proxy for the medium risk event plus climate change, as agreed with the EA. The impact of climate change on surface water flood risk should be considered at the site-specific FRA stage.

Using the low risk event as a proxy, the medium risk surface water event is likely to slightly increase in extent within the site when accounting for climate change (Figure 3-4). The third generation map highlights the area of ponding in the east of the site, with maximum flood depths shallow between 0.15 to 0.3m (Figure 3-5), with hazard predominantly categorised as 'low' (Figure 3-6).

1 Based on Section 7.5 Hazard rating. What is the Risk of Flooding from Surface Water map? Report version 2.0. April 2019. Environment Agency

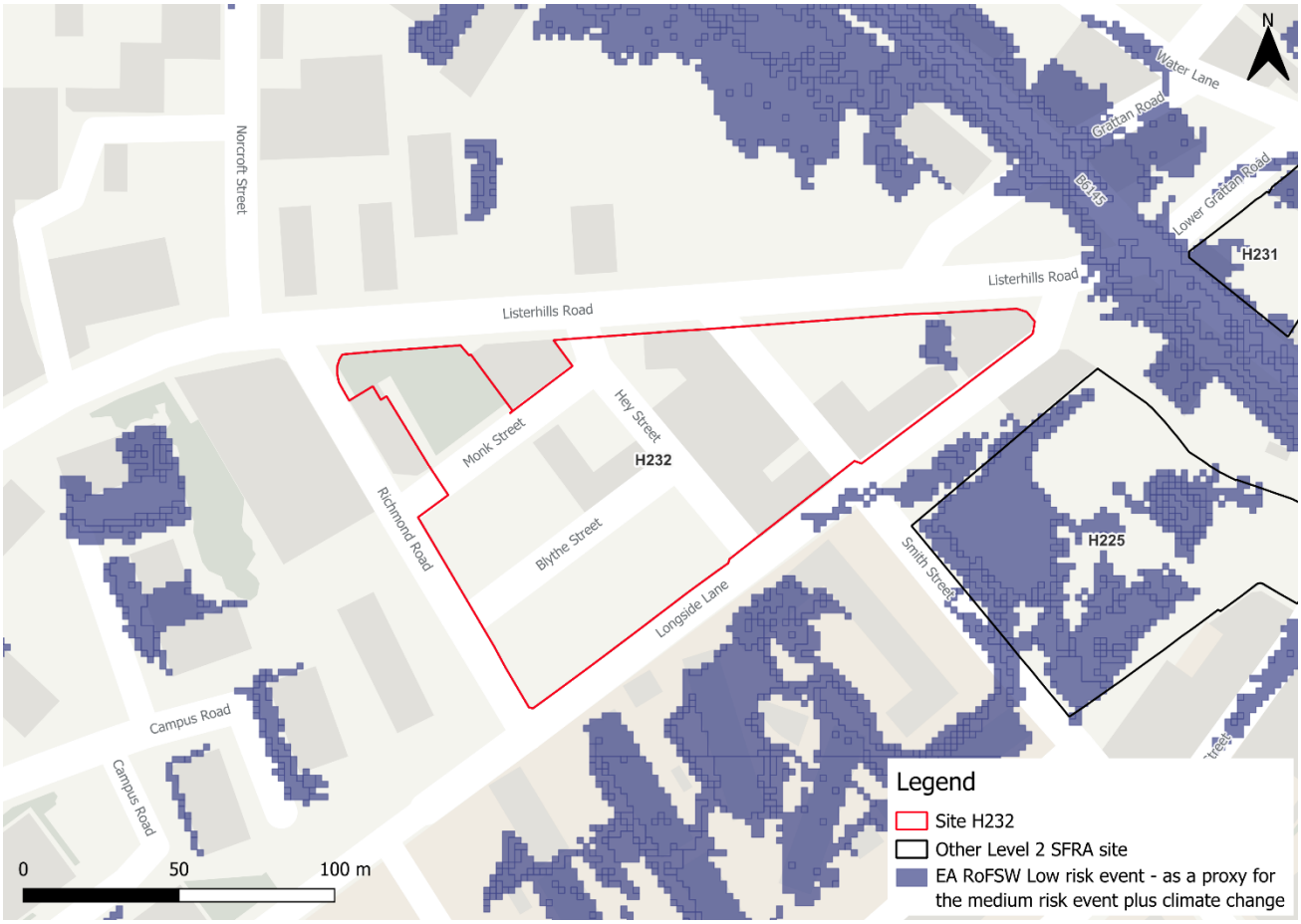


Figure 3-4: Low risk event surface water flood extent, as a proxy for the medium risk event plus climate change (NaFRA2 - Risk of Flooding from Surface Water map)



Figure 3-5: Low risk event surface water flood depths, as a proxy for the medium risk event plus climate change (Third generation - Risk of Flooding from Surface Water map)

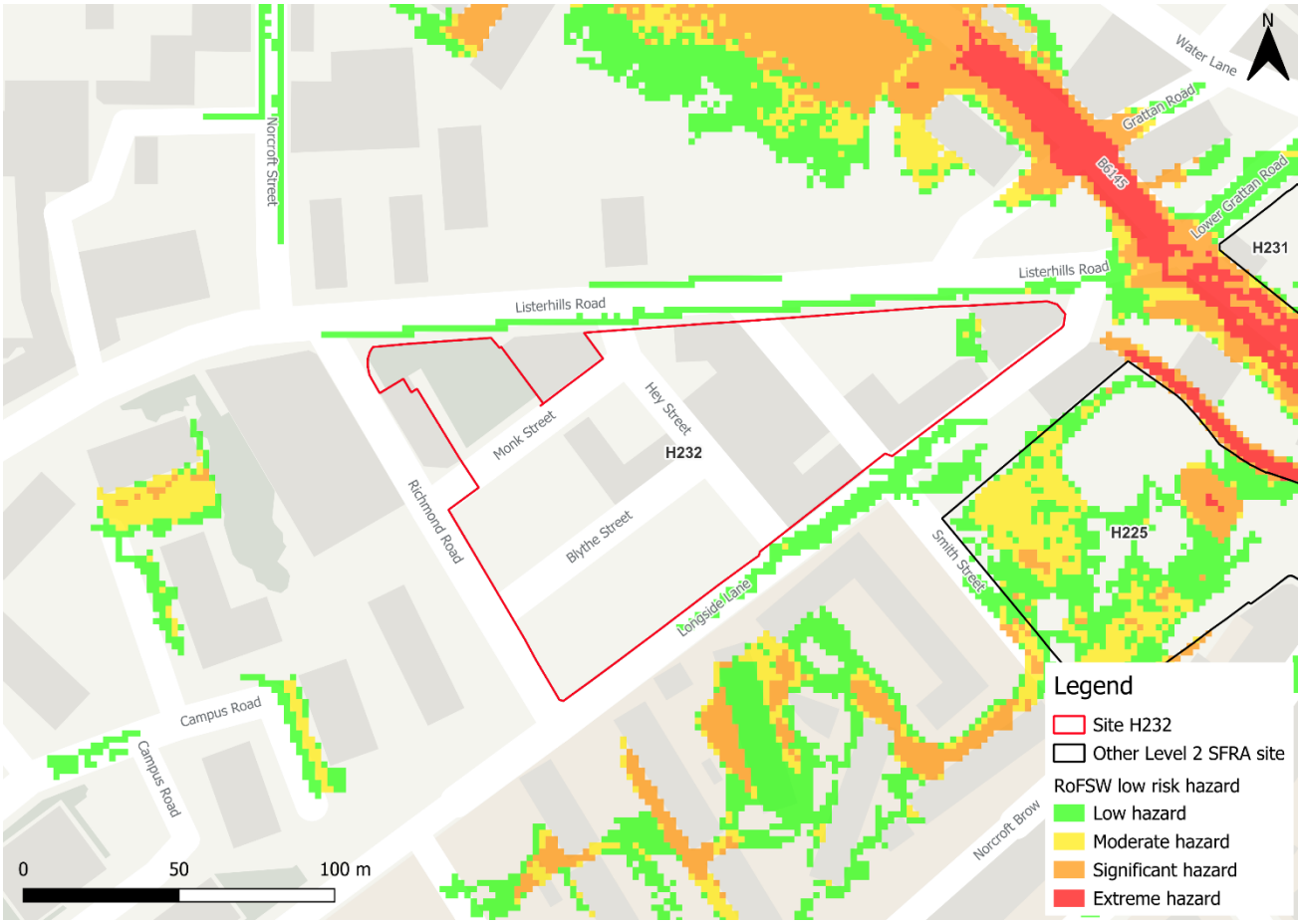


Figure 3-6: Low risk event surface water flood hazard, as a proxy for the medium risk event plus climate change (Third generation - Risk of Flooding from Surface Water map)

3.3 Observations, mitigation options and site suitability - surface water

- Current risk to the site is predominantly very low, with approximately 98% of the site being at very low risk. Surface water risk in the medium risk event is confined to a small area of ponding in the east of the site.
- The effects of climate change on surface water have not been modelled for this SFRA, however the low risk surface water event has been used as a proxy for the medium risk event plus climate change. In this event, there is surface water flood risk modelled to the east of the site.
- Topographic low spots should be considered and included in site design and ideally left in place to flood naturally when required.
- The drainage strategy must ensure there is no increase in surface water flood risk elsewhere as a result of new development. Existing brownfield rates will likely apply, though the developer should consult local LLFA guidance and the National SuDS guidance.
- Assessment of the current drainage system in place should be carried out to ascertain any current capacity issues and whether the current system could accommodate the proposed residential development or whether further capacity will be required.

- The RoFSW map is not suitable for identifying whether an individual property will flood and is therefore indicative. The RoFSW map is not appropriate to act as the sole evidence for any specific planning or regulatory decision or assessment of risk in relation to flooding at any scale without further supporting studies or evidence.

4 Risk from groundwater

Risk of groundwater emergence is assessed in this SFRA using JBA's 5m Groundwater Emergence Map. This dataset is recommended for use by the EA in the SFRA Good Practice Guide[2]. Figure 4-1 shows the map covering this site and the surrounding areas and Table 4-1 explains the risk classifications.

The entire site is located within an area where there is no risk of groundwater emergence. Infiltration SuDS may therefore be an appropriate option at this site as there is a lower risk of groundwater emergence. However, the underlying bedrock geology being less permeable means that the type of infiltration SuDS needs to be considered further through the drainage strategy (Figure 1-3).

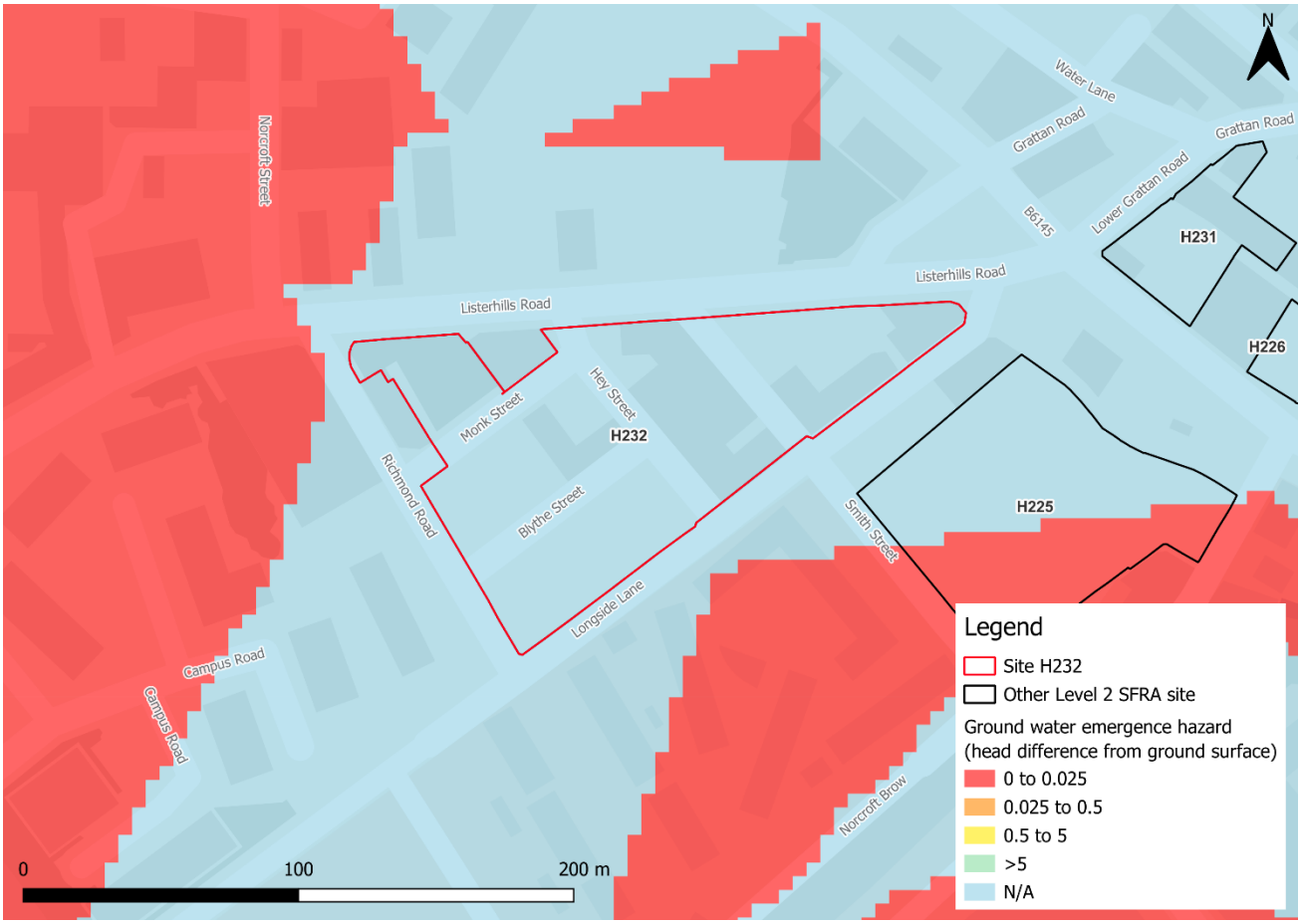


Figure 4-1: JBA 5m Groundwater Emergence Map

2 Strategic flood risk assessment good practice guide. ADEPT. December 2021.

Table 4-1: Groundwater Hazard Classification

Groundwater head difference (m)*	Class label
0 to 0.025	Groundwater levels are either at very near (within 0.025m of) the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
0.025 to 0.5	Groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
0.5 to 5	Groundwater levels are between 0.5m and 5m below the ground surface in the 100-year return period flood event There is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.
>5	Groundwater levels are at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater is not likely.
N/A	No risk. This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.
*Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.	

5 Residual risk

Although a site may be afforded some protection from defences and / or drainage infrastructure, there is always a residual risk of flooding from asset failure i.e. defence breaches, or blockages of culverts or drainage assets. There is potential residual risk to the site from a structural failure of the culverted channel to the east of the site (Figure 5-1).



Figure 5-1: Potential residual risk - Bradford Beck culvert adjacent to the site

5.1 Flood risk from reservoirs

The EA's Reservoir Flood Maps (RFM) (2021) show where water may go in the unlikely event of a reservoir or dam failure. Figure 5-2 shows the RFM in a 'dry day' and 'wet day' scenario. A 'dry day' scenario assumes that the water level in the reservoir is the same as the spillway level or the underside of the roof for a service reservoir and the watercourses upstream and downstream of the reservoir are at a normal level. A 'wet day' scenario assumes a worst-case scenario where a reservoir releases water held on a 'wet day' when local rivers have already overflowed their banks.

The site is potentially at risk from four reservoirs. All four reservoirs are located within Bradford. Of the four reservoirs, two are operated by the City of Bradford Metropolitan District Council, and two are operated by Yorkshire Water Services Ltd.

The EA's SFRA guidance states that where a proposed development site is at flood risk from a reservoir, then an assessment into whether the reservoir design or maintenance schedule needs improving should be carried out. Expert advice may be required from an all-reservoirs panel engineer. The Council should consult the relevant reservoir undertaker to ascertain whether the proposed development could affect the reservoir's risk designation, its design category or how it is operated. The Council, as category 1 responders, can access more detailed information about reservoir risk and reservoir owners using the Resilience Direct system.

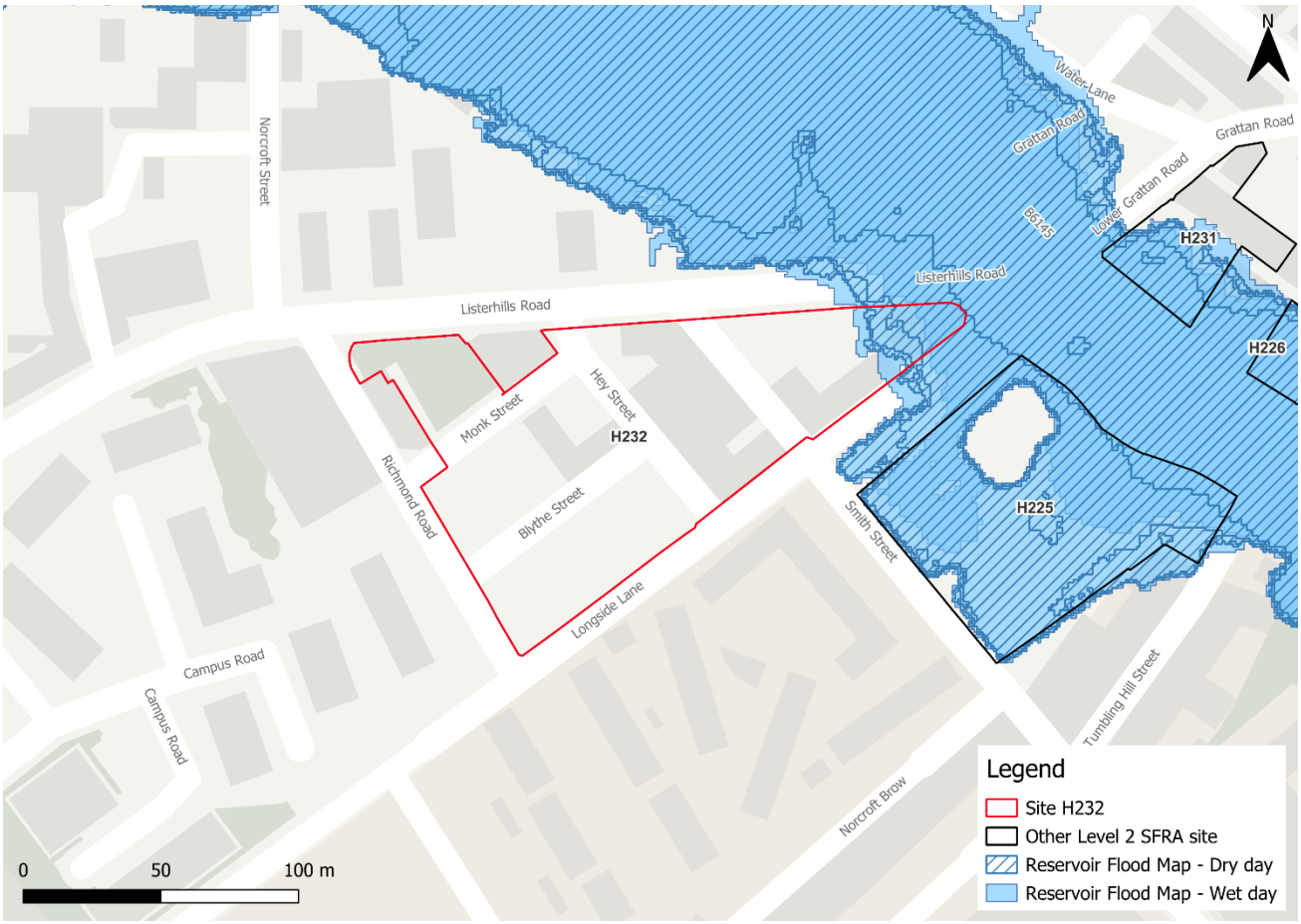


Figure 5-2: Flood risk from reservoirs

5.2 Observations, mitigation options and site suitability - residual risk

- The site is at potential residual risk from a breach of four reservoirs. Three reservoirs impact the site in the 'dry day' flood extent. Only Upper Chellow and Lower Chellow are modelled to impact the site based on the 'wet day' flood extent, which represents a prediction of the credible worst case scenario, therefore it's unlikely that any actual flood would be this large.
- Given the potential reservoir risk to the site, developers should consider[3]:
  - Consulting with the local resilience forum for advice on emergency planning,

3 Reservoir flood maps: when and how to use them | Environment Agency | 2021

- Consulting with relevant reservoir owners to understand the impact development may have on their reservoirs, and
- Using this Level 2 SFRA to understand whether any proposed development will be safe throughout its lifetime.

6 Overall site assessment

6.1 Can part b) of the exception test be passed?

This site is not required to pass part b) of the exception test[4] as it is not located within Flood Zone 3a, however it must still be proven that the development can be safe for its lifetime, which is generally considered to be 100 years for residential development.

6.2 Recommendations summary

Based on the evidence presented in the Level 1 SFRA (2023) and this Level 2 SFRA:

- It should be appropriate to develop this site given its location largely within Flood Zone 1 and nominal surface water risk.
- There should be no development above the Bradford Beck culvert which runs to the east of the site. The location and path of this culvert should be confirmed through a survey as part of the site-specific FRA
- There may be opportunities to deculvert and daylight the Bradford Beck culvert which could impact flood risk on the site.
- Development should be directed to the areas of the site within Flood Zone 1.

6.3 Site-specific FRA requirements and further work

At the planning application stage, the following should be considered

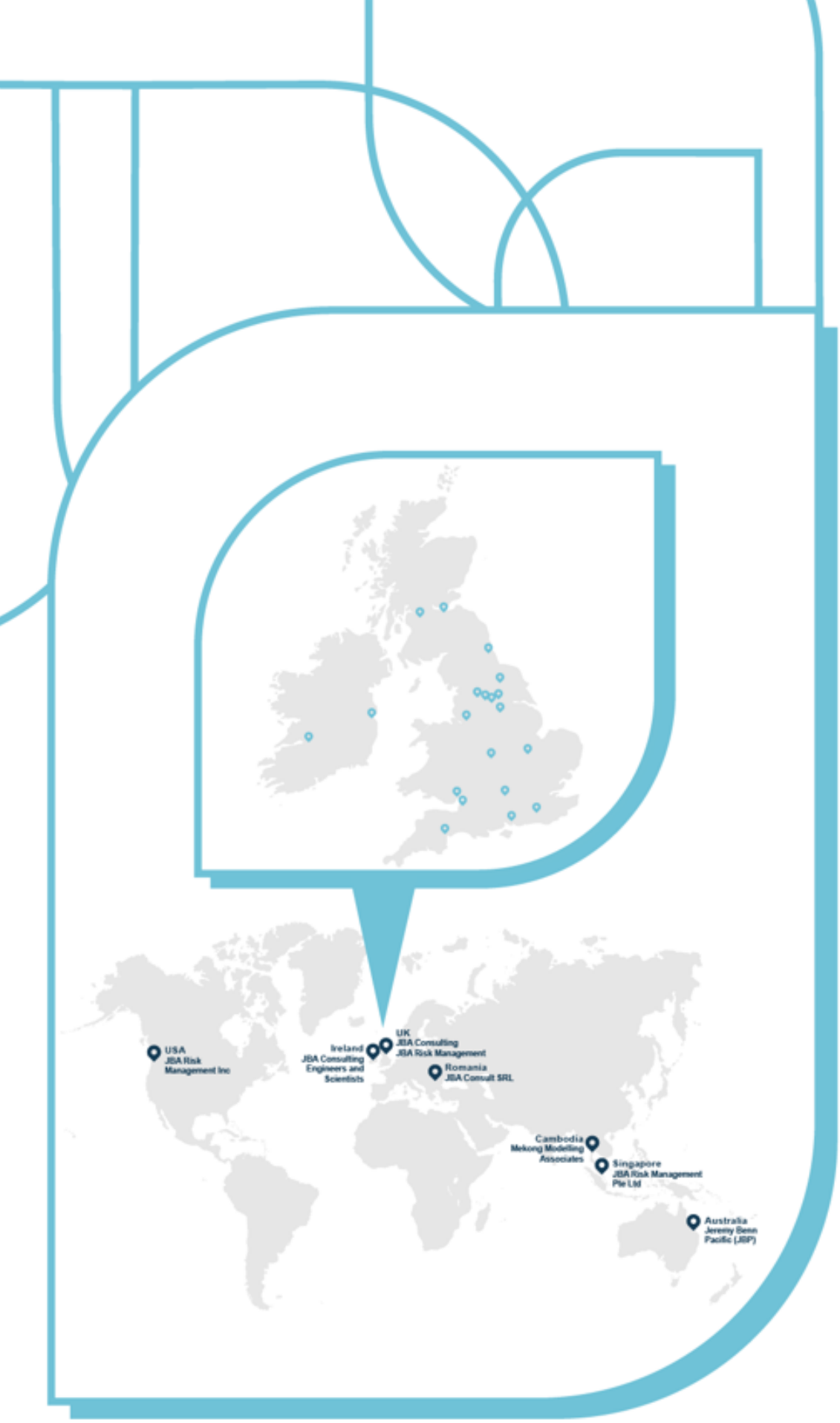
- Further modelling to understand the impacts of climate change on surface water flood risk to the site.
- Consultation with the relevant reservoir owners to understand the impact of development on reservoir risk designation.
- The FRA should be carried out in line with the latest versions of the NPPF; FRCC-PPG; EA guidance, the CBMDC Local Plan and national and local SuDS policy and guidelines.
- Throughout the FRA process, consultation should be carried out with the following, where applicable, the local planning authority, the lead local flood authority, emergency planning officers, the Environment Agency, Yorkshire Water, the highways authorities, and the emergency services.

4 Para 178 National Planning Policy Framework 2024

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Bradford Level 2 Strategic Flood Risk Assessment - Site H235

~~Final~~Final Draft

July 2026

Prepared for:

City of BRADFORD METROPOLITAN DISTRICT COUNCIL

www.jbaconsulting.com

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Contract

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This report describes work commissioned by City of Bradford Metropolitan District Council (CBMDC) by an instruction dated 19 July 2024. The Client's representative for the contract was Jonathan Dicken of CBMDC. Laura Thompson of JBA Consulting carried out this work.

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1 Background

This is a Level 2 Strategic Flood Risk Assessment (SFRA) site screening report for the City of Bradford Metropolitan District Council (CBMDC) Local Plan Site H235. The content of this Level 2 SFRA site screening report assumes the reader has already consulted the 'CBMDC Level 1 SFRA' (2023) and read the 'CBMDC Level 2 SFRA Main Report' (2026) and is therefore familiar with the terminology used in this report.

1.1 Site H235

- Location: Midland Mills, Valley Road
- Existing site use: Brownfield commercial
- Existing site use vulnerability: Less vulnerable
- Proposed site use: Housing
- Proposed site use vulnerability: More vulnerable
- Site area: 0.5 hectares
- Proposed development impermeable area: 0.45 hectares
- Watercourse: Bradford Beck
- CBMDC river model: Bradford Beck 2026
- Summary of requirements from scoping stage:
    - Level 1 SFRA recommendation was for withdrawal from allocation or more detailed assessment through Level 2 SFRA
    - Subject to the exception test as more vulnerable development proposed in Flood Zone 3a
    - Assessment of modelled fluvial flood depths, velocities and hazards
    - Assessment of surface water flood depths and hazards based on the EA's national Risk of Flooding from Surface Water dataset
    - Assessment of all other sources of flood risk
    - Modelling of residual risk from Bradford Beck culvert

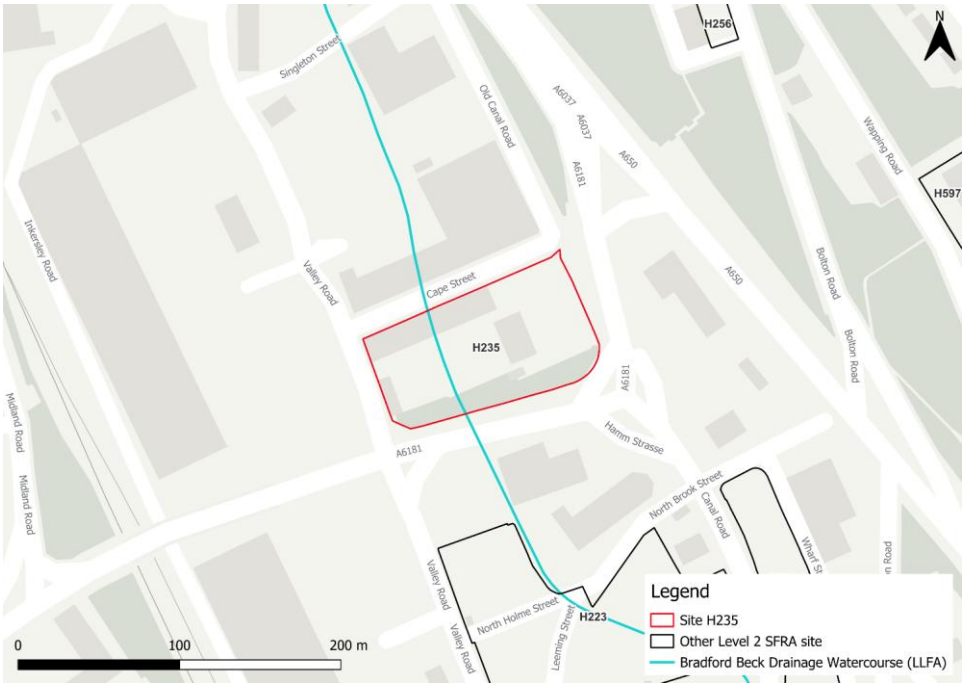


Figure 1-1: Existing site location boundary

The topography of the site is varied, with higher elevation ground along the boundaries of the site, sloping towards the centre of the site (Figure 1-2).



Figure 1-2: Topography

The underlying bedrock within the site is defined as 'Pennine Lower Coal Measures Formation', which comprises mudstone, siltstone, sandstone, coal, ironstone and ferricrete (Figure 1-3). This is overlain with superficial deposits of till. Mudstone, siltstone, coal, ironstone and ferricrete typically have low permeability, however this can be highly variable. Sandstone has a higher permeability.



Figure 1-3: Soils and geology

2 Flood risk from rivers

2.1 Existing risk

2.1.1 Flood Map for Planning and functional floodplain

Based on the EA's Flood Map for Planning (January 2026) and Flood Zone 3b (functional floodplain), as updated in this Level 2 SFRA, the percentage areas of the site within each fluvial flood zone are stated in Table 2-1 and can be viewed on Figure 2-1. This version of the Flood Map for Planning does not consider flood defence infrastructure (Section 2.3).

Fluvial flood risk to the site comes from Bradford Beck which is culverted beneath the western side of the site before re-emerging approximately 40m downstream of the northern site boundary. Functional floodplain is present within western side of the site and is based on a 8m buffer around the assumed channel of Bradford Beck. The area of functional floodplain onsite should be left free of development.

The mapped watercourse location may not represent the actual location of the culverted channel. Noting that, functional floodplain policy applies to the path of the culvert beneath the site and not the mapped functional floodplain, where these differ. The path of the culverted channel should be confirmed through a survey as part of the site-specific FRA.

The western and central areas of the site are situated within Flood Zone 3a and therefore at high risk of fluvial flooding. Much of the remaining area of the site is within Flood Zone 2 and therefore at medium risk of fluvial flooding.

Table 2-1: Existing fluvial flood risk based on percentage area of site at risk

Flood Zone 1 (% area)	Flood Zone 2 (% area)	Flood Zone 3a (% area)	Flood Zone 3b (% area)
10	27	51	12

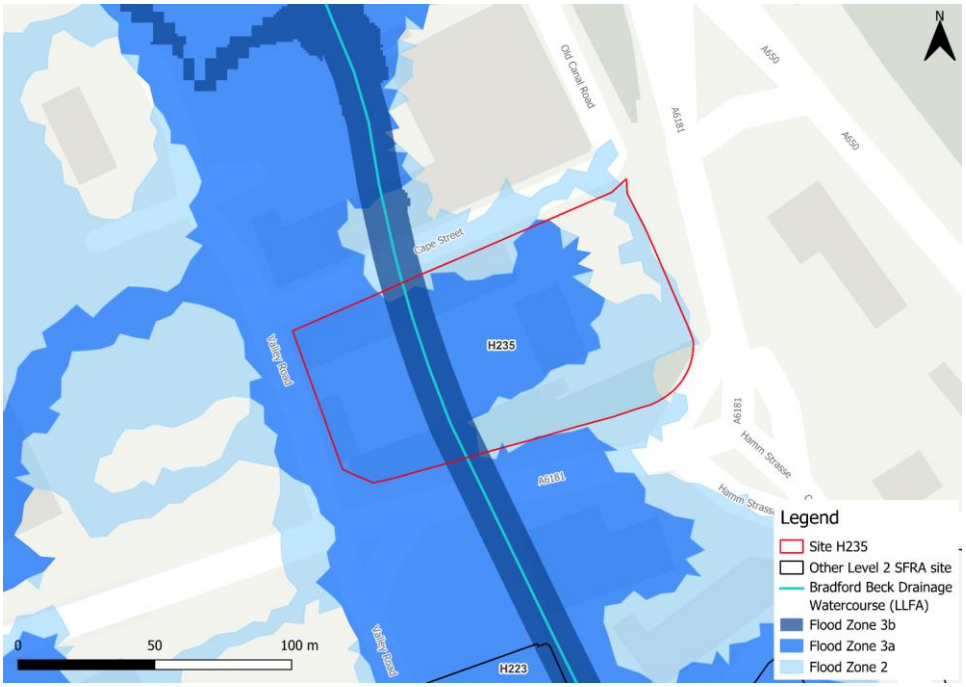


Figure 2-1: Existing risk from rivers to the site

2.1.2 Bradford Beck 2026 model outputs - present day

The Bradford Beck 2026 model does not show any flooding within the site during the 1% AEP. However, it is noted that the current Flood Zone 3a does not yet account for the latest Bradford Beck model outputs.

Figure 2-2 shows the modelled flood depths for the 0.1% AEP undefended event. The 2026 Bradford Beck model indicates widespread flooding across the site during the 0.1% AEP event. Modelled risk to the site varies compared to the flood extent shown in Flood Zone 2 of the FMfP with the modelled flood extent more closely resembling Flood Zone 3a. Therefore, the FMfP requires updating with the latest modelling for Bradford Beck. Maximum flood depths within the site are modelled to be significant, up to greater than 1.2m within the eastern side of the site. Within the western side of the site, flood depths are generally lower, between 0.15 and 0.9m (Figure 2-2).

Modelled flood velocities are varied across of the site (Figure 2-3). The areas of flooding with greater velocity appear to suggest a flow path entering the site from Hamm Strasse. Modelled flood hazard is 'very low hazard' around the perimeter of the site but 'danger for some' or 'danger for most' within the centre of the site (Figure 2-4).

Safe access and escape routes may be achievable from parts of the eastern side of the site, travelling via Cape Street or the A6181 (Canal Road).

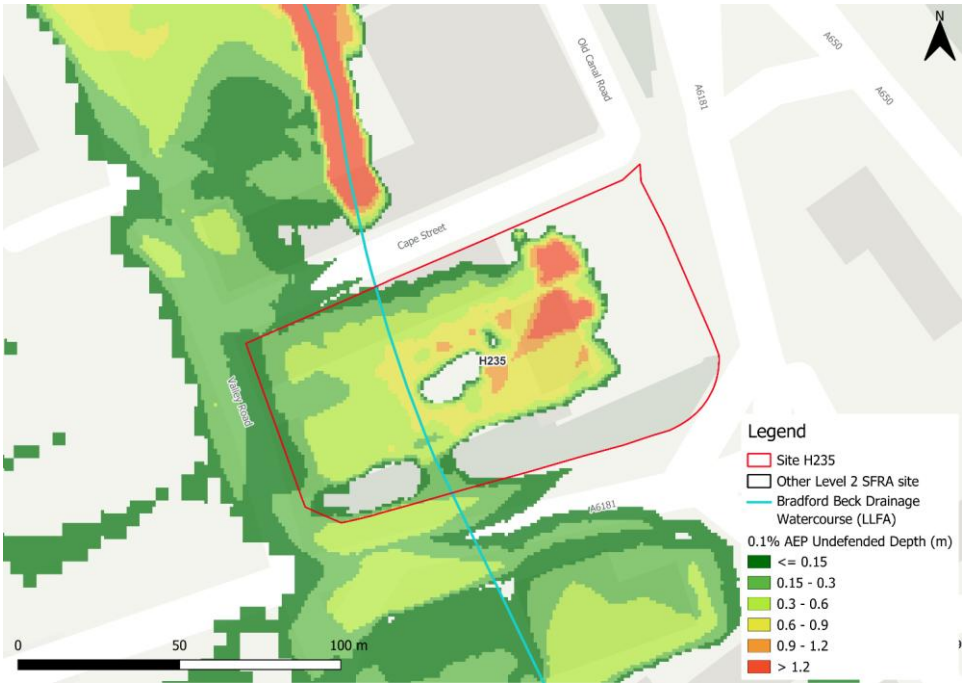


Figure 2-2: Flood depths for 0.1% AEP undefended flood event

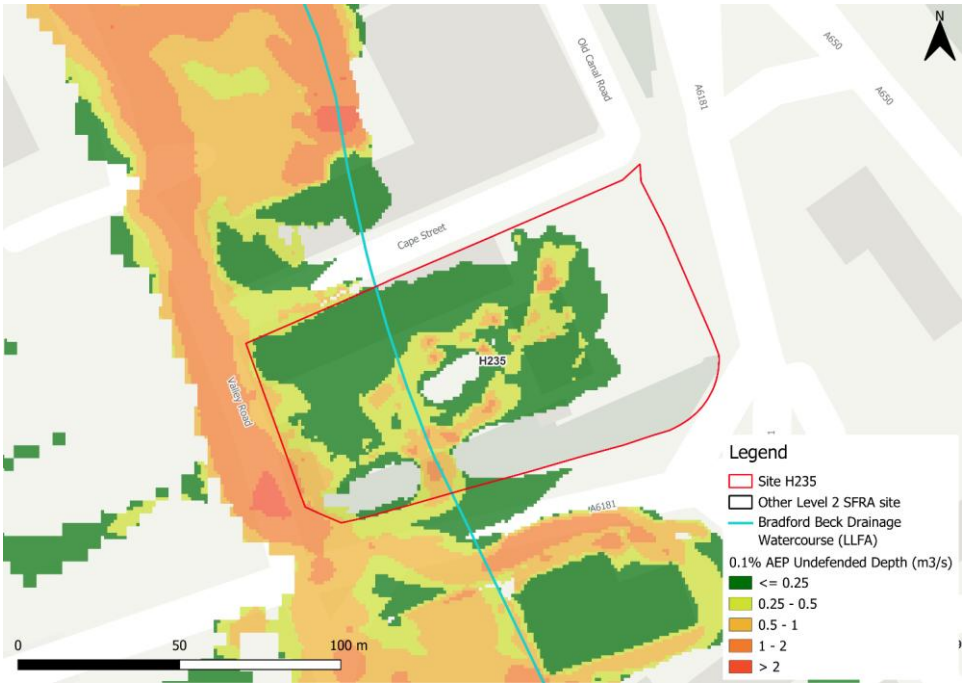


Figure 2-3: Flood velocities for 0.1% AEP undefended flood event

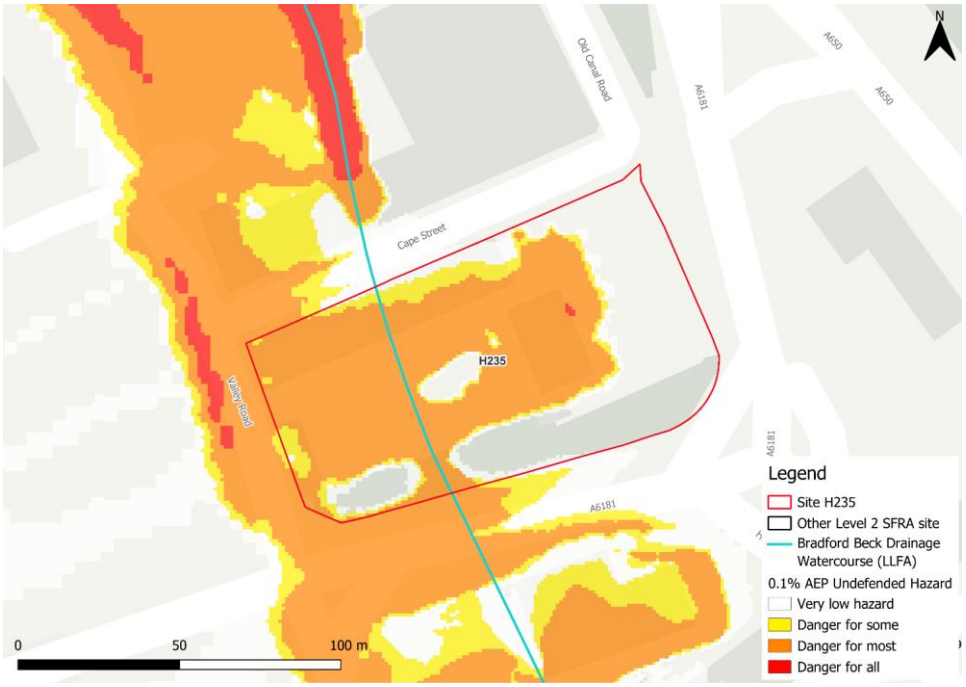


Figure 2-4: Flood hazard[1] for 0.1% AEP undefended flood event

2.2 Impacts from climate change

The EA's SFRA guidance states that SFRAs should assess the central allowance for less vulnerable, more vulnerable, highly vulnerable and water compatible development (Table 2-2). The impacts of climate change on flood risk from the Bradford Beck 2026 model have been modelled without flood defence infrastructure in place. As documented in Section 2.3.1, there are no formal engineered flood defences that would benefit the site.

1 Fluvial hazard ratings based on Table 4 of the SUPPLEMENTARY NOTE ON FLOOD HAZARD RATINGS AND THRESHOLDS FOR DEVELOPMENT PLANNING AND CONTROL PURPOSE – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1. May 2008.

Table 2-2: Modelled climate change allowances for peak river flows for the Aire and Calder Management Catchment

Return period (AEP event)	Central allowance 2080s (% increase)	Higher central allowance 2080s (% increase)	Upper end allowance 2080s (% increase)
3.3% (functional floodplain)	23%	31%	51%
1%	23%	31%	51%

2.2.1 Bradford Beck 2026 model outputs - climate change

Figure 2-5 shows the onsite modelled flood depths for the 1% AEP undefended event +23% for climate change. Risk is modelled to be greater in comparison to present day conditions with flooding impacting much of the centre and western side of the site. Maximum depths within the area at risk are significant, up to greater than 1.2m. Flood velocities are modelled to be largely less than or equal to 0.25 m^3/s, though there are isolated areas of greater velocity, up to between 0.5 and 1 m^3/s (Figure 2-6). The modelled flood hazard within the area at risk is varied with the deepest area of flooding, within the eastern side of the site, classified as 'danger for most' (Figure 2-7). Safe access and escape could likely be achieved from the eastern side of the site via Cape Street or the A6181 (Canal Road) during the climate change event.

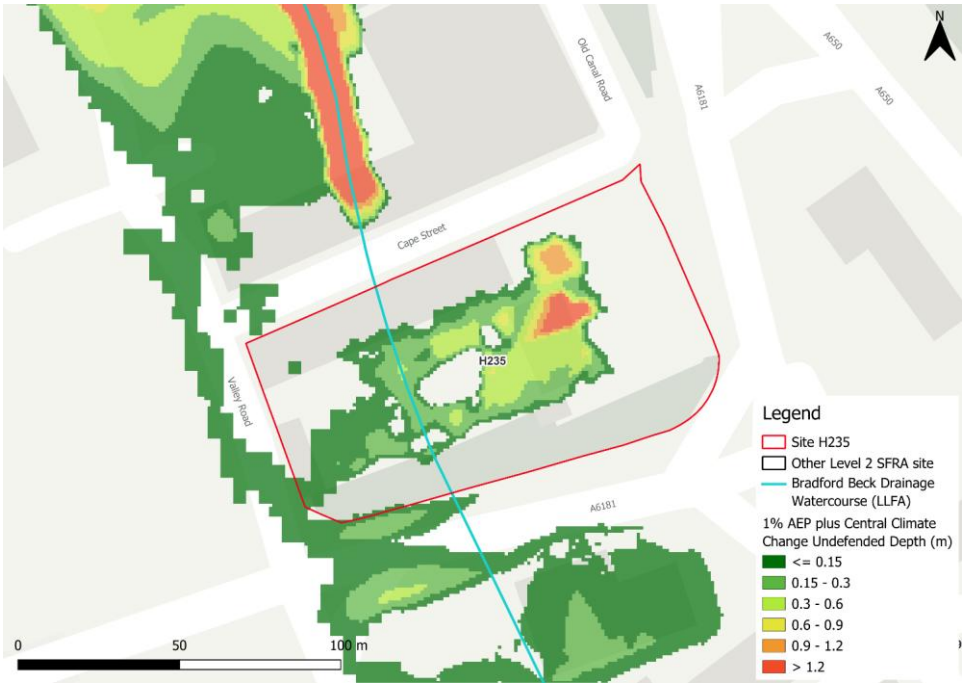


Figure 2-5: Flood depths for 1% AEP undefended flood event +23% (central climate change allowance)

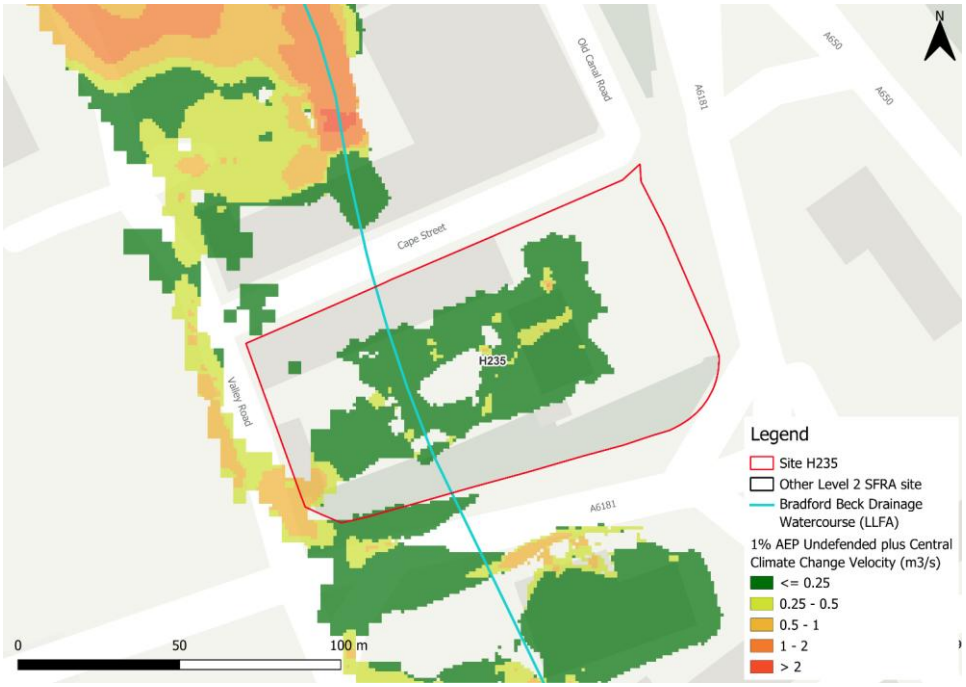


Figure 2-6: Flood velocities for 1% AEP undefended flood event +23% (central climate change allowance)

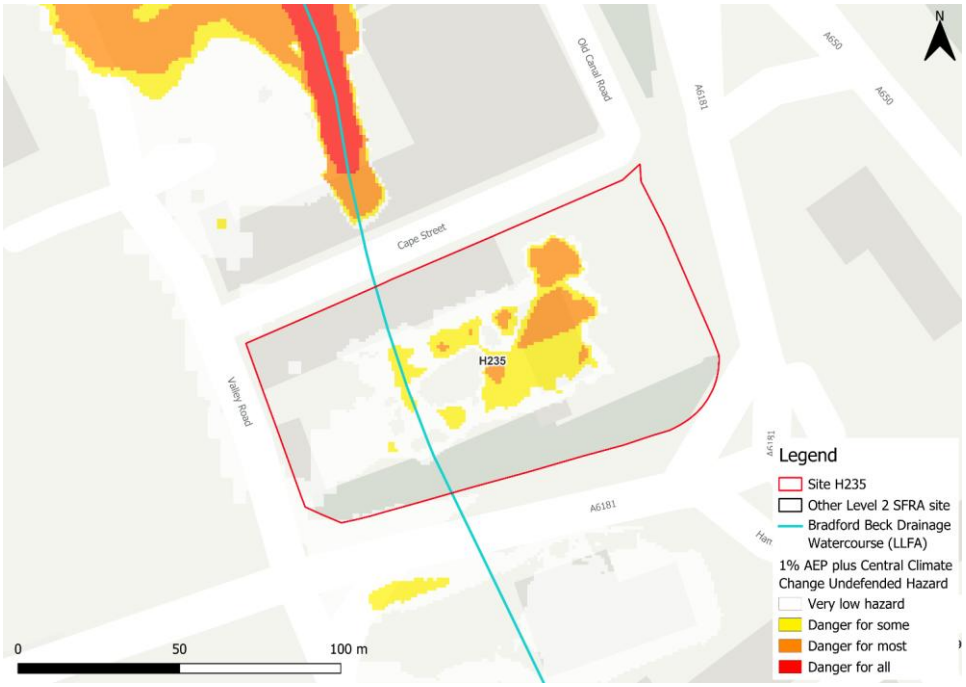


Figure 2-7: Flood hazard for 1% AEP undefended flood event +23% (central climate change allowance)

2.2.2 Flood Map for Planning - climate change

Climate change data in this area is unavailable from the EA's Flood Map for Planning plus Climate Change (2070-2125) dataset, as shown in Figure 2-8.

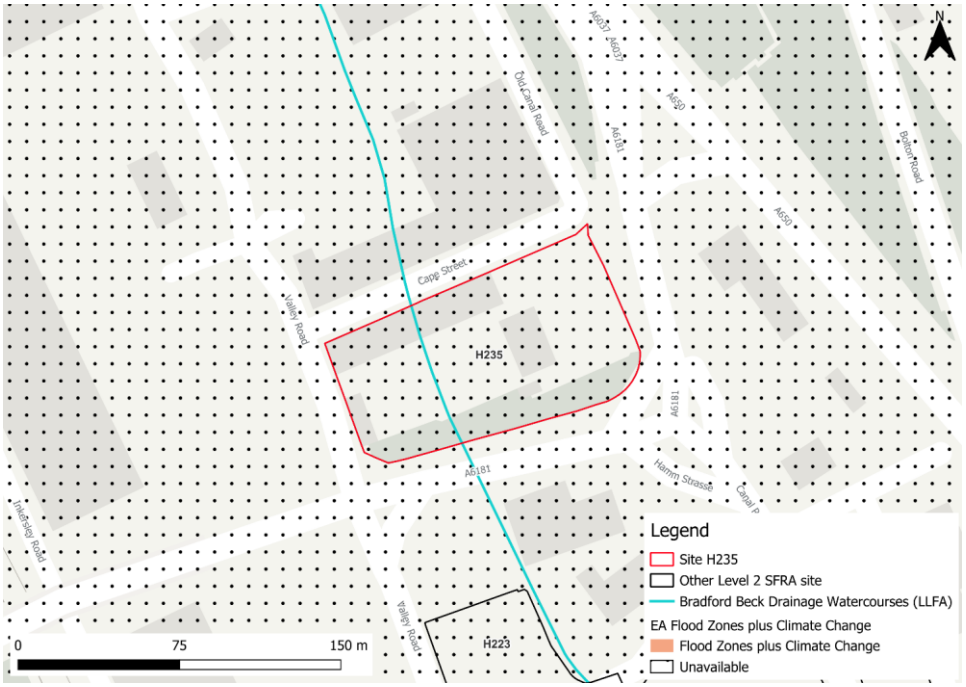


Figure 2-8: EA Flood Zones plus Climate Change

2.3 Flood risk management

2.3.1 Flood defences

The site does not benefit from any formal engineered flood defences, according to the EA's spatial flood defences dataset.

2.3.2 Working with Natural Processes

The EA's Working with Natural Processes (WwNP) dataset has been interrogated to identify opportunities for Natural Flood Management (NFM) to reduce flood risk to the site and surrounding areas. There are no applicable areas that could benefit the site.

2.4 Historic flood incidents

The EA's Historic Flood Map (HFM) and Recorded Flood Outlines (RFO) datasets have been considered. There are no recorded historic flood incidents within the vicinity of the site.

2.5 Emergency planning

2.5.1 Flood warnings

The EA operates a Flood Warning Service for properties located within a Flood Warning Area (FWA) for when a flood event is expected to occur. The entire site is located within a FWA, namely 123FWF785 - Bradford Beck and tributaries at Bradford.

Flood alerts may be issued before a flood warning for properties located within a Flood Alert Area (FAA) to provide advance notice of the possibility of flooding. A flood alert may be issued when there is less confidence that flooding will occur in a FWA. The entire site is also located within a FAA, namely 123WAF961 - Middle River Aire catchment.

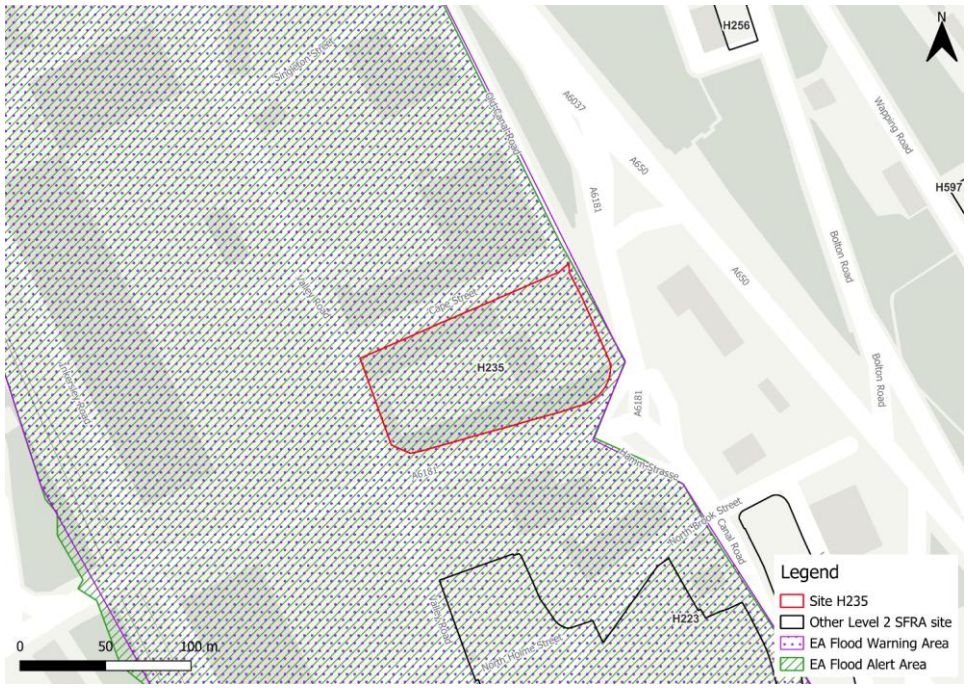


Figure 2-9: EA Flood Warning Areas and Flood Alert Areas

2.5.2 Access and escape routes

Based on available information, safe access and escape routes may be achievable during a 0.1% AEP flood event via the east of the site onto Cape Street or the A6181 (Canal Road) (Figure 2-10). Given the flood extent shown in the 1% AEP event plus 23% climate change, safe access and escape routes from the site are likely to be achievable during the climate change event.

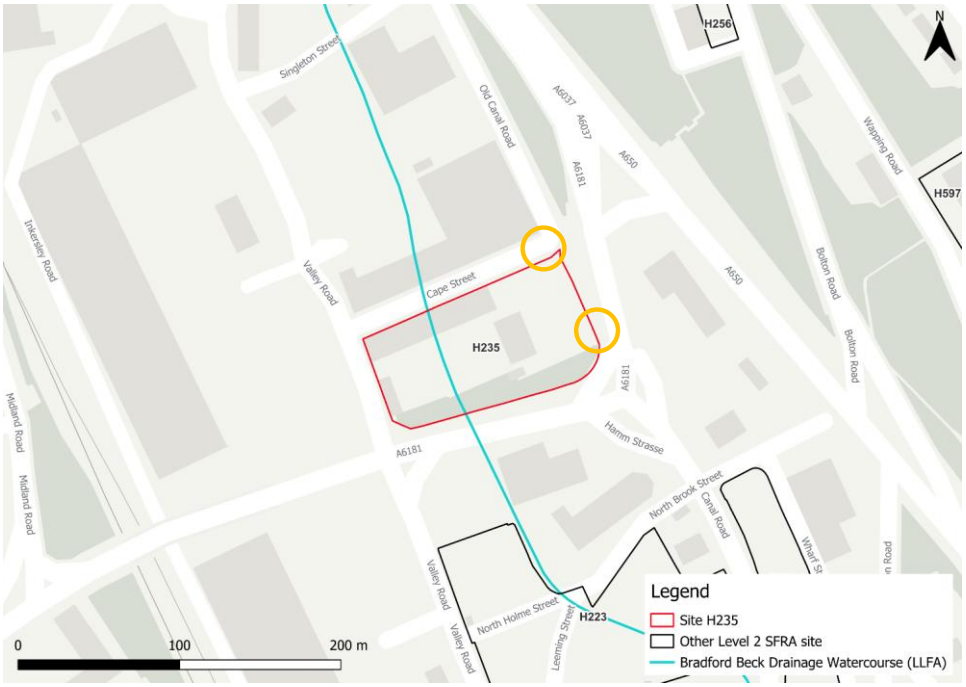


Figure 2-10: Potential access and escape routes

2.6 Observations, mitigation options, site suitability and sequential approach to development management- fluvial

- Observations
  - The proposed development of the site would see a change in the risk classification from less vulnerable to more vulnerable, according to the NPPF.
  - Given the change in use and therefore vulnerability of the site, the LPA must consider whether the change of use is acceptable and whether the development can be designed to be safe, including for adequate emergency planning provision, accounting for the information provided in this Level 2 SFRA (para 014 FRCC-PPG).
  - The existing development present onsite is a Grade II listed building. Therefore, the proposed development would see a conversion of the existing building and a subsequent change in use from commercial to residential. The LPA should consider what changes of use would be acceptable at this site (para 014 FRCC-PPG). There should be no increase in the footprint of the existing development within the areas of fluvial risk onsite.
  - ~~The~~ The site is shown to be within the functional floodplain through the centre of the site, representing the presence of the culverted Bradford Beck watercourse beneath the site. ~~Consideration should be given as to whether~~

~~deculverting and daylighting this section of culvert is feasible, supported by detailed modelling. The watercourse should be considered within site design and form a blue green corridor through the site.~~

- ~~If Bradford Beck remains culverted beneath the site, there should be no development above the culvert. The location and course of the culvert should be confirmed through a survey.~~
- If works are proposed on or near Bradford Beck, a separate permission may be required. The type of permission needed from the Lead Local Flood Authority will depend on the activity and location proposed.
- The western side and centre of the site are modelled to be at risk from fluvial sources (according to the Bradford Beck 2026 model) in the 0.1% AEP undefended scenario.
- The flood extents derived from the 2026 Bradford Beck model differs to those shown in the Flood Map for Planning (Flood Zone 3a and Flood Zone 2). The site is however not shown to flood during the modelled 1% AEP undefended event, in the Bradford Beck 2026 model. Therefore, the Flood Map for Planning requires updating with the latest model outputs from the Bradford Beck model.
- ~~Given the site is more vulnerable and within Flood Zone 3a, and also within the 1% AEP undefended event plus central climate change modelled flood outline, the site must be subject to and must pass the exception test. The site is however not shown to flood during the modelled 1% AEP undefended event (according to the Bradford Beck 2026 model).~~
- ~~Given the site is at medium risk from Bradford Beck (0.1% AEP event), and future risk with climate change is modelled to be significant, it is recommended that this site is not redeveloped for more vulnerable uses.~~
- The 1% AEP event with an allowance for climate change is what the EA considers to be the design event for a development to mitigate fluvial flood risk. Much of the site is shown to be at risk in the 1% AEP undefended +23% climate change event.

- Mitigation:
  - Were any plans for development to proceed, the site-specific FRA must show that development will be safe for its lifetime taking account of the vulnerability of its users, including for appropriate evacuation procedures and flood response infrastructure are in place to manage the fluvial risk associated with the extreme flood event.
  - Consideration should be given as to whether partially deculverting and daylighting the section of the Bradford Beck culvert currently not developed on is feasible, supported by detailed modelling. The watercourse should be considered within site design and form a blue green corridor through the site.
  - If Bradford Beck remains culverted beneath the site, there should be no additional development above the culvert. The location and course of the culvert should be confirmed through a survey.

- Within the areas of fluvial risk onsite, there may be opportunities to maintain less vulnerable uses, such as shops or businesses, situated on the ground floor with more vulnerable uses situated on the upper floors. However, safe access and escape routes must still be achievable.
- Property Flood Resilience (PFR) measures should be considered within site design to improve the flood resistance and resilience of the existing development.
-
- EA flood warnings and alerts should continue to be in place to ensure early evacuation of site users before an extreme flood event occurs.

- Access and escape:
  - Based on available information, site access and escape may be achievable in the 0.1% AEP and 1% AEP plus 23% climate change events from the east of the site.

3 Flood risk from surface water

3.1 Existing risk

At the time of writing, the EA's latest national Risk of Flooding from Surface Water (RoFSW) does not include depth and hazard information suitable for planning purposes. Therefore, this Level 2 SFRA considers the third generation RoFSW depth and hazard mapping in addition to the NaFRA2 extents, as agreed with the EA. Surface water depth and hazard should be confirmed at the site-specific FRA stage.

3.1.1 Risk of Flooding from Surface Water - NaFRA2 extents

Based on the EA's national scale Risk of Flooding from Surface Water (RoFSW) map (January 2026), surface water risk to the site is shown to vary across the site. Approximately 9% of the site is at high surface water risk. A further 42% of the site is at medium risk and a further 16% is at low surface water risk, as shown in Table 3-1.

In the high risk event, surface water risk is largely within the lower-lying centre of the site as well as in the south-eastern corner. In the medium risk event, the ponding within the centre of the site extends and merges into a large area of ponding which covers much of the western side and centre of the site. In the low risk event, surface water risk as extends further covering more of the site. Safe access and escape may remain achievable from the north-eastern corner of the site, via Cape Street.

Table 3-1: Existing surface water flood risk based on percentage area at risk using the RoFSW map

Very low risk (% area)	Low risk (% area)	Medium risk (% area)	High risk (% area)
33	16	42	9

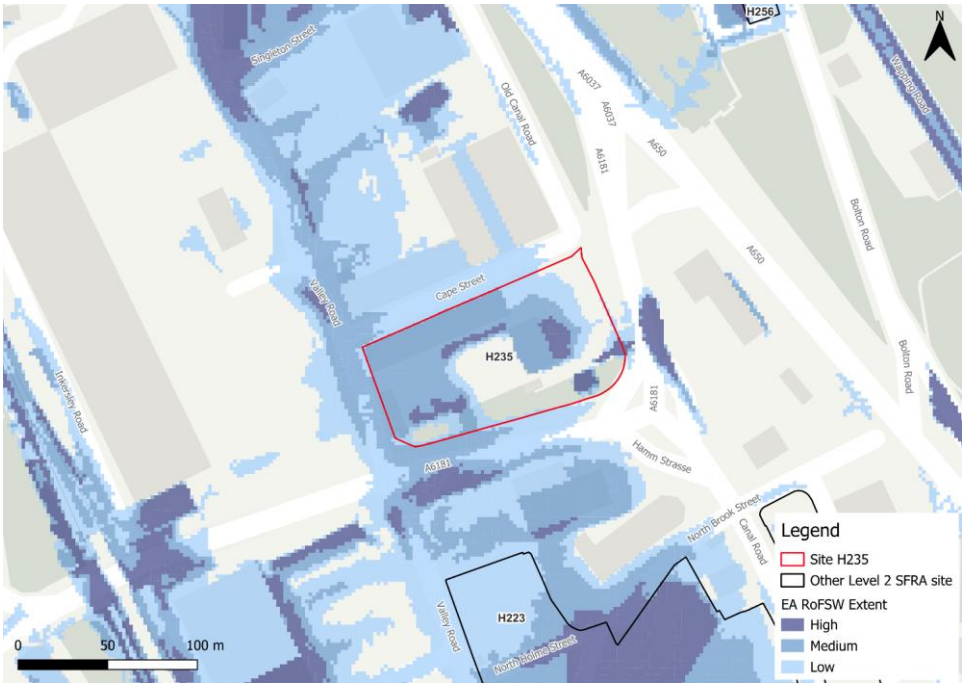


Figure 3-1: Surface water flood extents (NaFRA2 - Risk of Flooding from Surface Water map)

3.1.2 Risk of Flooding from Surface Water - third generation depths and hazards

Greatest flood depths within the site in the medium risk event are >1.2m (Figure 3-2) with hazard largely categorised as 'significant', and a small area modelled to be 'extreme' (Figure 3-3). Safe access and escape remain achievable from the north-eastern corner of the site, via Cape Street during all events. This route does become partially inundated in the medium and low risk events however depths remain largely low. Safe access and escape routes should be confirmed based on a drainage strategy through the FRA.

There are differences between the NaFRA2 RoFSW map and the third-generation depth and hazard mapping. The NaFRA2 RoFSW map does not map flooding less than 0.075m (7.5cm) in depth. Therefore, where the map may show no flooding, there may be shallow flooding up to a depth of 0.075m. In contrast, the third generation RoFSW does not map flooding with a hazard rating of less than 0.575. This could explain the differences observed between the NaFRA2 and third generation RoFSW. Assessment of surface water should be carried out at the site-specific FRA stage to robustly establish current and future surface water flood risk conditions.

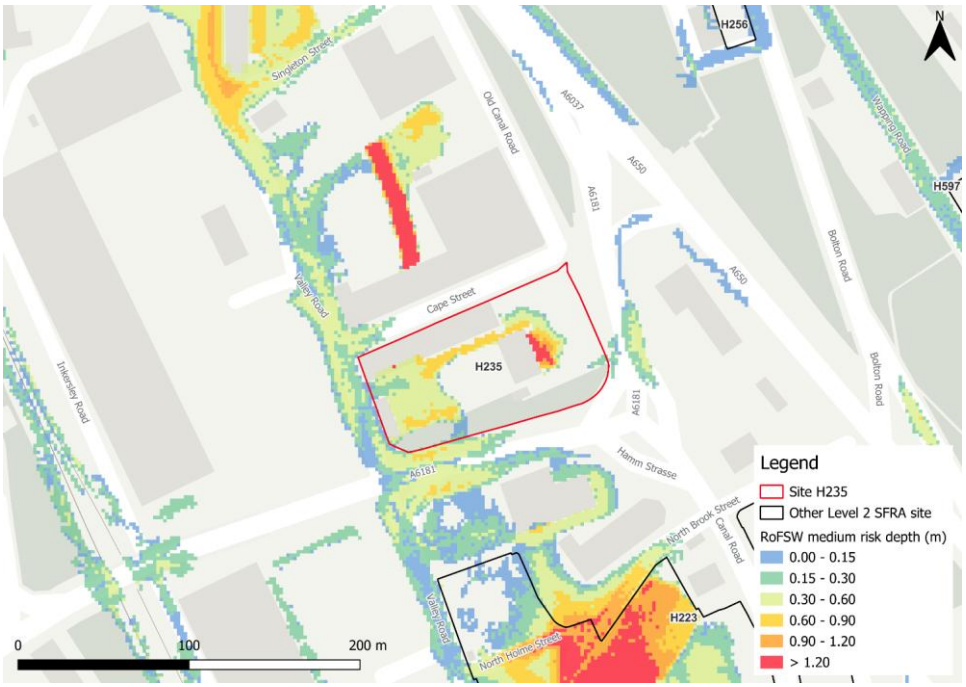


Figure 3-2: Medium risk event surface water flood depths (Risk of Flooding from Surface Water map)

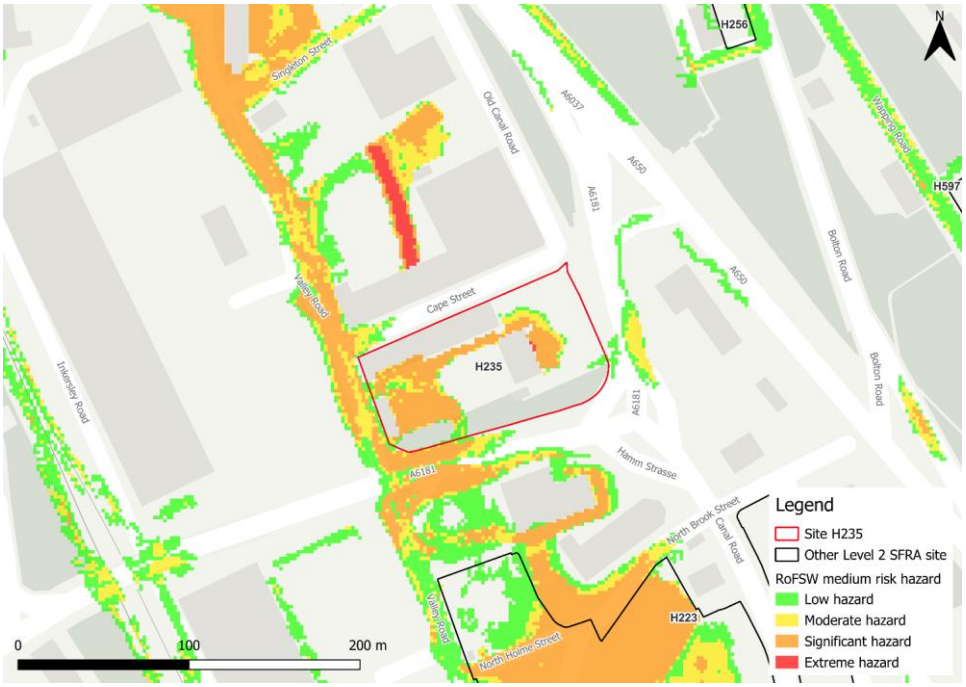


Figure 3-3: Medium risk event surface water flood hazard[2] (Risk of Flooding from Surface Water map)

3.2 Impacts from climate change

At the time of writing, the available national surface water climate change mapping is unsuitable for consideration in development planning. This Level 2 SFRA considers the low risk surface water event as a conservative proxy for the medium risk event plus climate change, as agreed with the EA. The impact of climate change on surface water flood risk should be considered at the site-specific FRA stage.

Using the low risk event as a proxy, the medium risk event is likely to increase in extent to cover much of the site when accounting for climate change (Figure 3-4). The third generation mapping indicates that maximum flood depths during the low risk event are modelled to be >1.2m (Figure 3-5), with areas of hazard categorised as 'extreme' (Figure 3-6). Safe access and escape routes may remain possible from the north-eastern corner of the site via Cape Street or the A6181 (Canal Road) with consideration to the shallow surface water depths also present during the climate change event. This should be confirmed through the site-specific FRA.

2 Based on Section 7.5 Hazard rating. What is the Risk of Flooding from Surface Water map? Report version 2.0. April 2019. Environment Agency

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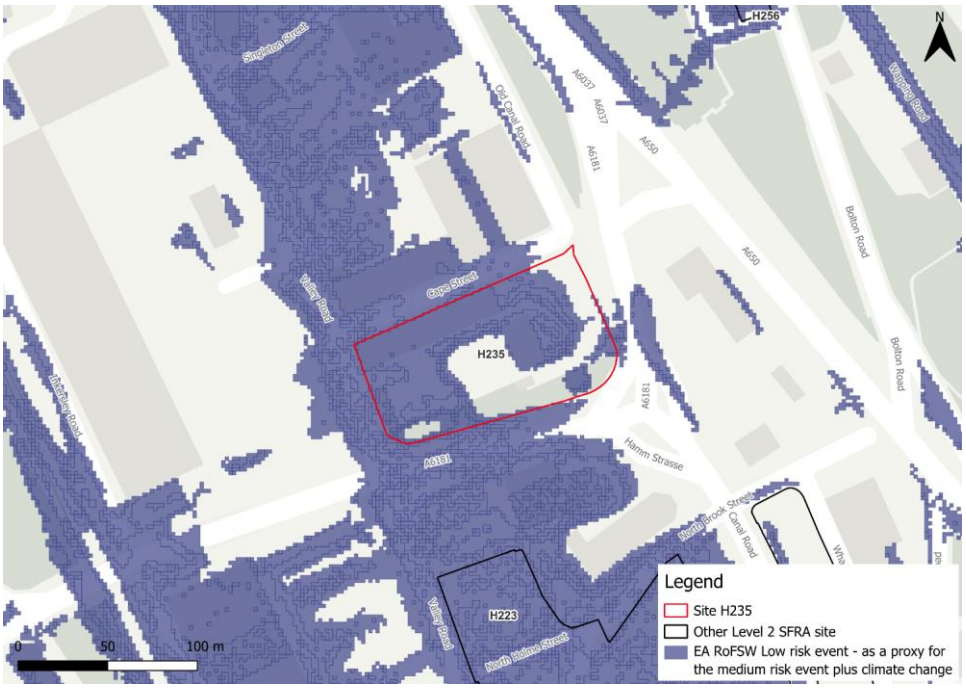


Figure 3-4: Low risk event surface water flood extent, as a proxy for the medium risk event plus climate change (NaFRA2 - Risk of Flooding from Surface Water map)

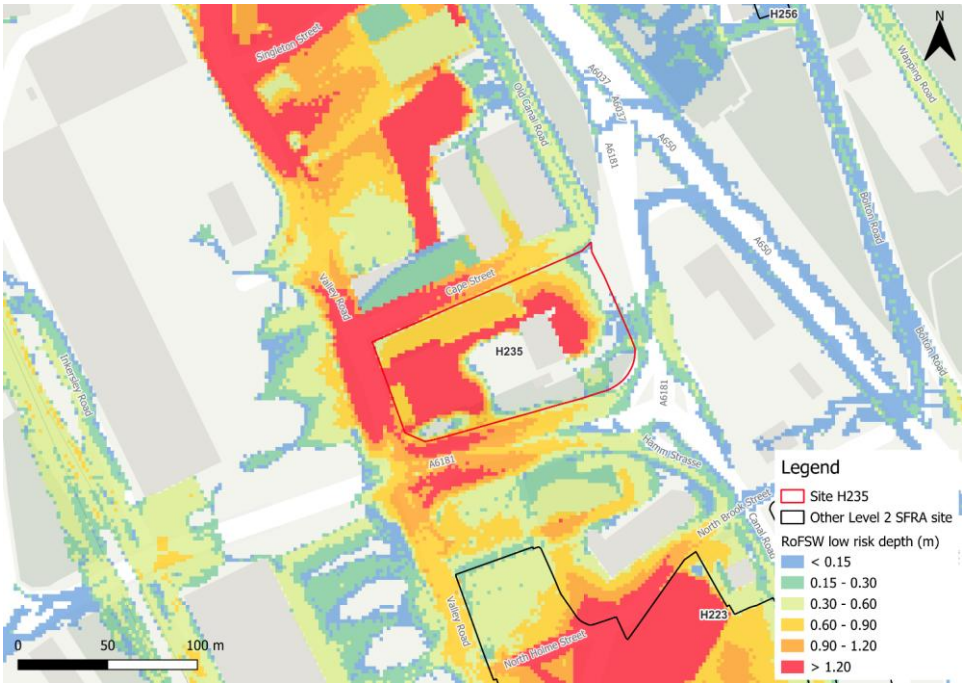


Figure 3-5: Low risk event surface water flood depths, as a proxy for the medium risk event plus climate change (Third generation - Risk of Flooding from Surface Water map)

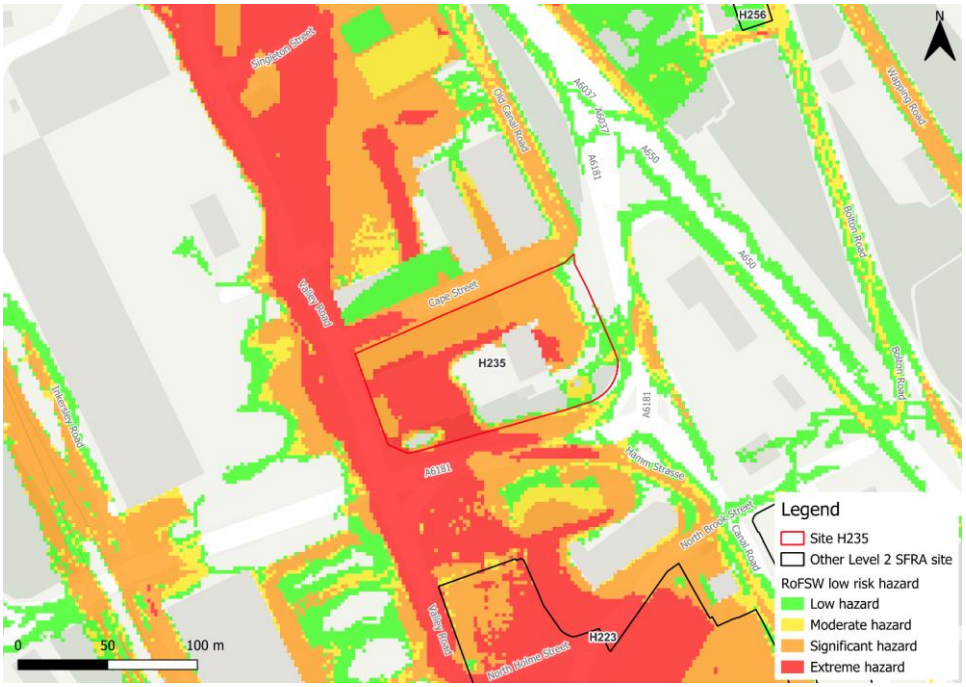


Figure 3-6: Low risk event surface water flood hazards[3], as a proxy for medium risk event plus climate change (Third generation - Risk of Flooding from Surface Water map)

3.3 Observations, mitigation options and site suitability - surface water

- The areas at surface water flood risk are within the fluvial risk areas and should therefore be included within any mitigation solutions for fluvial risk.
- Current risk is varied across the site. Surface water risk in the medium risk event is primarily within the west and centre of the site.
- Topographic depressions and flow paths should be considered and included in site design and ideally left in place to flood naturally when required. Any regrading of land must include like for like volumes to ensure risk is contained safely onsite for the lifetime of the development.
- Safe access and escape routes may be achievable via Cape Street or the A6181 (Canal Road), however these routes become partially inundated to shallow depths during the low risk and medium risk plus climate change events. This should be confirmed based on site-specific surface water modelling through the FRA.

3 Based on Section 7.5 Hazard rating. What is the Risk of Flooding from Surface Water map? Report version 2.0. April 2019. Environment Agency

- ~~Given the significant surface water risk to the site, it is recommended that this site would be converted to open greenspace for flood storage, amenity use and to provide environmental / ecological benefits.~~
- The RoFSW map is not suitable for identifying whether an individual property will flood and is therefore indicative. The RoFSW map is not appropriate to act as the sole evidence for any specific planning or regulatory decision or assessment of risk in relation to flooding at any scale without further supporting studies or evidence.

4 Risk from groundwater

Risk of groundwater emergence is assessed in this SFRA using JBA's 5m Groundwater Emergence Map. This dataset is recommended for use by the EA in the SFRA Good Practice Guide[4]. Figure 4-1 shows the map covering this site and the surrounding areas and Table 4-1 explains the risk classifications.

The entire site is located within an area where there is no risk of groundwater emergence. Groundwater conditions may therefore be suited to infiltration SuDS, however this should be considered further through the drainage strategy given the low permeability of the underlying bedrock (Figure 1-3).

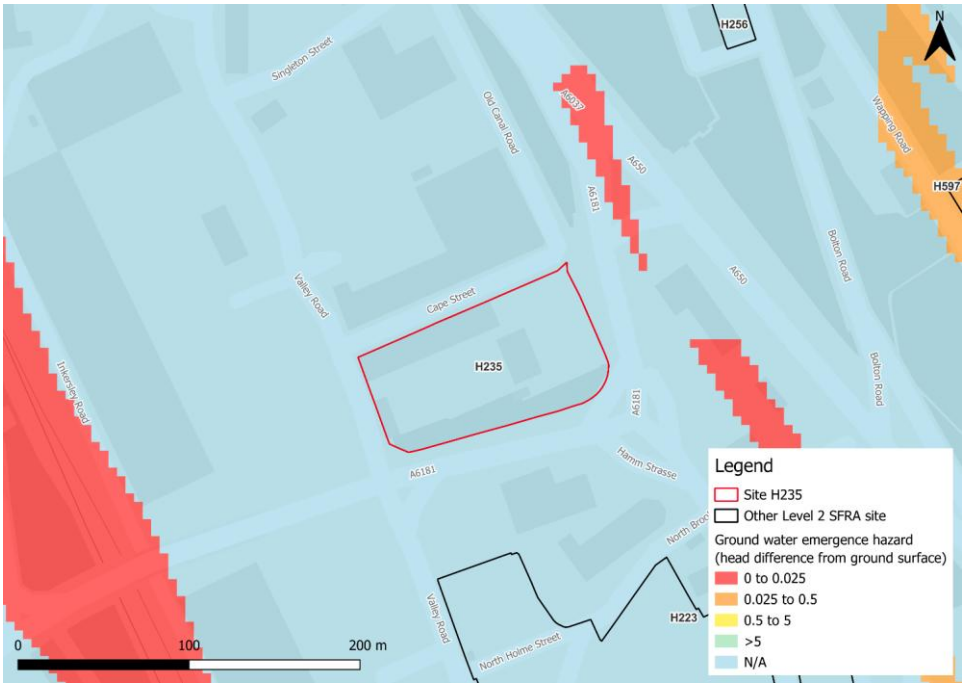


Figure 4-1: JBA 5m Groundwater Emergence Map

4 Strategic flood risk assessment good practice guide. ADEPT. December 2021.

Table 4-1: Groundwater Hazard Classification

Groundwater head difference (m)*	Class label
0 to 0.025	Groundwater levels are either at very near (within 0.025m of) the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
0.025 to 0.5	Groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
0.5 to 5	Groundwater levels are between 0.5m and 5m below the ground surface in the 100-year return period flood event There is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.
>5	Groundwater levels are at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater is not likely.
N/A	No risk. This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.
*Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.	

5 Residual risk

Although a site may be afforded some protection from defences and / or drainage infrastructure, there is always a residual risk of flooding from asset failure i.e. defence breaches, or blockages of culverts or drainage assets. Residual risk at this site comes from the potential blockage or structural failure of the structure beneath the site.

5.1 Potential blockage

A blockage of the culvert outlet approximately 40m downstream of the northern site boundary may cause water in the channel to back up and cause flooding to the site, depending on the severity of the blockage and the magnitude of the flood event. Culvert course and condition surveys may be required, including for consultation with the culvert owner.

The Bradford Beck 2026 model includes for a scenario in which all culverts within the model are blocked by 50%. Figure 5-1 shows the modelled flood depths for this scenario. The site is not modelled to flood in the baseline 1% AEP undefended event. Flooding to the site caused by a 50% blockage to the culvert downstream of the site is to depths similar to those modelled in the present day 0.1% AEP undefended event.



Figure 5-1: Flood depths for 1% AEP undefended flood event 50% culvert blockage scenario - structure downstream of the site

5.2 Flood risk from reservoirs

The EA's Reservoir Flood Maps (RFM) (2021) show where water may go in the unlikely event of a reservoir or dam failure. Figure 5-2 shows the RFM in a 'dry day' and 'wet day' scenario. A 'dry day' scenario assumes that the water level in the reservoir is the same as the spillway level or the underside of the roof for a service reservoir and the watercourses upstream and downstream of the reservoir are at a normal level. A 'wet day' scenario assumes a worst-case scenario where a reservoir releases water held on a 'wet day' when local rivers have already overflowed their banks.

The site is potentially at risk from four reservoirs located in Bradford. Of these four reservoirs, two are operated by Yorkshire Water Services Ltd and two are operated by the City of Bradford Metropolitan District Council.

The EA's SFRA guidance states that where a proposed development site is at flood risk from a reservoir, then an assessment into whether the reservoir design or maintenance schedule needs improving should be carried out. Expert advice may be required from an all-reservoirs panel engineer. The Council should consult the relevant reservoir undertaker to ascertain whether the proposed development could affect the reservoir's risk designation, its design category or how it is operated. The Council, as category 1 responders, can access more detailed information about reservoir risk and reservoir owners using the Resilience Direct system.

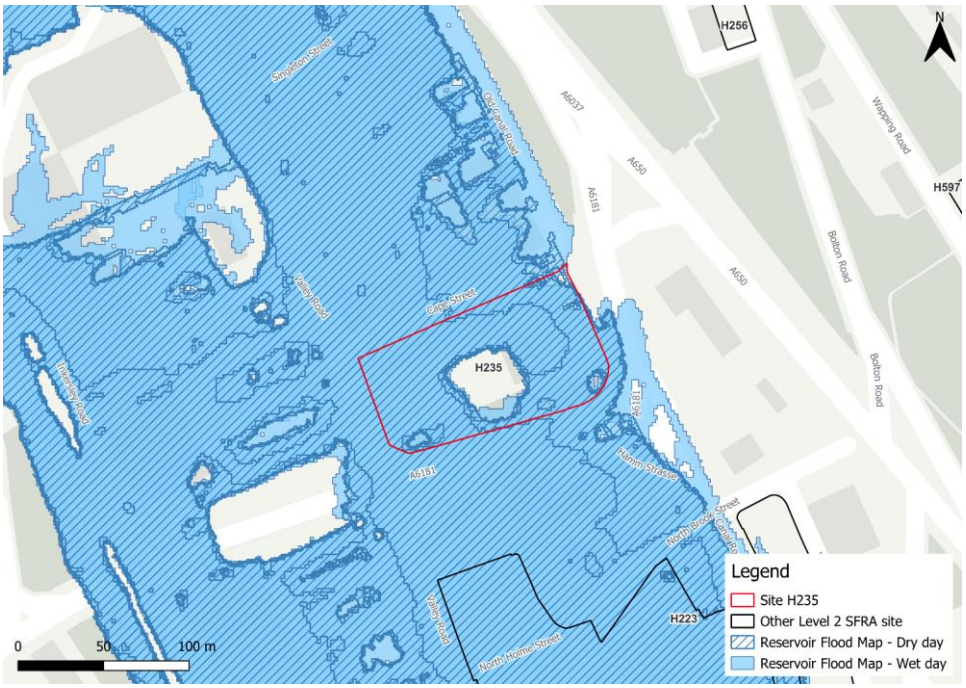


Figure 5-2: Flood risk from reservoirs

5.3 Observations, mitigation options and site suitability - residual risk

- The site is at potential residual risk from a blockage or structural failure of the culvert beneath the site. The modelled 50% culvert blockage scenario indicates that there is likely to be significant additional impacts to the site (the site does not flood in the baseline 1% AEP undefended event). The site-specific FRA could consider modelling a higher blockage proportion to understand whether there would be any additional risk to the site.
- Areas adjacent to culverts and bridges are at particular risk from the rapid onset of fast flowing and deep flooding, with little or no warning if structures become blocked. Emergency plans must be in place for such areas and safe access and escape routes must be in place for the lifetime of development. Resistance and resilience measures may also need to be put in place to manage residual flood risk when avoidance measures have been exhausted.
- The LPA should use the information on residual risk in this Level 2 SFRA to state in the local plan strategic policies a preferred mitigation strategy for ensuring development will be safe throughout its lifetime in relation to urban form, risk management and where flood mitigation measures are likely to have wider sustainable design implications (para 042, FRCC-PPG).
- The site is also at potential residual risk from a breach of four reservoirs. All four reservoirs impact the site in the 'dry day' flood extent. However, only Upper Chellow and Lower Chellow, are modelled to impact the site based on the 'wet day' flood extent, which represents a prediction of the credible worst case scenario, therefore it is unlikely that such an extreme flood event would occur.
- Given the potential reservoir risk to the site, developers should consider[5]:
  - Consulting with the local resilience forum for advice on emergency planning,
  - Consulting with relevant reservoir owners to understand the impact development may have on their reservoirs, and
  - Using this Level 2 SFRA to understand whether any proposed development will be safe throughout its lifetime.

5 Reservoir flood maps: when and how to use them | Environment Agency | 2021

6 Overall site assessment

6.1 Can part b) of the exception test be passed?

This site ~~is~~ may not be required to pass part b) of the exception test[6], ~~given~~ as it is proposed for a change of use rather than demolition of the existing buildings to make way for new development (para 014 FRCC-PPG).

~~more vulnerable uses and is located within Flood Zone 3a. It must be proven that the development can be safe for its lifetime, which is generally considered to be 100 years for residential development.~~

~~Based on the available information documented within this Level 2 SFRA, this site cannot pass the exception test given the 1% AEP event modelled future fluvial risk.~~

6.2 Recommendations summary

Based on the evidence presented in the Level 1 SFRA (2023) and this Level 2 SFRA:

- The existing development present onsite is a Grade II listed building. Therefore, the proposed development would see a conversion of the existing building and a subsequent change in use from commercial to residential. The LPA should consider what changes of use would be acceptable at this site (para 014 FRCC-PPG). There should be no increase in the footprint of the existing development within the areas of fluvial risk onsite.
- The site is shown to be within the functional floodplain through the centre of the site, representing the presence of the culverted Bradford Beck watercourse beneath the site. Consideration should be given as to whether partially deculverting and daylighting the section of culvert currently not developed on is feasible, supported by detailed modelling. The watercourse should be considered within site design and form a blue green corridor through the site.
- Within the areas of fluvial risk onsite, there may be opportunities to maintain less vulnerable uses, such as shops or businesses, situated on the ground floor with more vulnerable uses situated on the upper floors. However, safe access and escape routes must still be achievable.
- PFR measures should be considered within site design to improve the flood resistance and resilience of the existing development.~~The majority of the site is located within the 1% AEP event plus central climate change allowance modelled extent. Therefore, it is recommended that this site is converted to open space and used as a multifunctional greenspace for flood storage, amenity use and to provide environmental / ecological benefits, given the significant fluvial risk to the site.~~
-

Formatted: JBA Bullet List

Commented [JD1]: Doesn't take account of the Grade II listed building on the site and the conversion potential - need to discuss

Commented [LT2R1]: We hadn't appreciated that this was a listed building. Mike's email around change of use would apply here, in that it would be down to the LPA to decide what changes of use would be appropriate. The wording has been updated in the report to reflect the listed status of the building.

6 Para 178 National Planning Policy Framework 2024

- The Flood Map for Planning requires updating to include for the 2026 model of Bradford Beck.

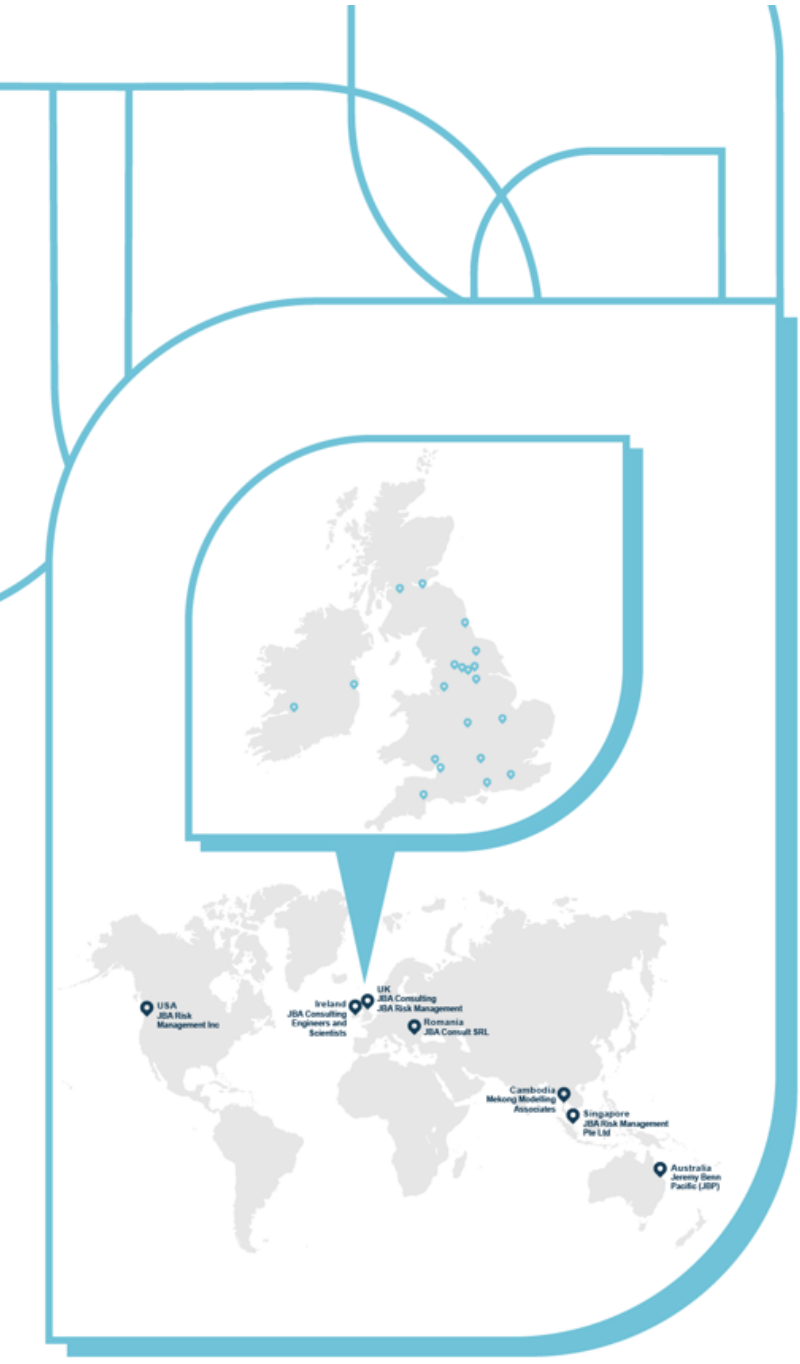
6.3 Site-specific FRA requirements and further work

- Any FRA should be carried out in line with the latest versions of the NPPF; FRCC-PPG; EA guidance; the CBMDC Local Plan and national and local SuDS policy and guidelines.
- Throughout the FRA process, consultation should be carried out with the following, where applicable, the local planning authority; the lead local flood authority; emergency planning officers; the Environment Agency; Yorkshire Water; the highways authorities; and the emergency services.

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Bradford Level 2 Strategic Flood Risk Assessment - Site H636

Final Draft

May 2025

Prepared for:

City of BRADFORD METROPOLITAN DISTRICT COUNCIL

www.jbaconsulting.com

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Contract

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JBA Project Code	2024s1078

This report describes work commissioned by City of Bradford Metropolitan District Council (CBMDC) by an instruction dated 19 July 2024. The Client's representative for the contract was Jonathan Dicken of CBMDC. Freya Nation of JBA Consulting carried out this work.

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Acknowledgements

We would like to thank the Environment Agency and Yorkshire Water for their assistance with this work.

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1 Background

This is a Level 2 Strategic Flood Risk Assessment (SFRA) site screening report for the City of Bradford Metropolitan District Council (CBMDC) Local Plan Site H636. The content of this Level 2 SFRA site screening report assumes the reader has already consulted the 'CBMDC Level 1 SFRA' (2023) and read the 'CBMDC Level 2 SFRA Main Report' (2024) and is therefore familiar with the terminology used in this report.

1.1 Site H636

- Location: Land east of Harrogate Road, Greengates
- Existing site use: Agricultural (grazing)
- Existing site use vulnerability: Less vulnerable
- Proposed site use: Residential
- Proposed site use vulnerability: More vulnerable
- Site area: 1 hectare
- Proposed development impermeable area: 0.9 hectares
- Environment Agency (EA) river model: N/A
- Watercourse: Carr Beck
- Summary of requirements from scoping stage:
    - Level 1 SFRA recommendation was for withdrawal from allocation or more detailed assessment through Level 2 SFRA
    - Subject to the exception test as more vulnerable development proposed in Flood Zone 3a
    - Assessment of modelled fluvial flood depths, velocities and hazards
    - Assessment of surface water flood depths and hazards based on the EA's national Risk of Flooding from Surface Water dataset
    - Assessment of all other sources of flood risk
    - Modelling of residual risk from Carr Beck culvert



Figure 1-1: Existing site location boundary

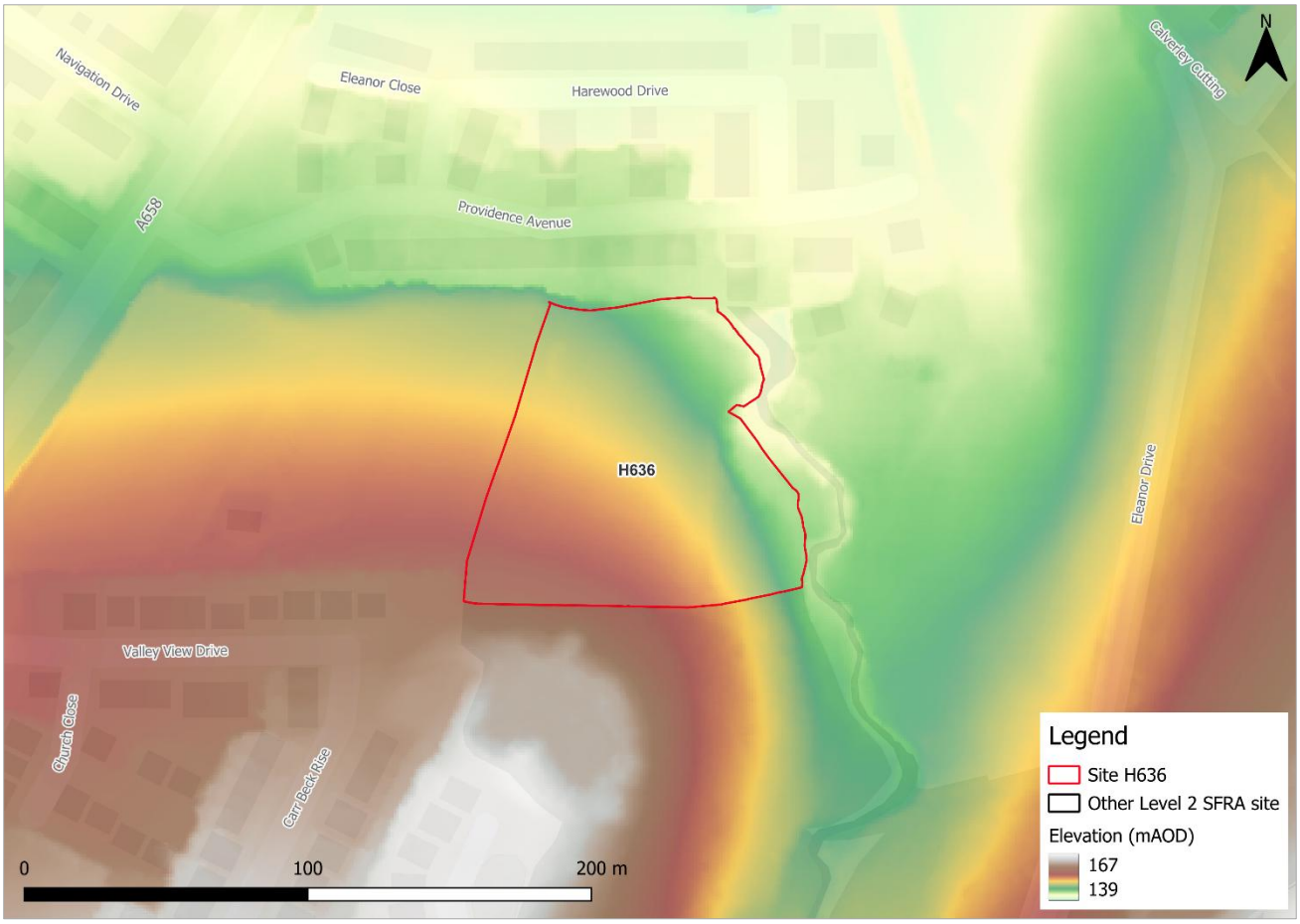


Figure 1-2: Topography

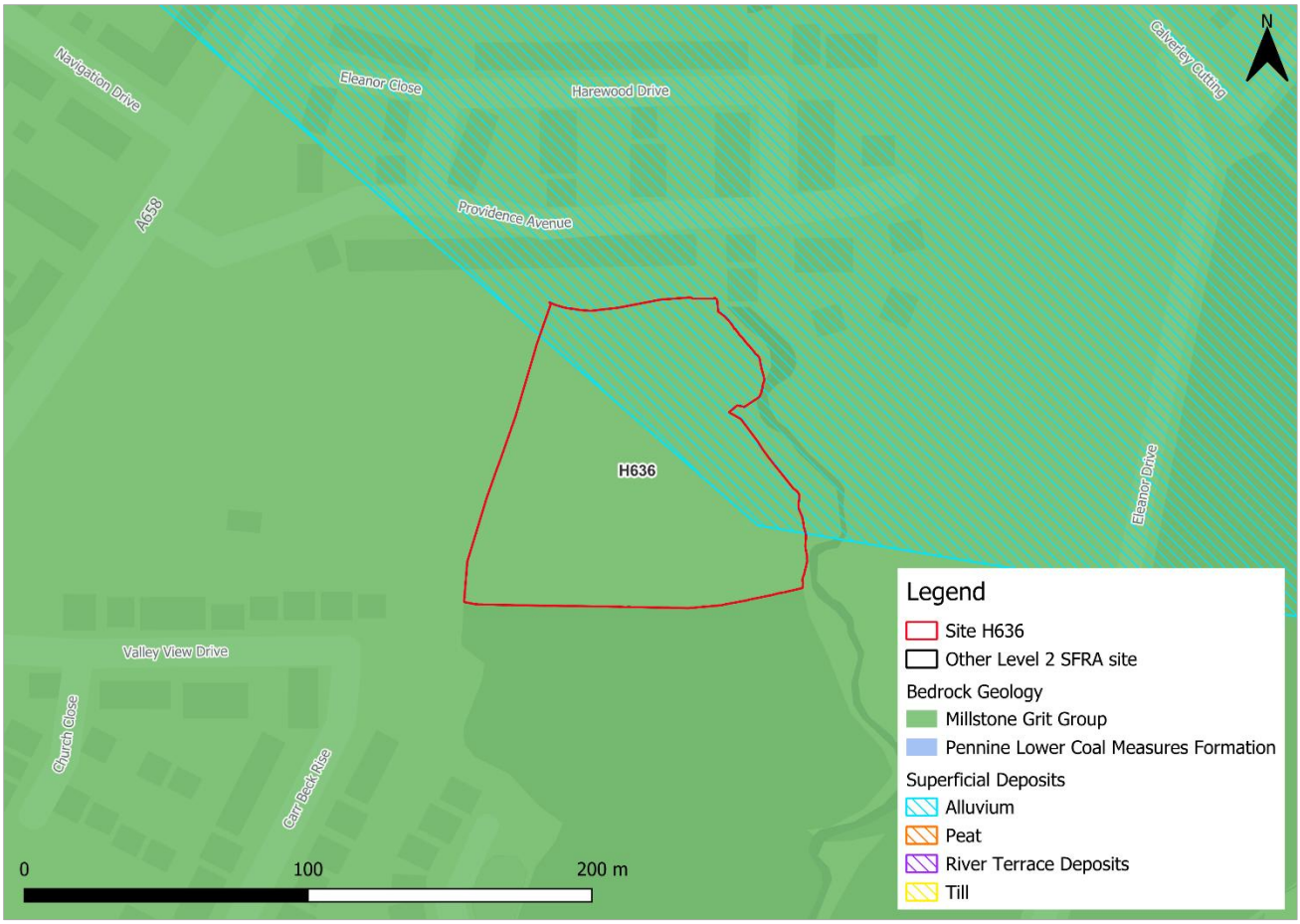


Figure 1-3: Soils and geology

2 Flood risk from rivers

2.1 Existing risk

2.1.1 Flood Map for Planning and functional floodplain

Based on the EA's Flood Map for Planning and Flood Zone 3b (functional floodplain), as updated in this Level 2 SFRA, the percentage areas of the site within each fluvial flood zone are stated in Table 2-1 and can be viewed on Figure 2-1. This version of the Flood Map for Planning does not consider flood defence infrastructure (Section 2.3) or the impacts of climate change (Section 2.2).

The majority of the site is modelled to be within Flood Zone 1. 7% of the site, namely adjacent to the course of Carr Beck (along the eastern site boundary) is within Flood Zone 3b, indicating it is at high risk of flooding from rivers. Additionally, further parts of the east of the site are within Flood Zone 2, indicating they are at medium risk of flooding from rivers, however this is only 1% of the site.

A model has not been made available for Carr Beck which is an ordinary watercourse, therefore the functional floodplain in this area is based on Flood Zone 3a of the Flood Map for Planning. The EA should be consulted on the data source of the Flood Map for Planning in this location. If the Flood Map for Planning is based on a detailed model of Carr Beck, any updates to this Level 2 SFRA and/or any site-specific FRA should make use of this model to understand modelled depths and hazards within the site.

Table 2-1: Existing fluvial flood risk based on percentage area of site at risk

Flood Zone 1 (% area)	Flood Zone 2 (% area)	Flood Zone 3a (% area)	Flood Zone 3b (% area)
92	1	0	7



Figure 2-1: Existing risk from rivers to the site

2.2 Impacts from climate change

The impact of climate change on flood risk from Carr Beck has not been modelled for this SFRA, as a model covering this watercourse was not made available for consideration. Therefore, in the absence of modelled climate change information, Flood Zone 2 of the Flood Map for Planning (based on the 0.1% AEP undefended event) can be used as a precautionary proxy for Flood Zone 3 plus climate change. Based on this approach, fluvial risk may increase in extent comparison to present day (Figure 2-1).

The impacts of climate change must be modelled using the EA's latest allowances for peak river flows to inform whether the site can be safe for its lifetime. The EA should be consulted on the data source of the Flood Map for Planning in this location. If the Flood Map for Planning is based on a detailed model of Carr Beck, any updates to this Level 2 SFRA and/or any site-specific FRA should make use of this model and include for the most up to date climate change allowances.

2.3 Flood risk management

2.3.1 Flood defences

The site does not benefit from any formal engineered flood defences, according to the EA's spatial flood defences dataset.

2.3.2 Working with Natural Processes

The EA's Working with Natural Processes (WwNP) dataset has been interrogated to identify opportunities for Natural Flood Management (NFM) to reduce flood risk to the site and surrounding areas. Within the site there is potential for riparian, wider catchment and floodplain tree planting. Tree planting can intercept, slow, store and filter water. In turn, this can reduce flood peaks and frequency, reduce sediment delivery to the watercourse and reduce bankside erosion. These areas are shown in Figure 2-2. The WwNP mapping is broadscale and indicative. Further investigation is required for any land shown to have potential for WwNP.

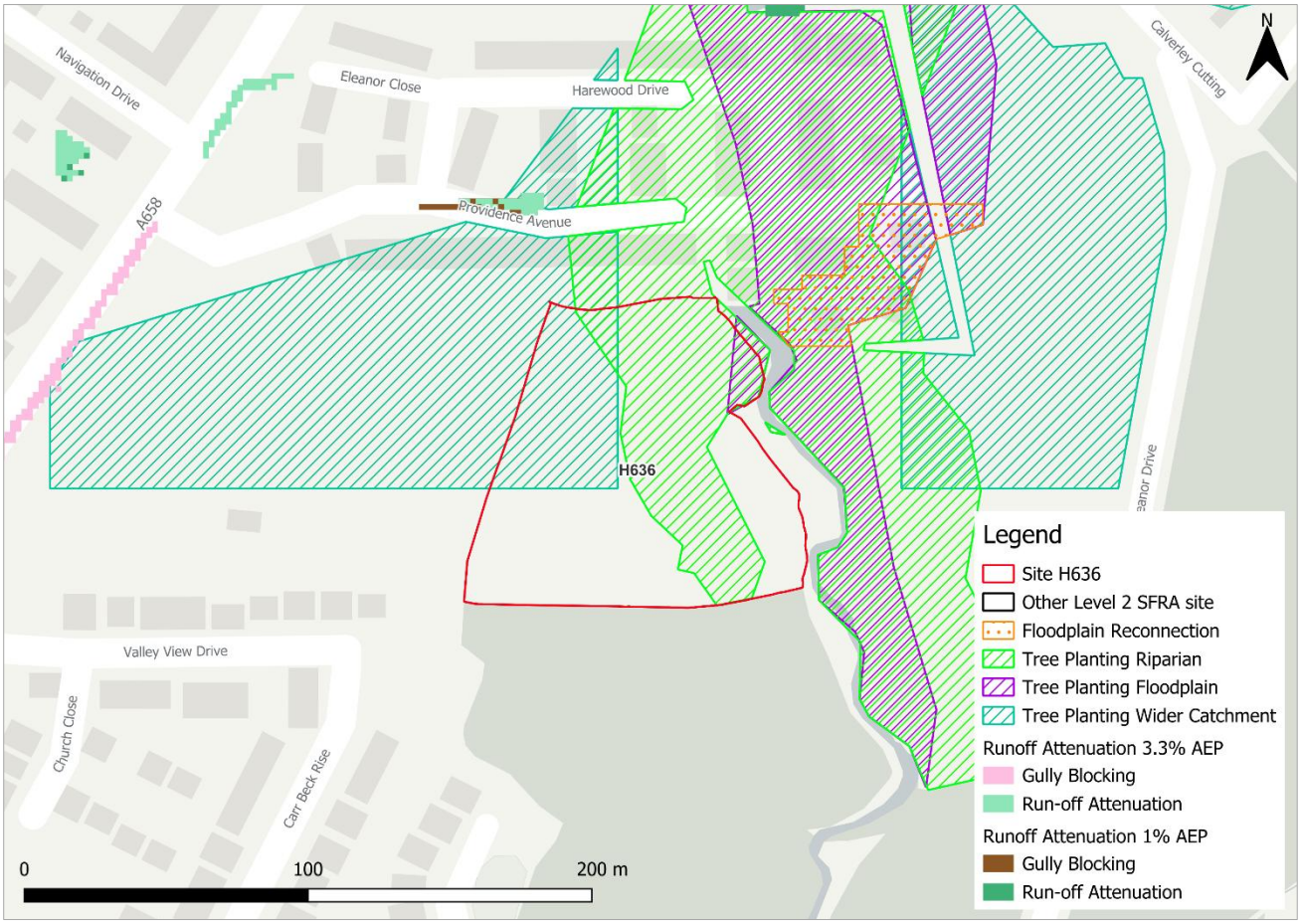


Figure 2-2: Natural Flood Management (NFM) potential mapping

2.4 Historic flood incidents

The EA's Historic Flood Map (HFM) and Recorded Flood Outlines (RFO) datasets have been considered. There are no recorded historic flood incidents within the vicinity of the site.

2.5 Flood warning and access and escape routes

The EA operates a Flood Warning Service for properties located within a Flood Warning Area (FWA) for when a flood event is expected to occur. The site is located within a FWA, namely 123FWF121 - River Aire at Esholt and Apperley Bridge, as shown in Figure 2-3.

Flood alerts may be issued before a flood warning for properties located within a Flood Alert Area (FAA) to provide advance notice of the possibility of flooding. A flood alert may be issued when there is less confidence that flooding will occur in a FWA. This site is located within a FAA, namely 123WAF961 - Middle River Aire catchment.

Based on available information, safe access and escape routes could likely be achieved during a flood event via the A658 (Harrogate Road) to the west of the site, travelling south.

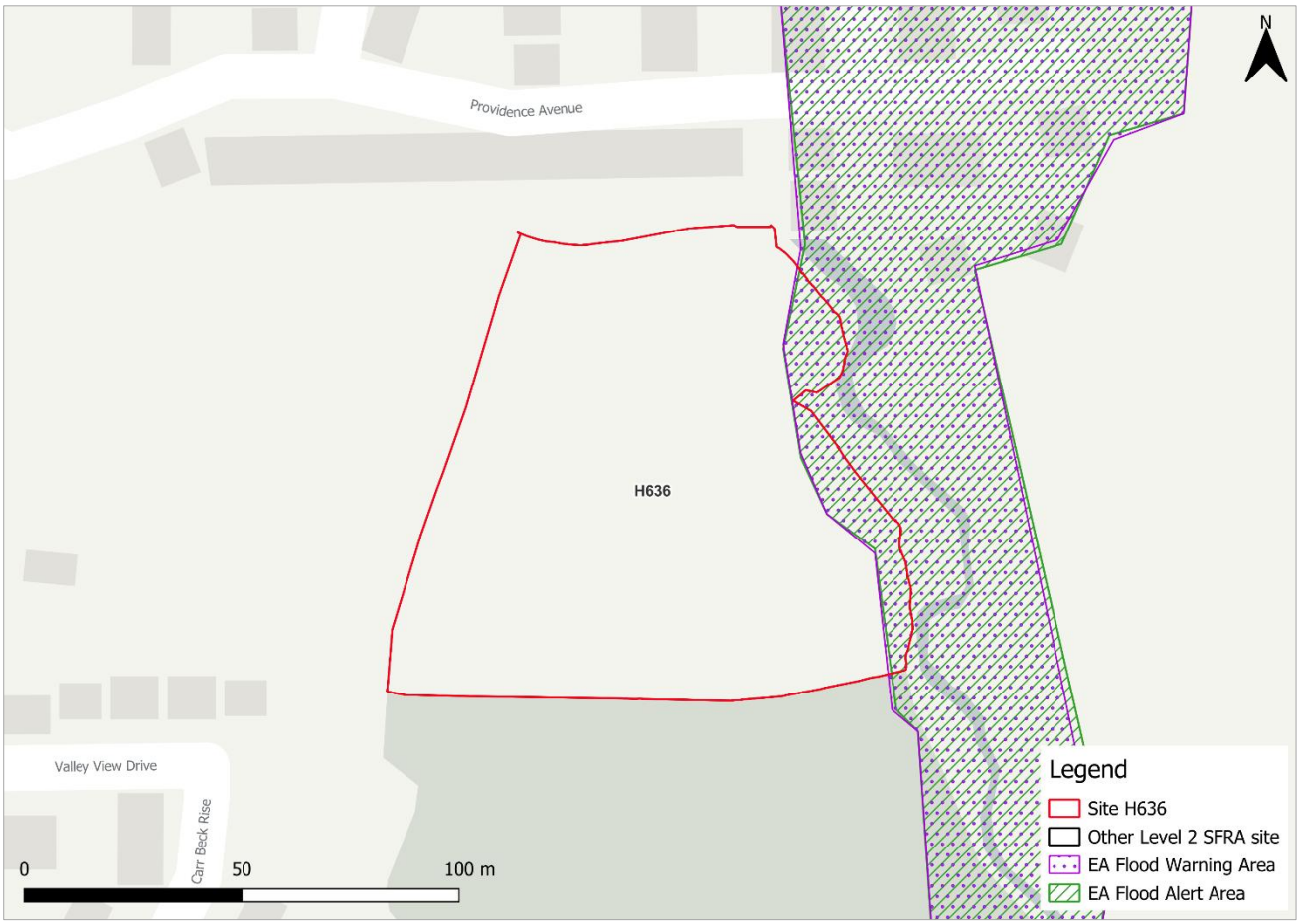


Figure 2-3: EA Flood Warning Areas and Flood Alert Areas

2.6 Observations, mitigation options and site suitability - fluvial

- The proposed development of the site would see a change in the risk classification from less vulnerable to more vulnerable, according to the NPPF.
- Given the change in use and therefore vulnerability of the site, the FRA must show that the development can be designed to be safe and that there is adequate emergency planning provision (para 014 FRCC-PPG).
- However, the site is modelled to be within the functional floodplain and Flood Zone 3a along the eastern boundary of the site, adjacent to Carr Beck. Development is not permitted within the functional floodplain and development should avoid Flood Zone 3a. If feasible, this area would be used as a green / blue corridor which can provide multifunctional benefits providing ecological, social and amenity value.
- Given the site is more vulnerable and within Flood Zone 3a the site must be subject to and must pass the exception test.
- The EA's Flood Zone 2 extent has been used as a proxy to provide a precautionary estimate of the 1% AEP undefended event plus climate change. Based on this approach, fluvial risk is modelled to marginally increase in extent in comparison to the present day Flood Zone 3b and 3a, impacting the eastern side of the site.
- The EA should be consulted on the data source of the Flood Map for Planning in this location. If the Flood Map for Planning is based on a detailed model of Carr Beck, any updates to this Level 2 SFRA and/or any site-specific FRA should make use of this model and include for the most up to date climate change allowances to fully ascertain fluvial risk to this site.
- Given Carr Beck is an ordinary watercourse, for works on or near the ordinary watercourse, which have the potential to obstruct flow, the developer must apply for Ordinary Watercourse Consent from the LLFA.
- EA flood warnings and alerts should continue to be in place to ensure early evacuation of site users before an extreme flood event occurs.
- Safe access and escape routes could likely be achieved during a flood event via the A658 to the west of the site, based on available information.

3 Flood risk from surface water

3.1 Existing risk

Based on the EA's national scale Risk of Flooding from Surface Water (RoFSW) map, surface water risk is predominantly very low. However, 2% of the site is within the low risk zone, 1% in the medium risk and 1% in the high risk, as shown in Table 3-1.

In the high risk event, surface water is confined to the northern half of the eastern site boundary, adjacent to the flow path along Carr Beck and therefore within the functional floodplain. In the medium risk event, flooding encroaches marginally further across the eastern site boundary. In the low risk event, flooding encroaches further into the site, particularly into the northeastern site corner.

Greatest flood depths within the site during the medium risk event are > 1.2 m (Figure 3-1) with areas of hazard classified as extreme (Figure 3-2). Safe access and escape routes may remain achievable in all events via the A658 to the west of the site, though during the extreme event it should be noted there is a flow path with a hazard classified as moderate along parts of this road.

Table 3-1: Existing surface water flood risk based on percentage area at risk using the RoFSW map

Very low risk (% area)	Low risk (% area)	Medium risk (% area)	High risk (% area)
96	2	1	1

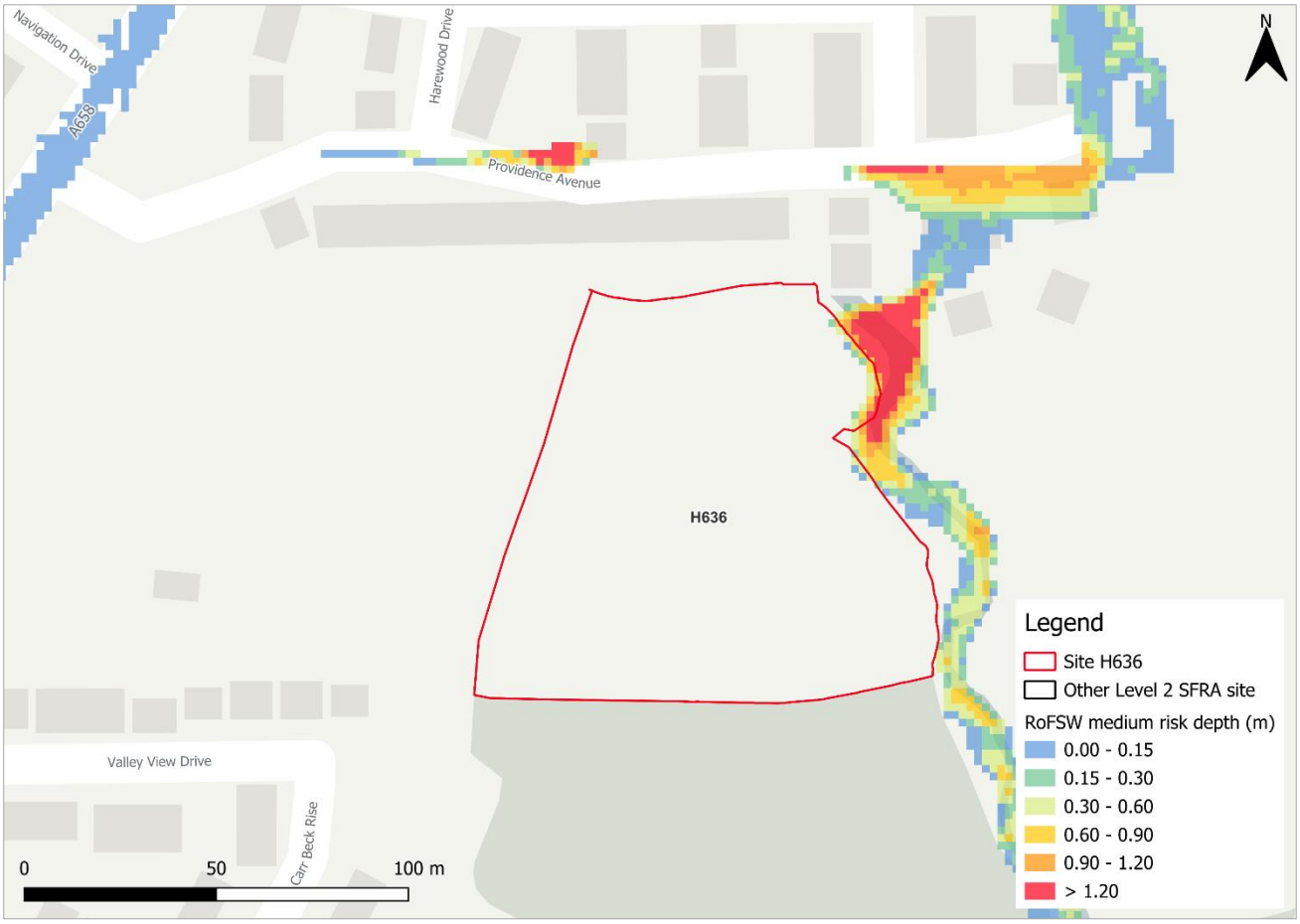


Figure 3-1: Medium risk event surface water flood depths (Risk of Flooding from Surface Water map)

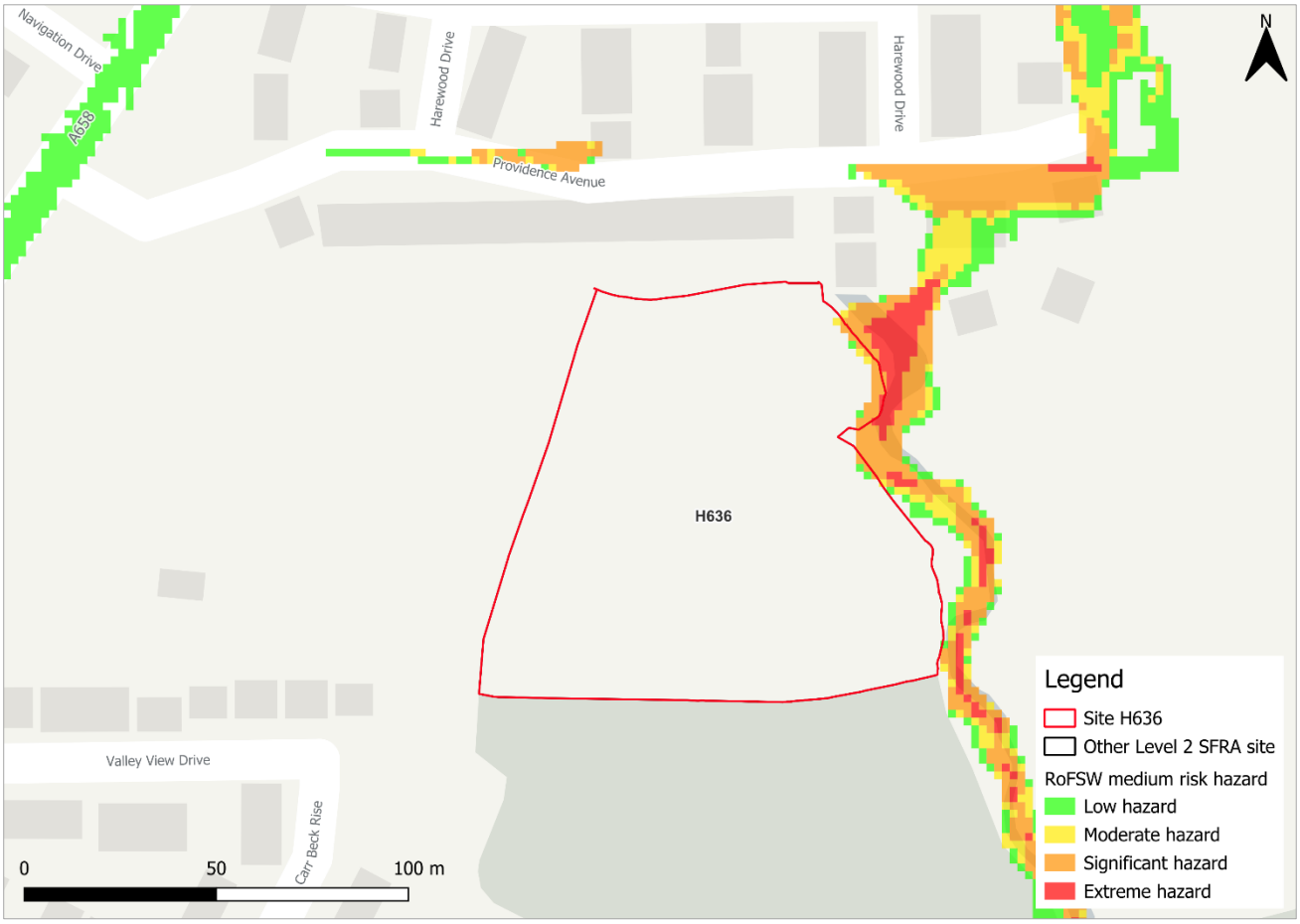


Figure 3-2: Medium risk event surface water flood hazard[1] (Risk of Flooding from Surface Water map)

3.2 Impacts from climate change

The impact of climate change on surface water flood risk has been modelled. This allows for direct comparison with the RoFSW map. With consideration of the EA's SFRA guidance, the latest climate change allowances have been modelled as shown in Table 3-2.

Table 3-2: Modelled climate change allowances for rainfall for the Aire and Calder management catchment

Return period	Central allowance 2070s (% increase)	Upper end allowance 2070s (% increase)
3.3% (high risk)	25%	40%
1% (medium risk)	30%	45%

Figure 3-3 shows the modelled surface water flood depths for the medium risk event +45% climate change. Risk is modelled to be greater than for present day conditions, with the

1 Based on Section 7.5 Hazard rating. What is the Risk of Flooding from Surface Water map? Report version 2.0. April 2019. Environment Agency

medium risk climate change event showing a similar level of risk to the low risk present day event. Maximum depths remain > 1.2 m, particularly along the eastern site boundary, with areas of hazard categorised as extreme (Figure 3-4). Safe access and escape routes may remain achievable in all events via the A658 to the west of the site, though during the extreme event it should be noted there is a flow path with a hazard classified as moderate along parts of this road.

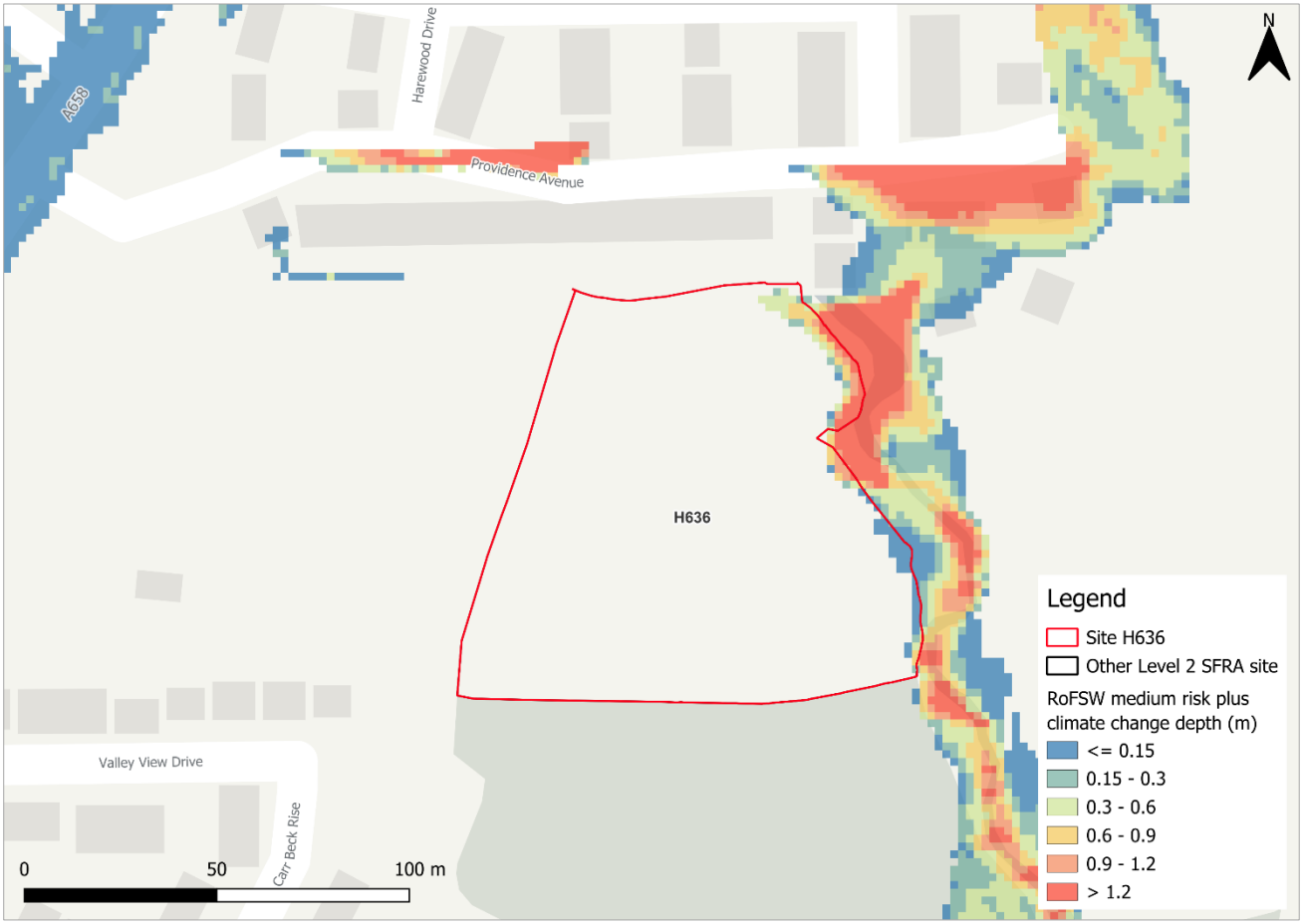


Figure 3-3: Medium risk event surface water flood depths plus 45% climate change (based on Risk of Flooding from Surface Water map)

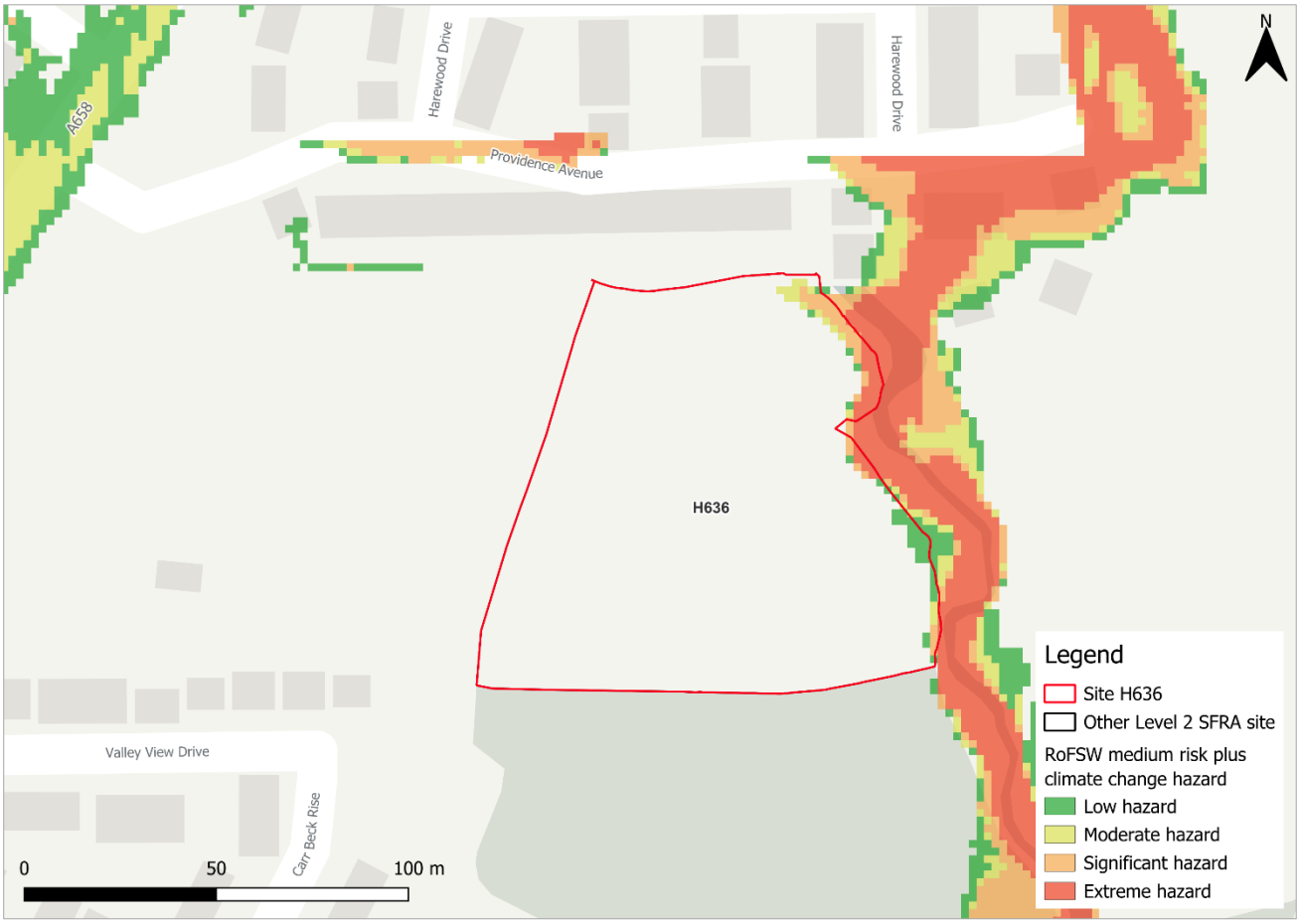


Figure 3-4: Medium risk event surface water flood hazards plus 45% climate change (based on Risk of Flooding from Surface Water map)

3.3 Observations, mitigation options and site suitability - surface water

- Current and future risk to the site are predominantly very low, with approximately 96% of the site being at very low risk. However, there is significant risk along the eastern border of the site during all events. Development should not take place within 8 metres of the riverbank which should alleviate the surface water and fluvial risk.
- Safe access and escape routes may be achievable via the A658 in all events, though in the extreme event it should be noted that there is flooding with a significant hazard rating in the flow path on this road.
- The use of appropriate SuDS should be investigated. The groundwater table is varied across the site judging from the Groundwater Emergence Map in Figure 4-1, therefore investigation into suitable SuDS will require appropriate ground and infiltration survey, and drainage design should include surface water modelling based on layout plans and detailed design and full consultation with the LLFA.
- Note that the RoFSW map is not suitable for identifying whether an individual property will flood and is therefore indicative. The RoFSW map is not appropriate to act as the sole evidence for any specific planning or regulatory decision or

assessment of risk in relation to flooding at any scale without further supporting studies or evidence.

4 Risk from groundwater

Risk of groundwater emergence is assessed in this SFRA using JBA's 5m Groundwater Emergence Map. This dataset is recommended for use by the EA in the SFRA Good Practice Guide[2]. Figure 4-1 shows the map covering this site and the surrounding areas and Table 4-1 explains the risk classifications.

The site is located across an area with various groundwater risk. Along the eastern site boundary and across part of the southwest of the site there is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely. At the southwestern corner of the site flooding from groundwater is not likely and in the remainder of the site there is no risk of groundwater emergence.



Figure 4-1: JBA 5m Groundwater Emergence Map

2 Strategic flood risk assessment good practice guide. ADEPT. December 2021.

Table 4-1: Groundwater Hazard Classification

Groundwater head difference (m)*	Class label
0 to 0.025	Groundwater levels are either at very near (within 0.025m of) the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
0.025 to 0.5	Groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
0.5 to 5	Groundwater levels are between 0.5m and 5m below the ground surface in the 100-year return period flood event There is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.
>5	Groundwater levels are at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater is not likely.
N/A	No risk. This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.
*Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.	

5 Residual risk

Although a site may be afforded some protection from defences and / or drainage infrastructure, there is always a residual risk of flooding from asset failure i.e. breaching / overtopping of flood defences, blockages of culverts or bridge openings.

Residual risk at this site comes from possible blockage of the culvert beneath Providence Avenue, as shown in Figure 5-1. Residual risk could not be modelled for this culvert given the absence of a suitable river model for Carr Beck. The EA should be consulted on the data source of the Flood Map for Planning in this location. If the Flood Map for Planning is based on a detailed model of Carr Beck, any updates to this Level 2 SFRA and/or any site-specific FRA should make use of this model to understand modelled residual risk of culvert blockage within the site.



Figure 5-1: Potential blockage location

5.1 Flood risk from canals

The site is not likely to be at risk from a canal breach.

5.2 Flood risk from reservoirs

The EA's Reservoir Flood Maps (RFM) (2021) show where water may go in the unlikely event of a reservoir or dam failure. A 'dry day' scenario assumes that the water level in the reservoir is the same as the spillway level or the underside of the roof for a service reservoir and the watercourses upstream and downstream of the reservoir are at a normal level. A 'wet day' scenario assumes a worst-case scenario where a reservoir releases water held on a 'wet day' when local rivers have already overflowed their banks.

The not shown to be at risk of reservoir flooding.

5.3 Flood risk from sewers

Flooding from the sewer network can occur when flow entering the system, such as an urban storm water drainage system, exceeds its available discharge capacity, the system becomes overloaded, blocked or it cannot discharge due to a high water level in the receiving watercourse.

According to Yorkshire Water's records, there have been no incidents of sewer flooding in the area over the last two years.

5.4 Observations, mitigation options and site suitability - residual risk

- There is residual risk to the site from a blockage of the Carr Beck culvert beneath Providence Avenue. The owner of this culvert is currently unknown. Once established, the owner should be able to advise on funding and maintenance arrangements for this asset into the future. Consultation with the LLFA will also be required given this is an ordinary watercourse.
- Areas adjacent to culverts and bridges are at particular risk from the rapid onset of fast flowing and deep flooding, with little or no warning if structures become blocked. Emergency plans must be in place for such areas and safe access and egress routes must be in place for the lifetime of development. Resistance and resilience measures may also be put in place to manage residual flood risk when avoidance measures have been exhausted.
- Given the potential residual risk to this site, the following should be considered:
    - Use of flood resistance and resilience measures,
    - Adequate flood warnings and alerts should remain in place, in consultation with the EA,
    - Provision of emergency escape routes including for vehicular access for emergency services. Judgements on whether the site can be regarded as safe will need to consider the feasibility and provision of evacuation from the site during a flood,
    - Provision of detailed emergency plans and signage for site users.

6 Overall site assessment

6.1 Can part b) of the exception test be passed?

This site is required to pass part b) of the exception test[3] due to its location in Flood Zone 3a. The site should be able to pass the exception test if development avoids the area of the site within the functional floodplain / Flood Zone 3b and Flood Zone 3a.

6.2 Recommendations, FRA requirements, and further work

Based on the evidence presented in the Level 1 SFRA (2023) and this Level 2 SFRA:

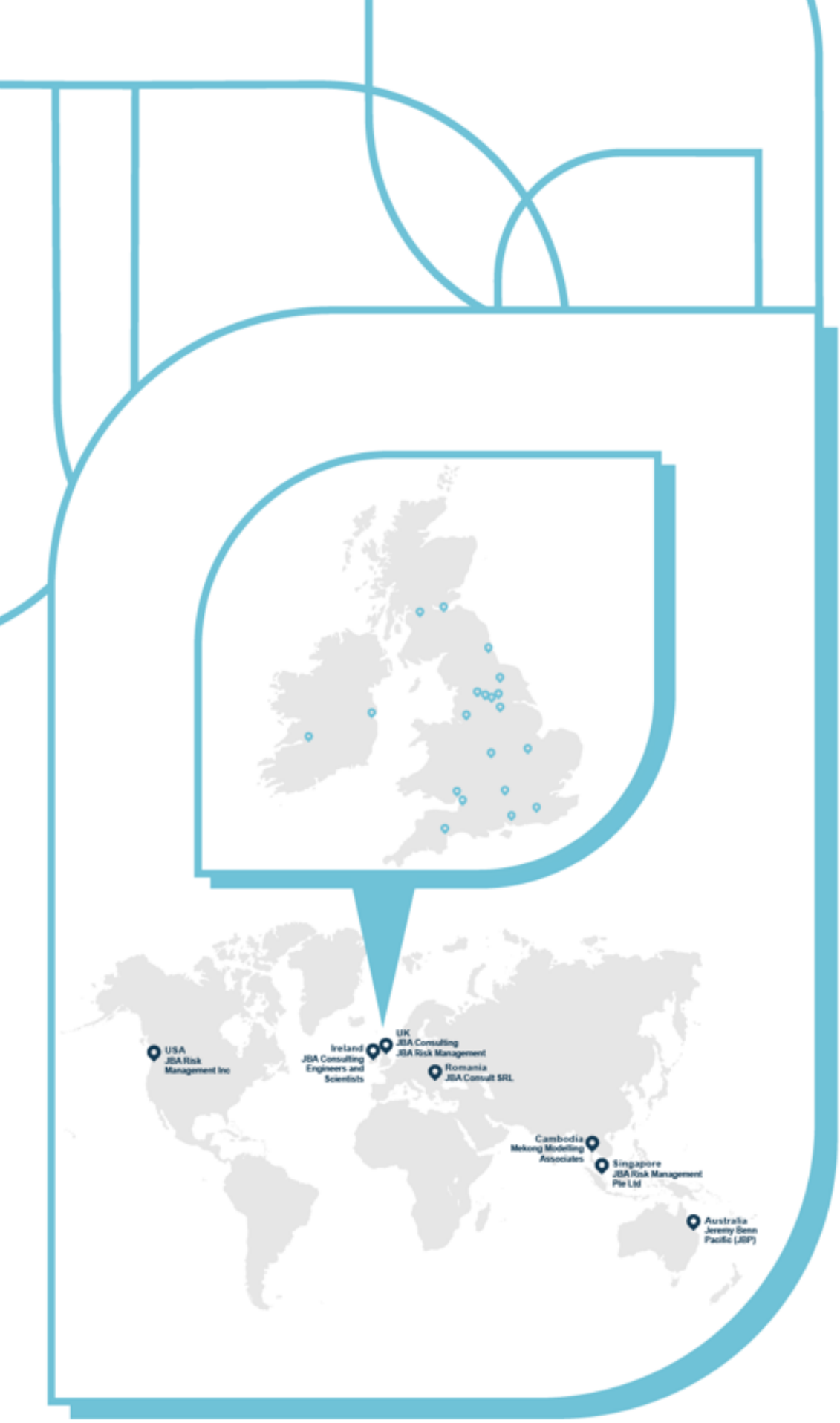
- Updated present day and climate change modelling of Carr Beck should be used to update this Level 2 SFRA at the earliest opportunity to provide an up-to-date strategic assessment of flood risk to this site and the surrounding areas.
- This site could be allocated if development avoids the eastern side of the site at modelled fluvial and surface water risk. However, the LPA must make it clear that this site cannot be developed until the required information detailed in this SFRA on existing and future flood risk from Carr Beck is fully ascertained.
- Residual risk from the culvert must also be ascertained.
- Any FRA should produce a detailed drainage strategy which should include ground investigation for infiltration SuDS suitability.
- Any FRA should be carried out in line with the latest versions of the NPPF; FRCC-PPG; EA online guidance; the CBMDC Local Plan and national and local SuDS policy and guidelines.
- Throughout the FRA process, consultation should be carried out with the following, where applicable, the local planning authority; the lead local flood authority; emergency planning officers; the Environment Agency; Yorkshire Water; the highways authorities; and the emergency services.

3 Para 178 National Planning Policy Framework 2024

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Bradford Level 2 Strategic Flood Risk Assessment - Site H643

Final Draft

May 2025

Prepared for:

City of BRADFORD METROPOLITAN DISTRICT COUNCIL

www.jbaconsulting.com

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Contract

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JBA Project Code	2024s1078

This report describes work commissioned by City of Bradford Metropolitan District Council (CBMDC) by an instruction dated 19 July 2024. The Client's representative for the contract was Jonathan Dicken of CBMDC. Dominic Richardson of JBA Consulting carried out this work.

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Acknowledgements

We would like to thank the Environment Agency and Yorkshire Water for their assistance with this work.

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1 Background

This is a Level 2 Strategic Flood Risk Assessment (SFRA) site screening report for the City of Bradford Metropolitan District Council (CBMDC) Local Plan Site H643. The content of this Level 2 SFRA site screening report assumes the reader has already consulted the 'CBMDC Level 1 SFRA' (2023) and read the 'CBMDC Level 2 SFRA Main Report' (2024) and is therefore familiar with the terminology used in this report.

1.1 Site H643

- Location: Land at Friars Industrial Estate, Idle
- Existing site use: Commercial and car parking
- Existing site use vulnerability: Less vulnerable
- Proposed site use: Housing
- Proposed site use vulnerability: More Vulnerable
- Site area: 2.58 hectares
- Proposed development impermeable area: 1.93 hectares
- Environment Agency (EA) river model: N/A
- Watercourse: N/A
- Summary of requirements from scoping stage:
    - Level 1 SFRA recommendation was for withdrawal from allocation or more detailed assessment through Level 2 SFRA.
    - Assessment of surface water flood depths and hazards based on the EA's national Risk of Flooding from Surface Water dataset.
    - Assessment of all other sources of flood risk.
    - Modelling of latest EA climate change allowances for peak rainfall intensities.

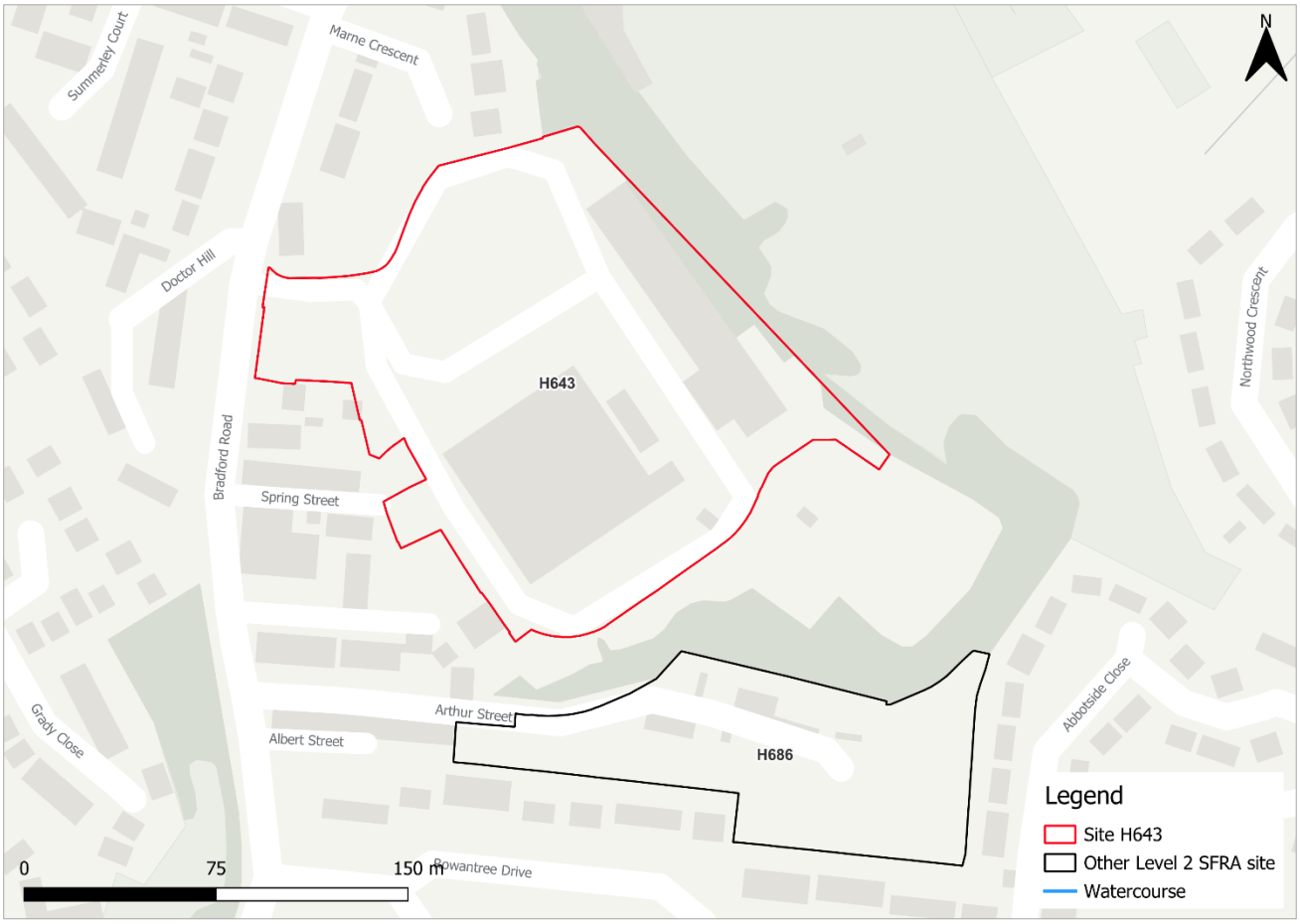


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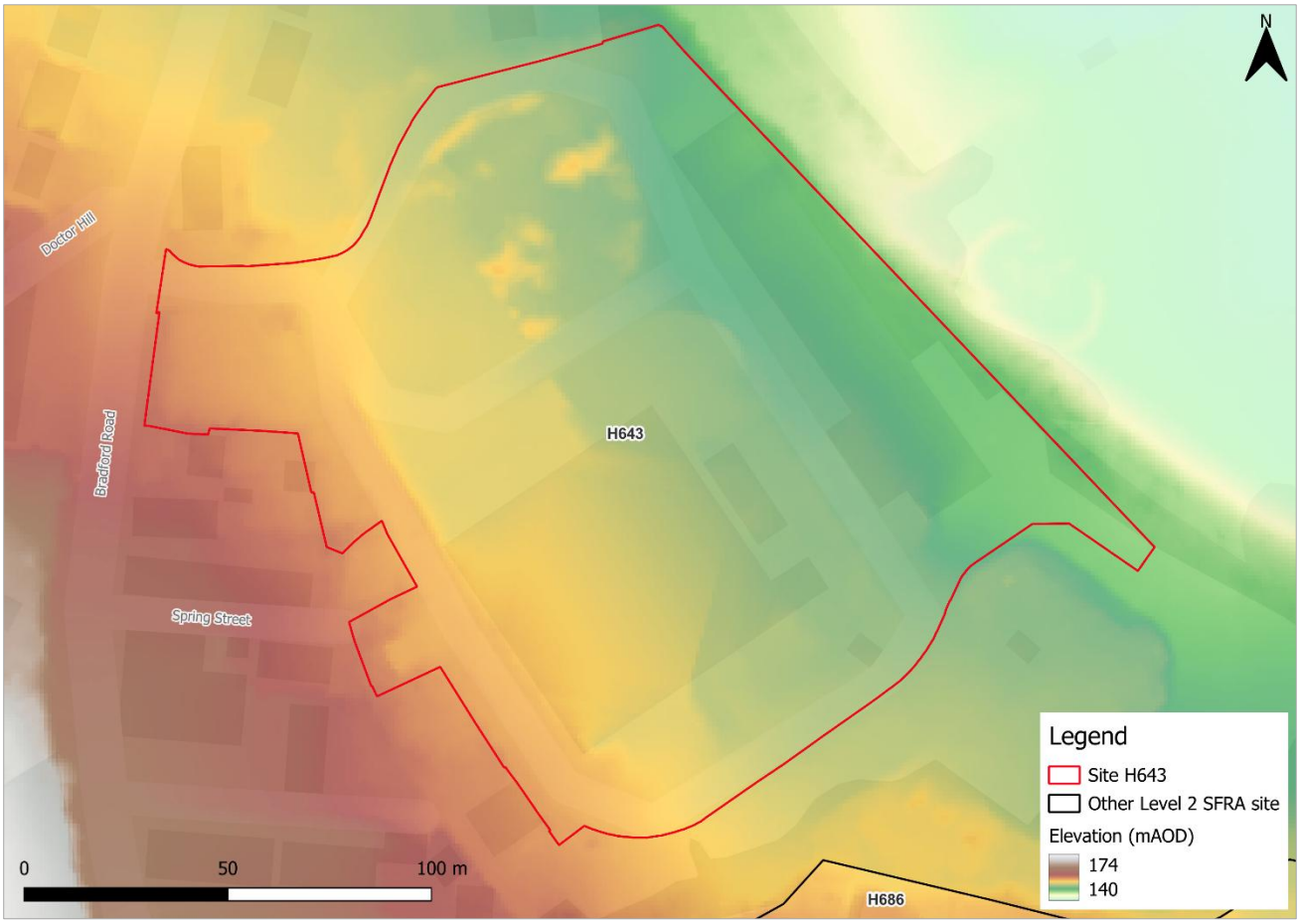


Figure 1-2: Topography

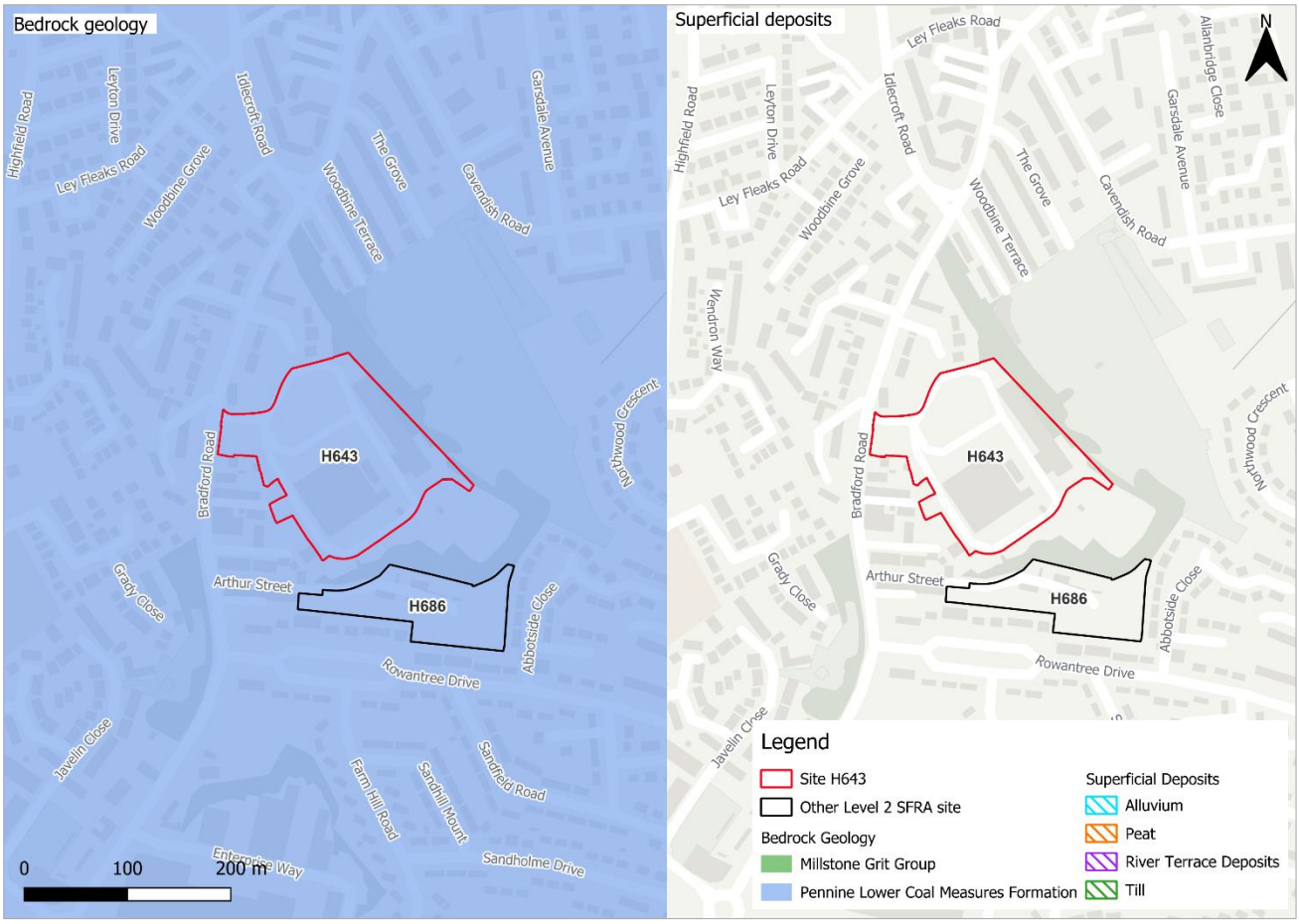


Figure 1-3: Soils and geology

2 Flood risk from rivers

2.1 Existing risk

2.1.1 Flood Map for Planning and functional floodplain

Based on the EA's Flood Map for Planning and Flood Zone 3b (functional floodplain), as updated in this Level 2 SFRA, the percentage areas of the site within each fluvial flood zone are stated in Table 2-1 and can be viewed on Figure 2-1. This version of the Flood Map for Planning does not consider flood defence infrastructure (Section 2.2) or the impacts of climate change.

The site is entirely located within Flood Zone 1 indicating it is at low risk of flooding from rivers.

Table 2-1: Existing fluvial flood risk based on percentage area of site at risk

Flood Zone 1 (% area)	Flood Zone 2 (% area)	Flood Zone 3a (% area)	Flood Zone 3b (% area)
100	0	0	0

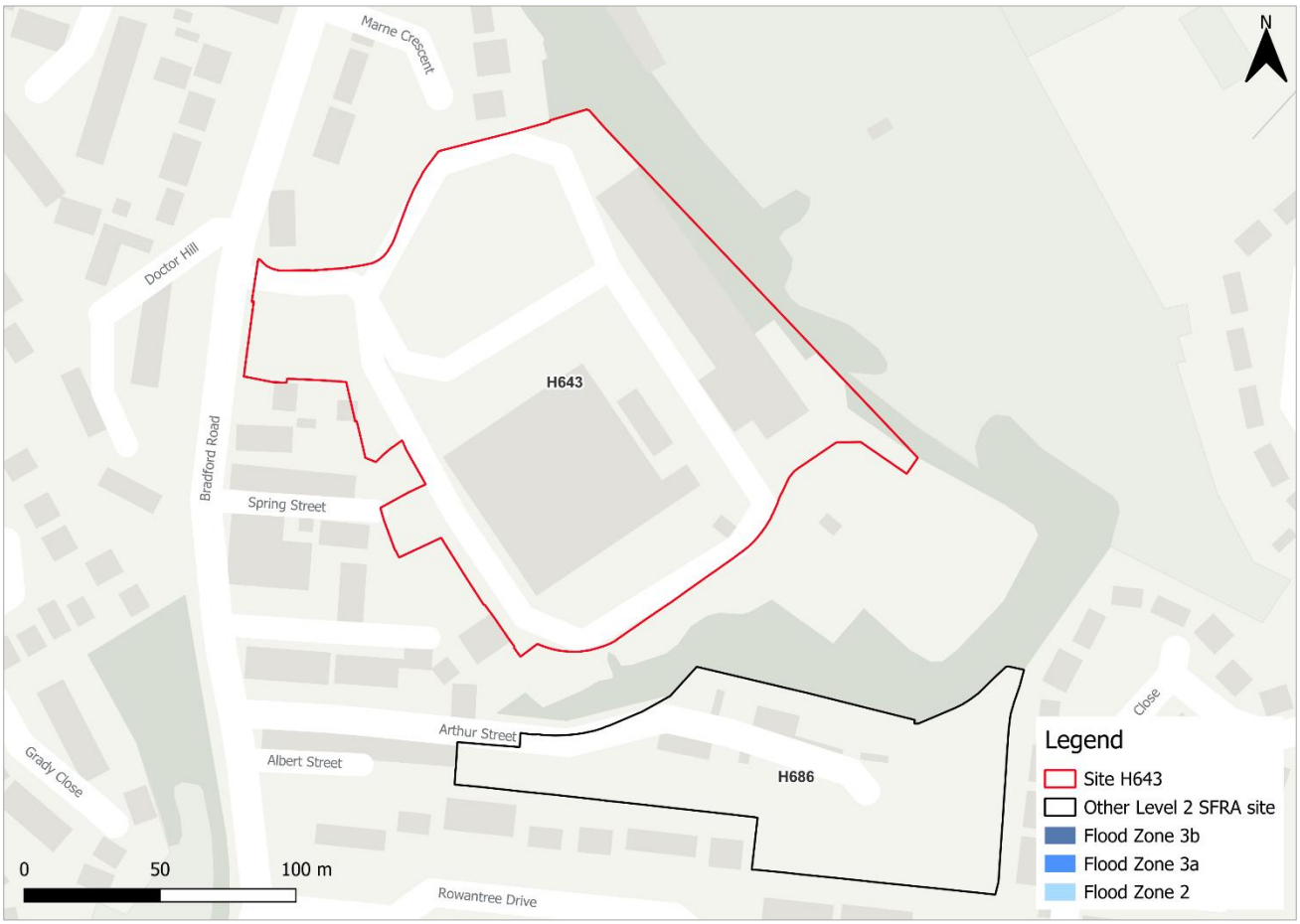


Figure 2-1: Existing risk from rivers to the site

2.2 Historic land-use mapping

Historic land-use mapping held by the LLFA indicates a watercourse within the southeastern corner of the site, possibly Haigh Beck. This should be confirmed, and the exact location ascertained, through site investigation. Potential flood risk from this watercourse may need to be ascertained at the FRA stage. No development should take place over the top of a culvert nor within 8m either side of the culverted section of watercourse.

2.3 Flood risk management

2.3.1 Flood defences

The site does not benefit from any formal engineered flood defences, according to the EA's spatial flood defences dataset.

2.3.2 Working with Natural Processes

The EA's Working with Natural Processes (WwNP) dataset has been interrogated to identify opportunities for Natural Flood Management (NFM) to reduce flood risk to the site and surrounding areas. There are no applicable areas either upstream of or within the site.

2.4 Historic flood incidents

The EA's Historic Flood Map (HFM) and Recorded Flood Outlines (RFO) datasets have been considered. There are no recorded historic flood incidents within the vicinity of the site.

2.5 LLFA flood incidents

The LLFA have record of one flood incident northwest of the site, which occurred in 2003. Developers should contact the LLFA for further information at the FRA stage, to assess potential flood risk to the site associated with this incident.

2.6 Flood warning and access and escape routes

The EA operates a Flood Warning Service for properties located within a Flood Warning Area (FWA) for when a flood event is expected to occur. The site is not located within a FWA.

Flood alerts may be issued before a flood warning for properties located within a Flood Alert Area (FAA) to provide advance notice of the possibility of flooding. A flood alert may be issued when there is less confidence that flooding will occur in a FWA. This site is not located within an FAA.

Based on available information, safe access and escape routes could likely be achieved during a flood event via Bradford Road which adjoins the west of the Site.

2.7 Observations, mitigation options and site suitability - fluvial

- The proposed development of the site would see a change in the risk classification from less vulnerable to more vulnerable, according to the NPPF.
- Given the change in use and therefore vulnerability of the site, the FRA must show that the development can be designed to be safe and that there is adequate emergency planning provision (para 014 FRCC-PPG).
- The site is wholly located within Flood Zone 1 indicating it is at low risk of flooding from rivers.
- Historic mapping indicates there may be a watercourse culverted beneath the site. If present, the culvert represents potential residual risk of flooding to the site through culvert failure or blockage. This may need to be further investigated and modelled at the FRA stage. Modelling should include for residual risk and options for culvert removal.
- No development should take place over the top of a culvert nor within 8m either side of the culverted section of watercourse.
- Assuming the culvert is located beneath the site, opportunities for opening up the culvert should be explored for inclusion in site design as a blue green corridor. This would remove any residual risk of flooding to the site as a result of culvert failure or blockage.

3 Flood risk from surface water

3.1 Existing risk

Based on the EA's national scale Risk of Flooding from Surface Water (RoFSW) map, surface water risk is shown to vary across the site. Approximately 2% of the site is within the high risk surface water flood zone, a further 7% of the site is within the medium risk flood zone and a further 20% of the site is at low surface water flood risk, as shown in Table 3-1.

In the high-risk event, surface water pooling can be observed within the site in an area of topographic depression adjacent to the pre-existing building located on the northeastern boundary of the site. In the medium risk event, this area of pooling expands and forms part of a surface water flow path that runs northwards from the southern boundary of the site constrained by the current building, as seen in Figure 3-1. In the low risk event, surface water pooling expands in size and the surface water flow path is observed to be routed around the majority of the existing roads within the site. Surface water is clearly shown to be constrained by existing buildings and transport routes within the site area.

Greatest surface water flood depths in the medium risk event are 0.30 - 0.60 m (Figure 3-1) with some areas of significant hazard in the area of surface water pooling adjacent to the building located along the northeast boundary of the site (Figure 3-2). Safe access and escape routes should be achievable via Bradford Road in the high and medium risk events, however in the low risk event significant areas of the road are inundated with floodwater of moderate to significant hazard. Safe access and escape routes may be challenging to achieve in this event.

Table 3-1: Existing surface water flood risk based on percentage area at risk using the RoFSW map

Very low risk (% area)	Low risk (% area)	Medium risk (% area)	High risk (% area)
71	20	7	2

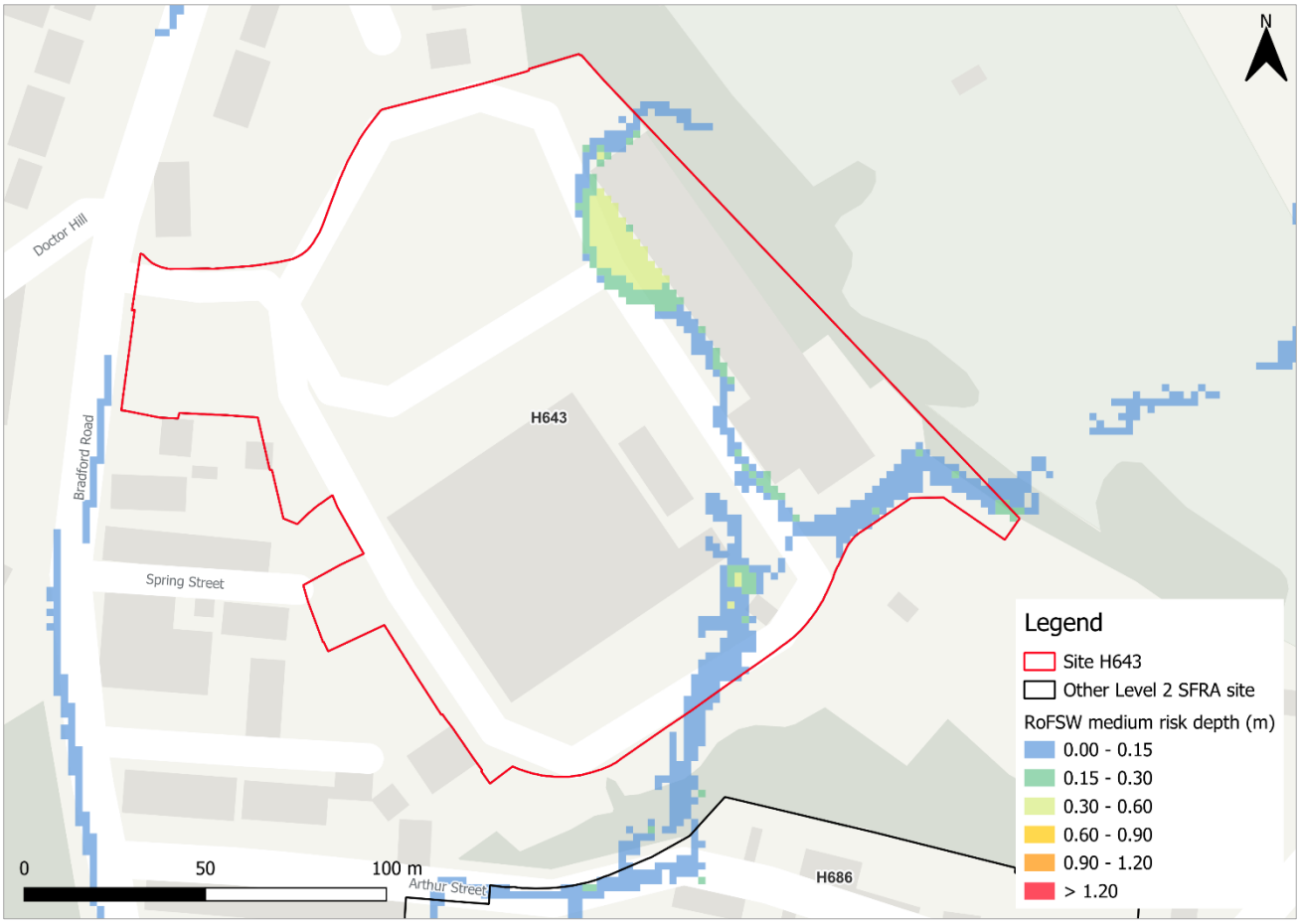


Figure 3-1: Medium risk event surface water flood depths (Risk of Flooding from Surface Water map)

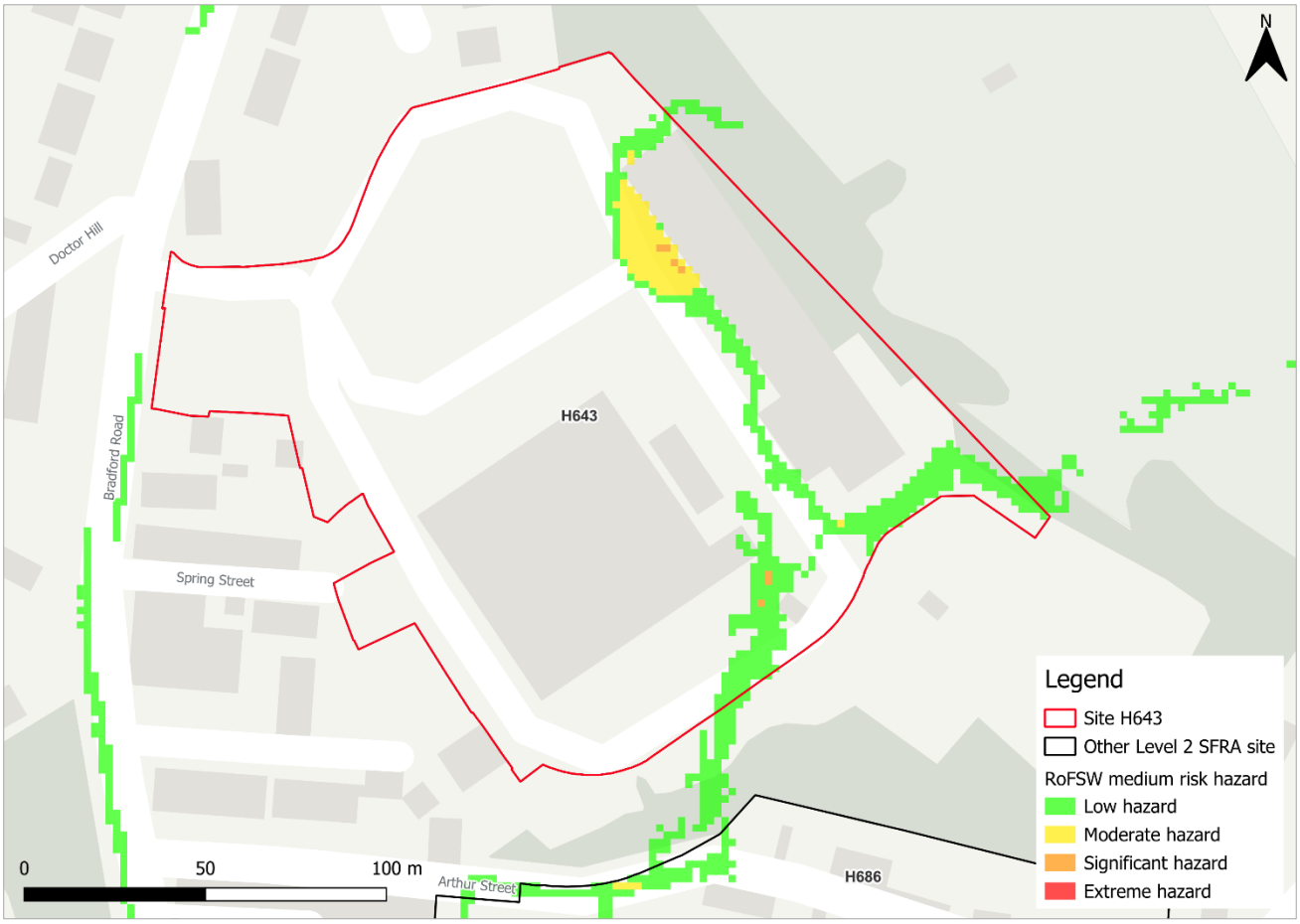


Figure 3-2: Medium risk event surface water flood hazard[1] (Risk of Flooding from Surface Water map)

3.2 Impacts from climate change

The impact of climate change on surface water flood risk has been modelled. This allows for direct comparison with the RoFSW map. With consideration of the EA's SFRA guidance, the latest climate change allowances have been modelled as shown in Table 3-2.

Table 3-2: Modelled climate change allowances for rainfall for the Aire and Calder management catchment

Return period	Central allowance 2070s (% increase)	Upper end allowance 2070s (% increase)
3.3% (high risk)	25%	40%
1% (medium risk)	30%	45%

Figure 3-3 shows the modelled surface water flood depths for the medium-risk event +45% climate change. Risk is modelled to be greater than for present day conditions, with the

1 Based on Section 7.5 Hazard rating. What is the Risk of Flooding from Surface Water map? Report version 2.0. April 2019. Environment Agency

medium risk climate change event showing a comparable but slightly greater level of risk to the present-day low risk event. Maximum flood depths are approximately 1 m with areas of significant hazard shown in the site as well as an instance of extreme hazard (Figure 3-4).

Bradford Road is shown to be inundated with surface water in the medium risk climate change event. Whilst this is primarily of a low to moderate hazard level in the connecting area to the site, floodwaters are shown to be of a moderate to significant hazard level in places further along the route. Safe access and escape routes may be challenging to achieve in this event.

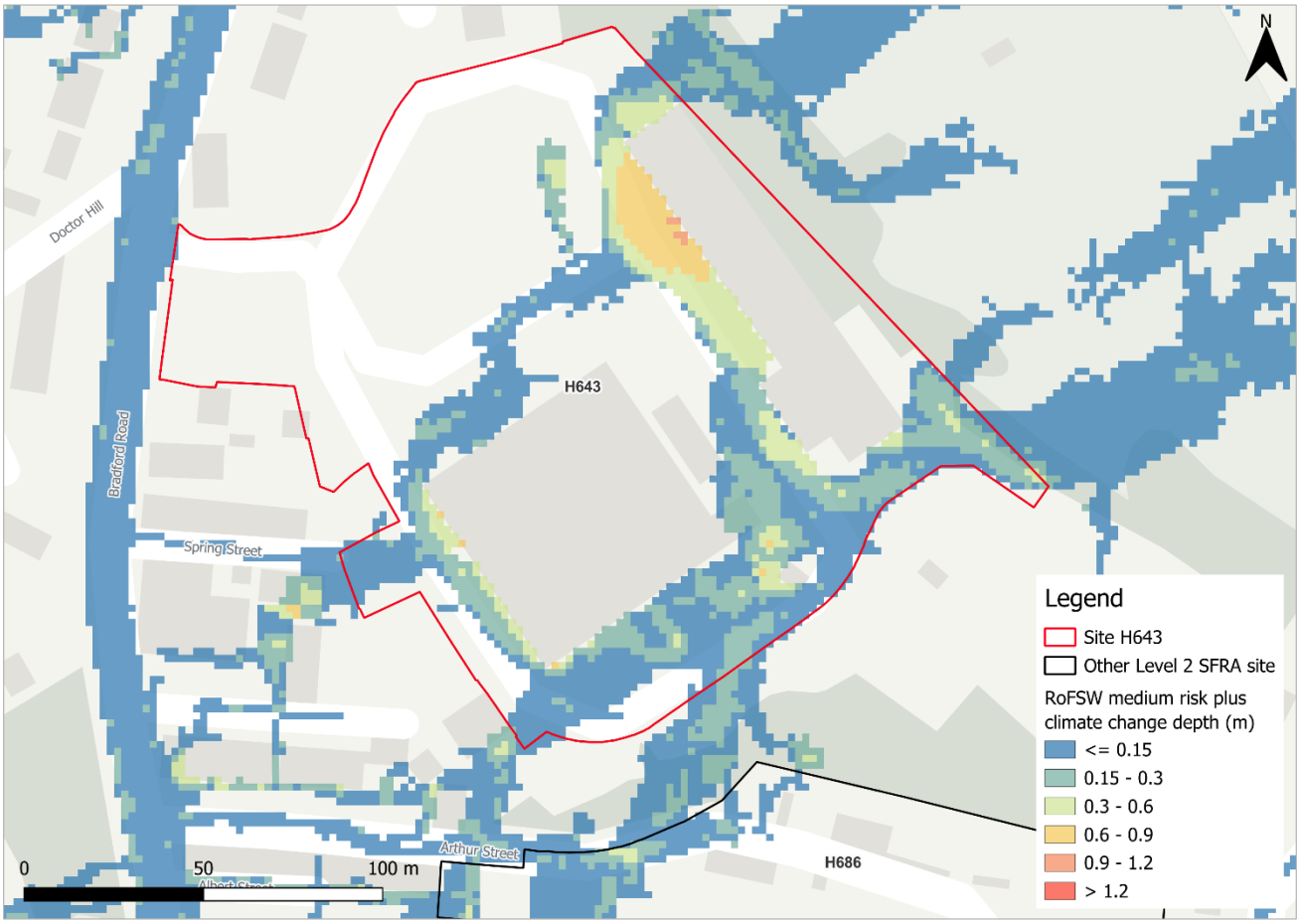


Figure 3-3: Medium risk event surface water flood depths plus 45% climate change (based on Risk of Flooding from Surface Water map)

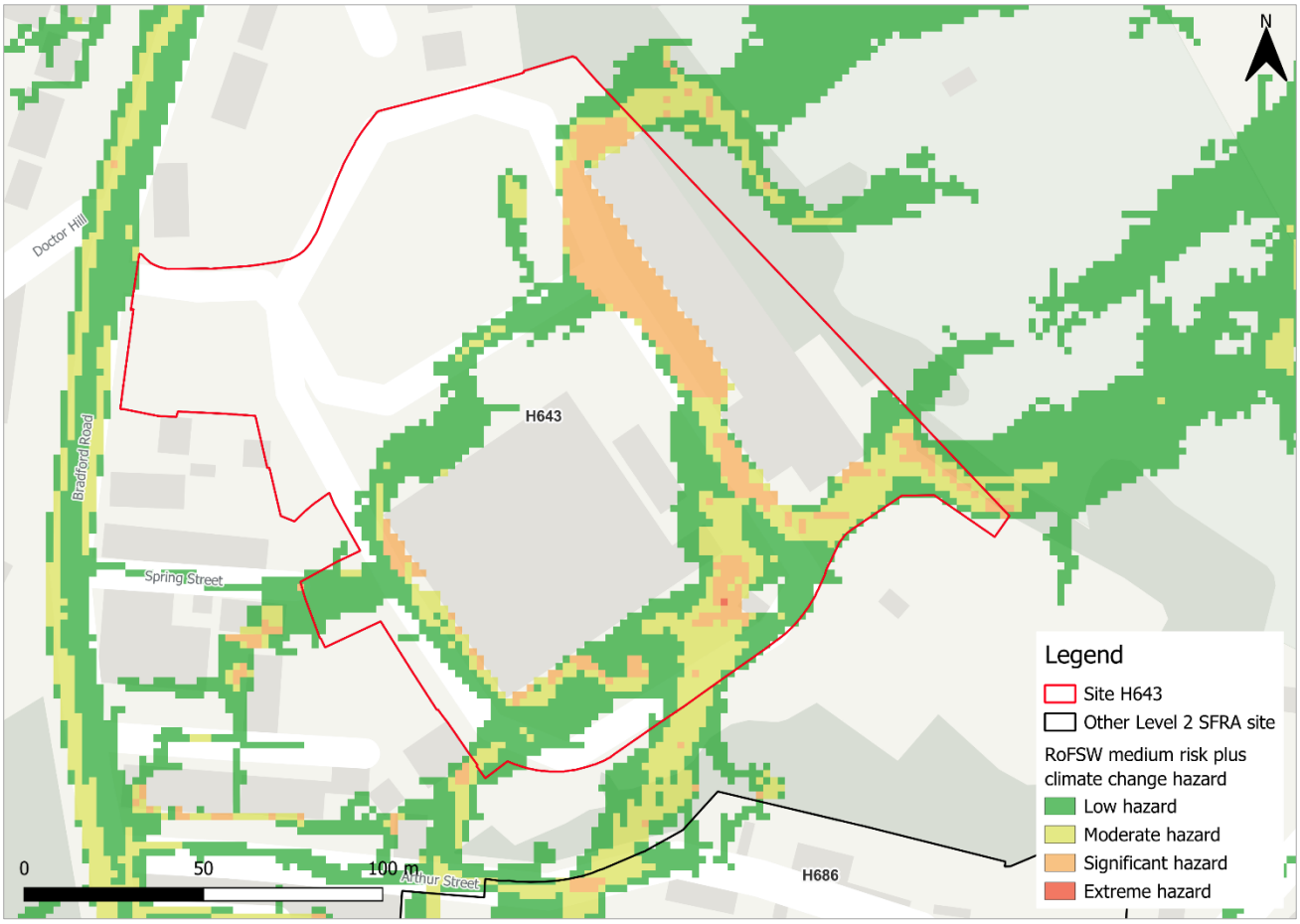


Figure 3-4: Medium risk event surface water flood hazards plus 45% climate change (based on Risk of Flooding from Surface Water map)

3.3 Observations, mitigation options and site suitability - surface water

- Current risk and future risk are significant. However, flow routes are constrained by existing buildings and roads. Any change in site layout involving the demolition of current buildings and changes to road layouts will require detailed surface water modelling.
- Any regrading of land must include like for like volumes to ensure risk is contained safely onsite for the lifetime of development. A full drainage strategy would be required to ensure there is no increase in surface water flood risk elsewhere as a result of new development. Runoff rates should be restricted to brownfield or betterment on existing. This will require surface water modelling based on layout plans and detailed design as well as full consultation with the LLFA.
- The use of appropriate SuDS should be investigated. The groundwater table is likely to be low across the site judging from the Groundwater Emergence Map in Figure 4-1, therefore infiltration SuDS may be an option. This will require appropriate ground and infiltration survey, and surface water modelling based on layout plans and detailed design as well as full consultation with the LLFA.

- Assessment of the current drainage system in place should be carried out to ascertain any current capacity issues and whether the current system could accommodate the proposed residential development or whether further capacity will be required.
- Any plans associated with future development would need to provide safe access and escape routes from the site that are viable in all events. This may require liaison with the Council highways department, Yorkshire Water and the LLFA.
- Were development of this site to proceed, given the proximity of this site to neighbouring site H686 it would be prudent to formulate a strategy to develop these sites in tandem and for consultation between each developer to take place to ensure a joined-up approach for sustainable development is in place.
- Note that the RoFSW map is not suitable for identifying whether an individual property will flood and is therefore indicative. The RoFSW map is not appropriate to act as the sole evidence for any specific planning or regulatory decision or assessment of risk in relation to flooding at any scale without further supporting studies or evidence.

4 Risk from groundwater

Risk of groundwater emergence is assessed in this SFRA using JBA's 5m Groundwater Emergence Map. This dataset is recommended for use by the EA in the SFRA Good Practice Guide[2]. Figure 4-1 shows the map covering this site and the surrounding areas whilst Table 4-1 explains the risk classifications.

The majority of the site is indicated not to be at risk of groundwater emergence. It is noted that in the northwest and southeast of the site, groundwater levels are indicated to be at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater remains unlikely in these areas. Groundwater conditions may be suited to infiltration SuDS for the majority of the site; however, ground investigations will be required within the northwest and southeast of the site through the site-specific FRA to ascertain groundwater levels and conditions.

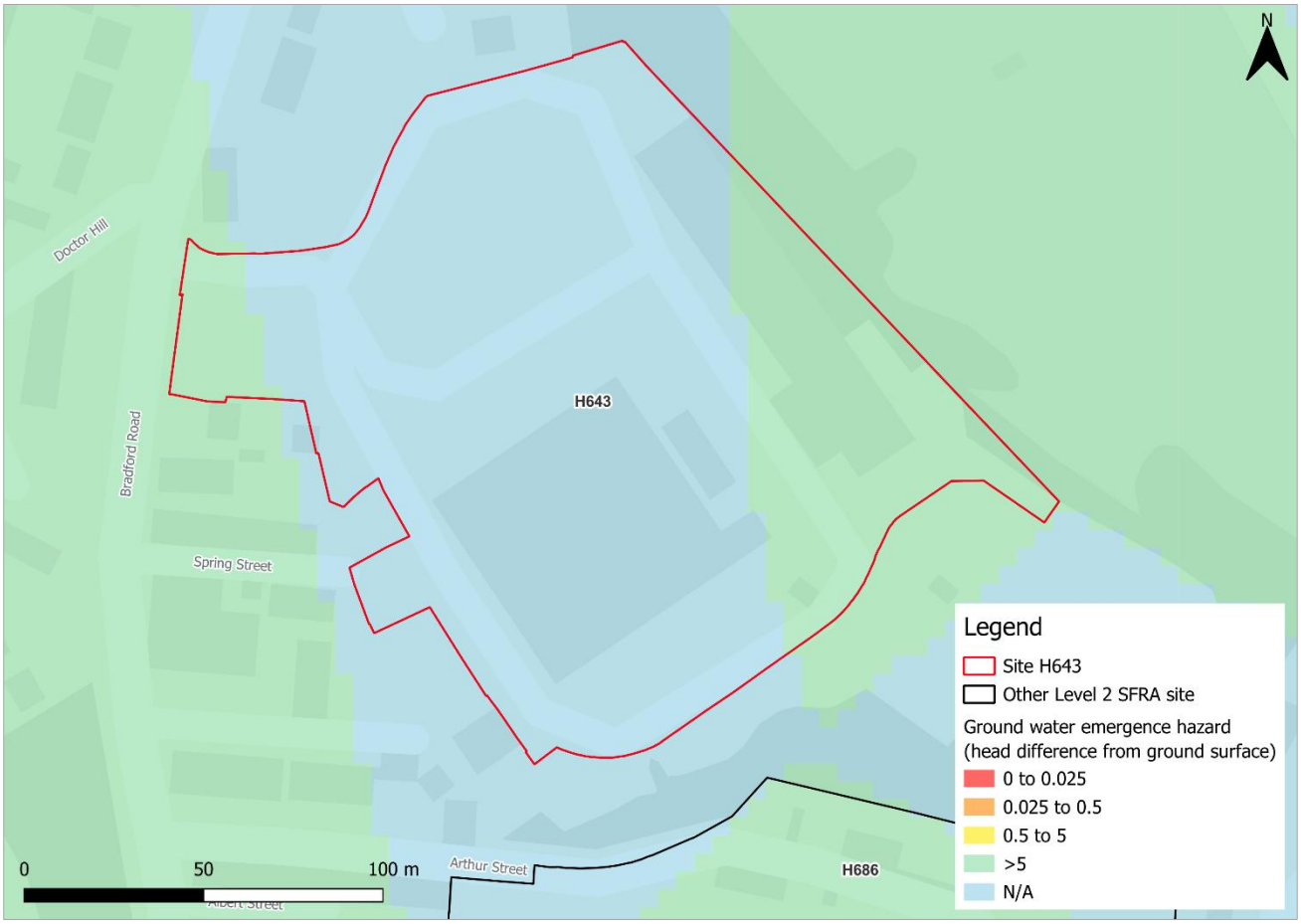


Figure 4-1: JBA 5m Groundwater Emergence Map

2 Strategic flood risk assessment good practice guide. ADEPT. December 2021.

Table 4-1: Groundwater Hazard Classification

Groundwater head difference (m)*	Class label
0 to 0.025	Groundwater levels are either at very near (within 0.025m of) the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
0.025 to 0.5	Groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
0.5 to 5	Groundwater levels are between 0.5m and 5m below the ground surface in the 100-year return period flood event There is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.
>5	Groundwater levels are at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater is not likely.
N/A	No risk. This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.
*Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.	

5 Residual risk

5.1 Potential culvert

Historic land-use mapping held by the LLFA, indicates that there may be a watercourse culverted beneath the southeastern corner of the site. If a watercourse is present, there will be a residual risk of flooding to the site were there to be a culvert failure or blockage. A model for this watercourse is not available. Therefore, residual risk could not be modelled for this Level 2 SFRA.

5.2 Flood risk from canals

The site is not likely to be at risk from a canal breach.

5.3 Flood risk from reservoirs

The EA's Reservoir Flood Maps (RFM) (2021) show where water may go in the unlikely event of a reservoir or dam failure. A 'dry day' scenario assumes that the water level in the reservoir is the same as the spillway level or the underside of the roof for a service reservoir and the watercourses upstream and downstream of the reservoir are at a normal level. A 'wet day' scenario assumes a worst-case scenario where a reservoir releases water held on a 'wet day' when local rivers have already overflowed their banks.

The site is not modelled to be at risk from reservoir flooding.

5.4 Flood risk from sewers

Flooding from the sewer network can occur when flow entering the system, such as an urban storm water drainage system, exceeds its available discharge capacity, the system becomes overloaded, blocked or it cannot discharge due to a high-water level in the receiving watercourse.

According to Yorkshire Water's records, there have been no incidents of sewer flooding in the area over the last two years.

5.5 Observations, mitigation options and site suitability - residual risk

- There is no modelled residual risk to the site.
- Historic mapping indicates there may be a watercourse culverted beneath the site. If present, the culvert represents potential residual risk of flooding to the site through culvert failure or blockage. This may need to be further investigated and modelled at the FRA stage.

6 Overall site assessment

6.1 Can part b) of the exception test be passed?

This site is not required to pass part b) of the exception test[3] as it is located within Flood Zone 1, however it must still be proven that the development can be safe for its lifetime, which is 100 years for residential development.

6.2 Recommendations, FRA requirements, and further work

Based on the evidence presented in the Level 1 SFRA (2023) and this Level 2 SFRA:

- It should be appropriate to develop this site for more vulnerable purposes given its location in Flood Zone 1.
- Historic mapping indicates there may be a watercourse culverted beneath the site. If present, the culvert represents potential residual risk of flooding to the site through culvert failure or blockage. This may need to be further investigated and modelled at the FRA stage. Modelling should include for residual risk and options for culvert removal.
- No development should take place over the top of a culvert nor within 8m either side of the culverted section of watercourse.
- Assuming the culvert is located beneath the site, opportunities for opening up the culvert should be explored for inclusion in site design as a blue green corridor. This would remove any residual risk of flooding to the site as a result of culvert failure or blockage.
- There is significant risk from surface water in the present day low-risk event and medium risk event plus climate change. A detailed drainage strategy will be required to ensure there is no increase in surface water flood risk elsewhere as a result of new development.
- Surface water should be retained onsite which may reduce units. This will require detailed surface water modelling based on layout plans and detailed design alongside full consultation with the LLFA on required runoff rates, likely to be brownfield or betterment.
- Groundwater conditions in the northwest and southeast of the site must be investigated further through the site-specific FRA to ascertain groundwater levels and conditions.
- Given the proximity of this site to neighbouring site H686 it would be prudent to formulate a strategy within development plans to develop these sites in tandem and for consultation between each developer to take place to ensure a joined-up approach for sustainable development is in place.
- The Council highways department should be consulted, along with Yorkshire Water and the LLFA regarding existing highway drainage networks, surface water

3 Para 178 National Planning Policy Framework 2024

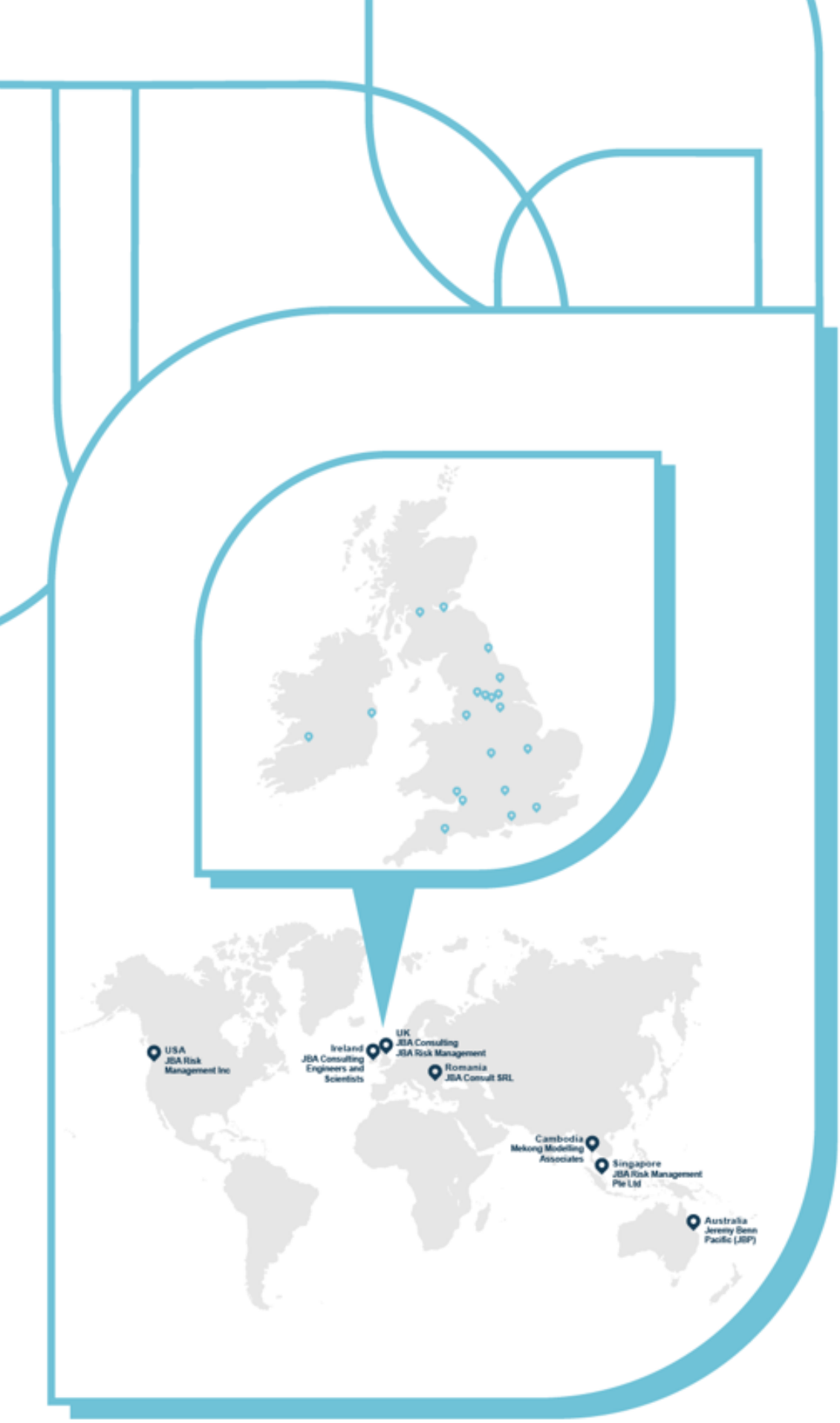
sewers and LLFA assets, and whether increased capacities may be required to enable sustainable development in the long term.

- Any FRA should be carried out in line with the latest versions of the NPPF; FRCC-PPG; EA online guidance; the CBMDC Local Plan and national and local SuDS policy and guidelines.
- Throughout the FRA process, consultation should be carried out with the following, where applicable, the local planning authority; the lead local flood authority; emergency planning officers; the Environment Agency; Yorkshire Water; the highways authorities; and the emergency services.

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