Appendix B - GMSF Allocations Flood Risk Summaries

2019 GMSF Allocation:	GM Allocation 31 – Land East of Boothstown
Area (ha)	29.03
Catchment	Shaw Brook
Proposed use	Residential

Figures illustrating allocation and main risk sources

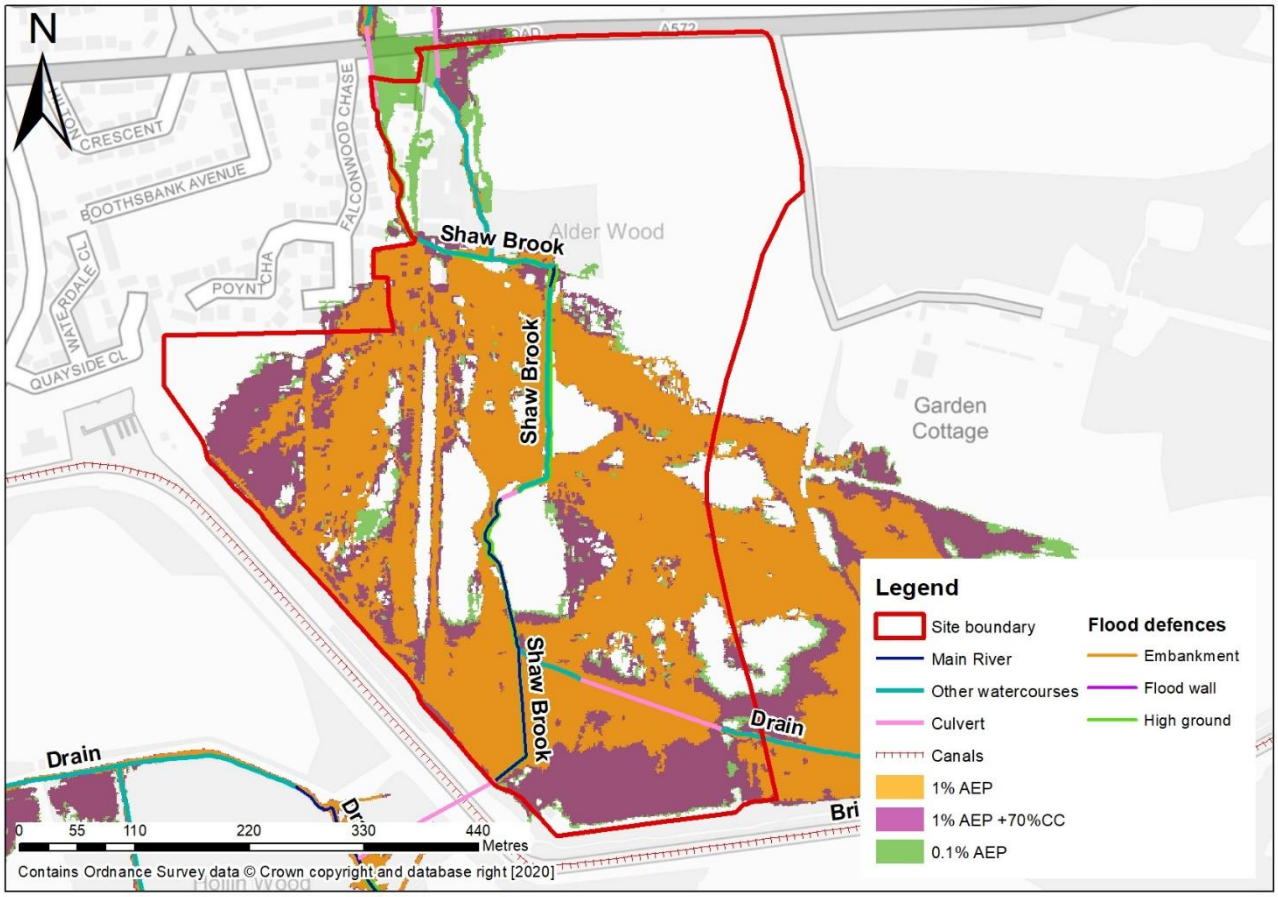

Figure 1: JFlow fluvial modelled flood outlines for the present day 1% and 0.1% AEP events and future risk 1% AEP event with +70% climate change uplift

2019 GMSF Allocation:	GM Allocation 31 – Land East of Boothstown

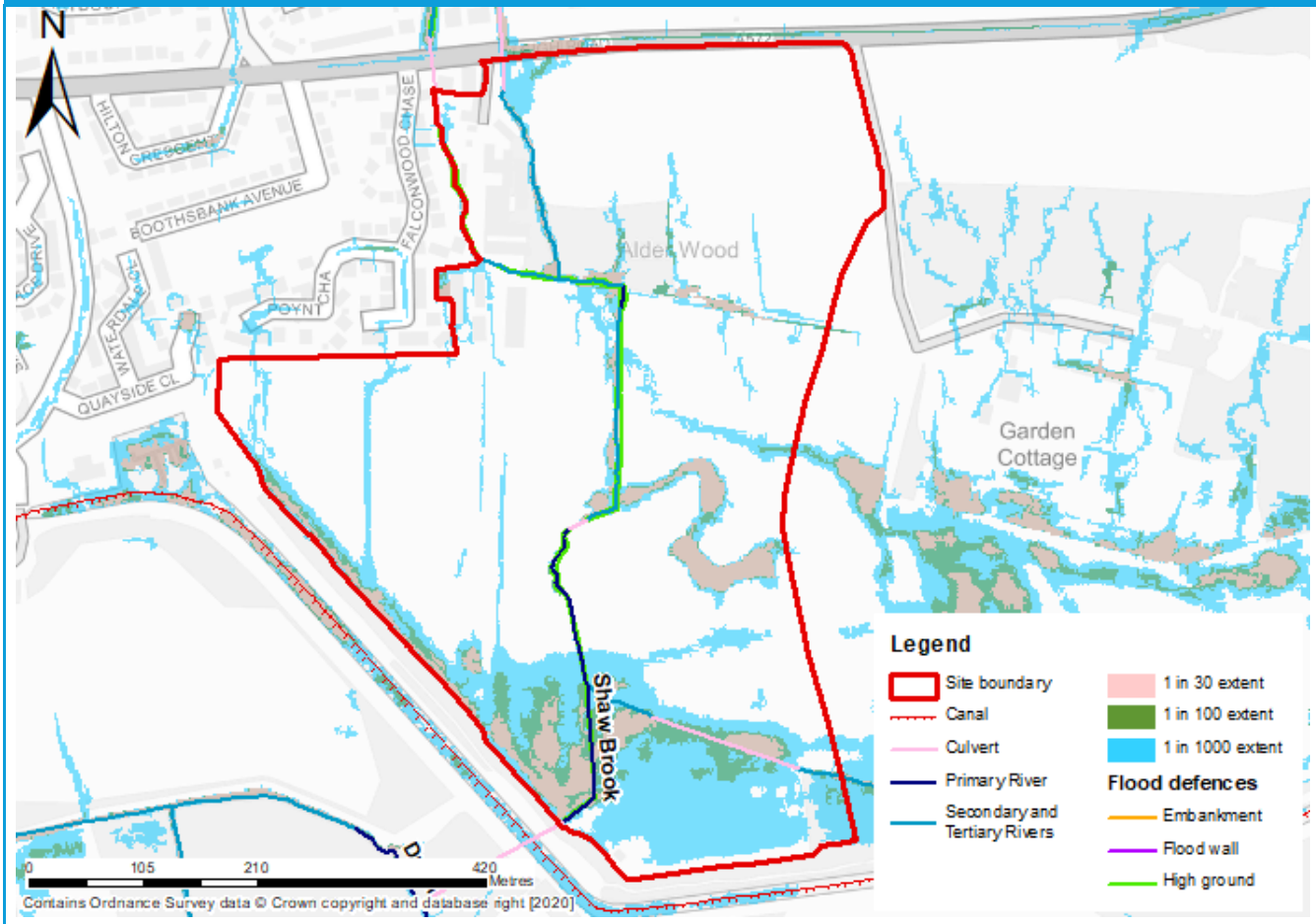

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**0.1% AEP**	**1% AEP**	**1% AEP +CC70**
	44.77	1.74	34.44	53.13
	• Fluvial risk (Figure 1) was modelled as part of this Level 2 SFRA using JBA's inhouse JFlow software. • JFlow is a broadscale 2D modelling tool that does not include detailed channel survey. The modelled outputs are not detailed enough to inform on risk in a site-specific Flood Risk Assessment. • The modelling shows considerably greater risk to the site than the EA's Flood Map for Planning, at the time of writing.			
Surface Water Risk (%)	**Low**	**Medium**	**High**	
	25.58	9.28	5.26	
Climate Change Considerations	• The 1% AEP +70% climate change event outline covers approximately 53% of the site leaving the northern section uncovered. The average depths for the +70% climate change uplift event are approximately 220mm with the maximum depths lying just under 3m. • The current surface water 0.1% AEP event outline provides an indication of the likely increase in extent of the more frequent events. The outline covers over 25% of the site primarily in the south with flow paths being consistent with Shaw Brook.			

2019 GMSF Allocation:	GM Allocation 31 – Land East of Boothstown
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents. • There are 8 recorded points where manholes saw flood volume stored on the surface during a 1% AEP event, but then was returned after storm subsidence. Additionally, 1 site did surcharge during a simulated 1% AEP event where water is lost to adjacent water systems via overland flow routes.
Reservoir Flood Risk	• The site is not within any EA reservoir flood outlines.
Historical Flooding	• The site lies outside of the Environment Agency's Historic Flood Map (HFM) and historical records for Salford City Council.
Groundwater Flood Risk	• Due to the site's proximity to Shaw Brook, groundwater levels are likely to be similar to the corresponding levels in the river. Groundwater will follow topography and may be an issue in this instance. Groundwater should be assessed as part of the FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • The northern third of the site is within the Salford North West CDA.
Defended	• Based on the Environment Agency's Spatial Flood Defences dataset, the river is bound by informal defences of high ground which have been assessed at condition grade 3 meaning 'Fair' (Table 1.1 Condition Assessment Manual[1]).
Flood Warning	• The site lies outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes	• The GMCA Level 1 SFRA (2019) included a screening assessment of sites against the EA's WwNP dataset. • The site is almost entirely within areas of tree planting within the WwNP dataset. Additionally, there are areas of riparian planting alongside both banks of Shaw Brook, running through the centre of the site. Both these areas can significantly delay the peak runoff in catchments as well enhancing floodplain roughness to obstruct significant flow paths. • There are also smaller areas around the site within the dataset as runoff attenuation features. These are areas of high flow within the RoFSW maps based on the premise that runoff time may be influenced by temporary storage if designed correctly.
Flood Risk Summary	• According to the Flood Map for Planning, 1% of the site is within Flood Zone 3. 17% is shown to be within Flood Zone 3b, however, this Flood Zone 3b outline should be reassessed as its origin is unknown. • The broadscale JFlow modelling shows considerably greater risk to the site. Given these significant differences between the current Flood Map for Planning and the latest JFlow modelling, further detailed modelling will be required to fully quantify flood risk to the site from Shaw Brook. • Based on the outputs from the Level 2 site assessment, a further, more detailed flood risk review[2] has been carried out for the site which illustrates an indicative SuDS plan to mitigate fluvial risk, including zoning of development around several onsite and offsite attenuation basins, linked by a network of open and piped swales. There is also an option to install a further culvert under the Bridgewater Canal to direct floodwater to a purpose-built offsite wetland, if required. The capacities and volumes of these indicative basins and swales are based on the flood extents and depths produced from the JFlow modelling. It is strongly advised that, the site-

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bgat-e-e.pdf

[2] Peel Investments (North) Limited, GM ALLOCATION 31 - LAND EAST OF BOOTHSTOWN, SALFORD. Site Appraisal - Drainage and Flood Risk, May 2020

2019 GMSF Allocation:	GM Allocation 31 – Land East of Boothstown
	specific FRA for the site includes detailed 2D hydraulic modelling of Shaw Brook, based on detailed channel survey. • The more detailed flood risk review also indicates that fluvial flows to RHS site that lies adjacent to the east can be attenuated through the network of swales and attenuation and basins and the opening up the culvert at the southern end of the site. • 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. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. As the site is currently greenfield, infiltration SuDS should be possible, subject to ground investigation and contamination testing.

2019 GMSF Allocation:	GM Allocation 38 – High Lane
Area (ha)	19.89
Catchment	High Lane Brook
Proposed use	Residential

Figures illustrating allocation and main risk sources

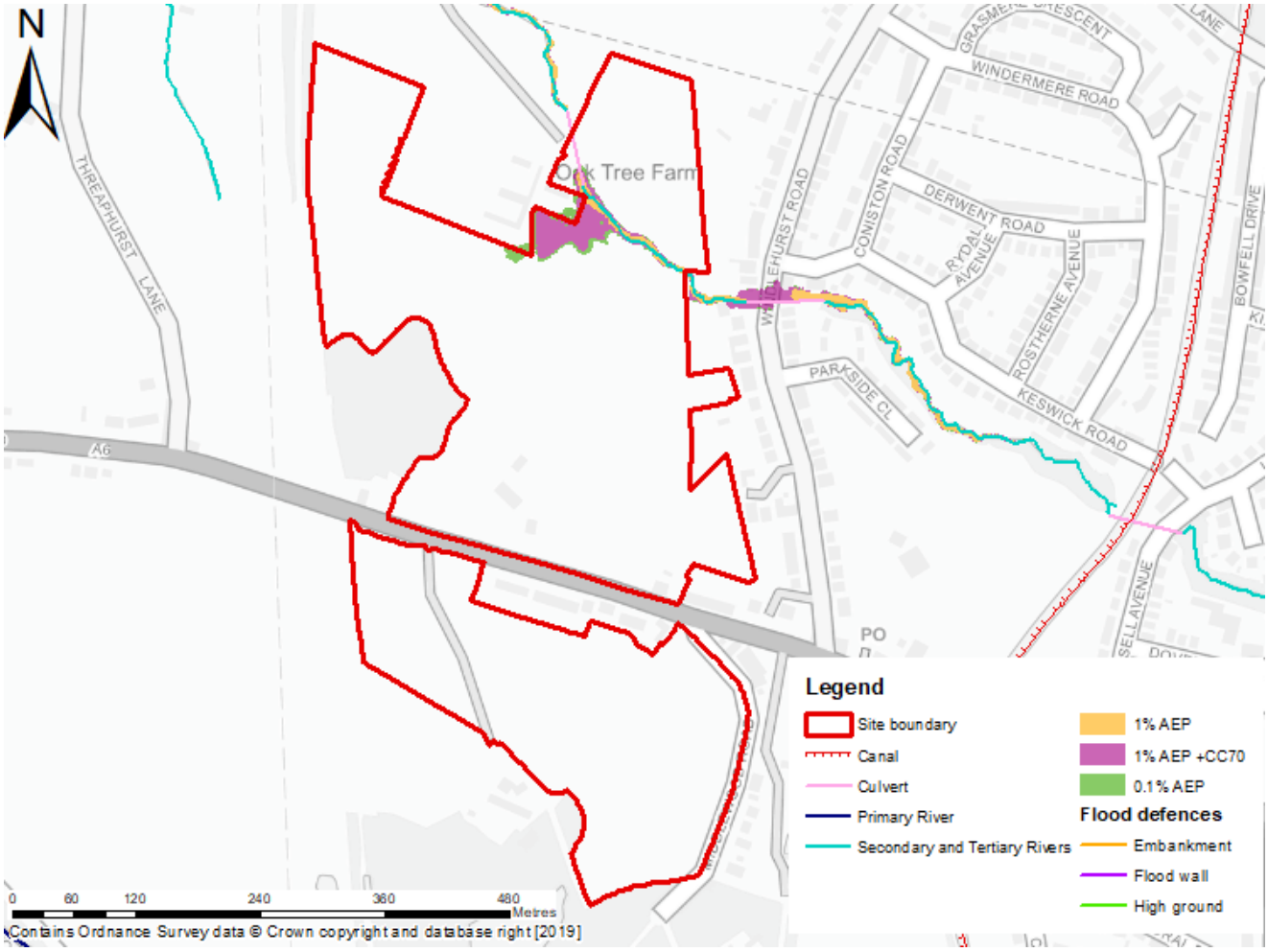

Figure 1: JFlow fluvial modelled flood outlines for the present day 1% and 0.1% AEP events and future risk 1% AEP event with +70% climate change uplift

2019 GMSF Allocation:	GM Allocation 38 – High Lane

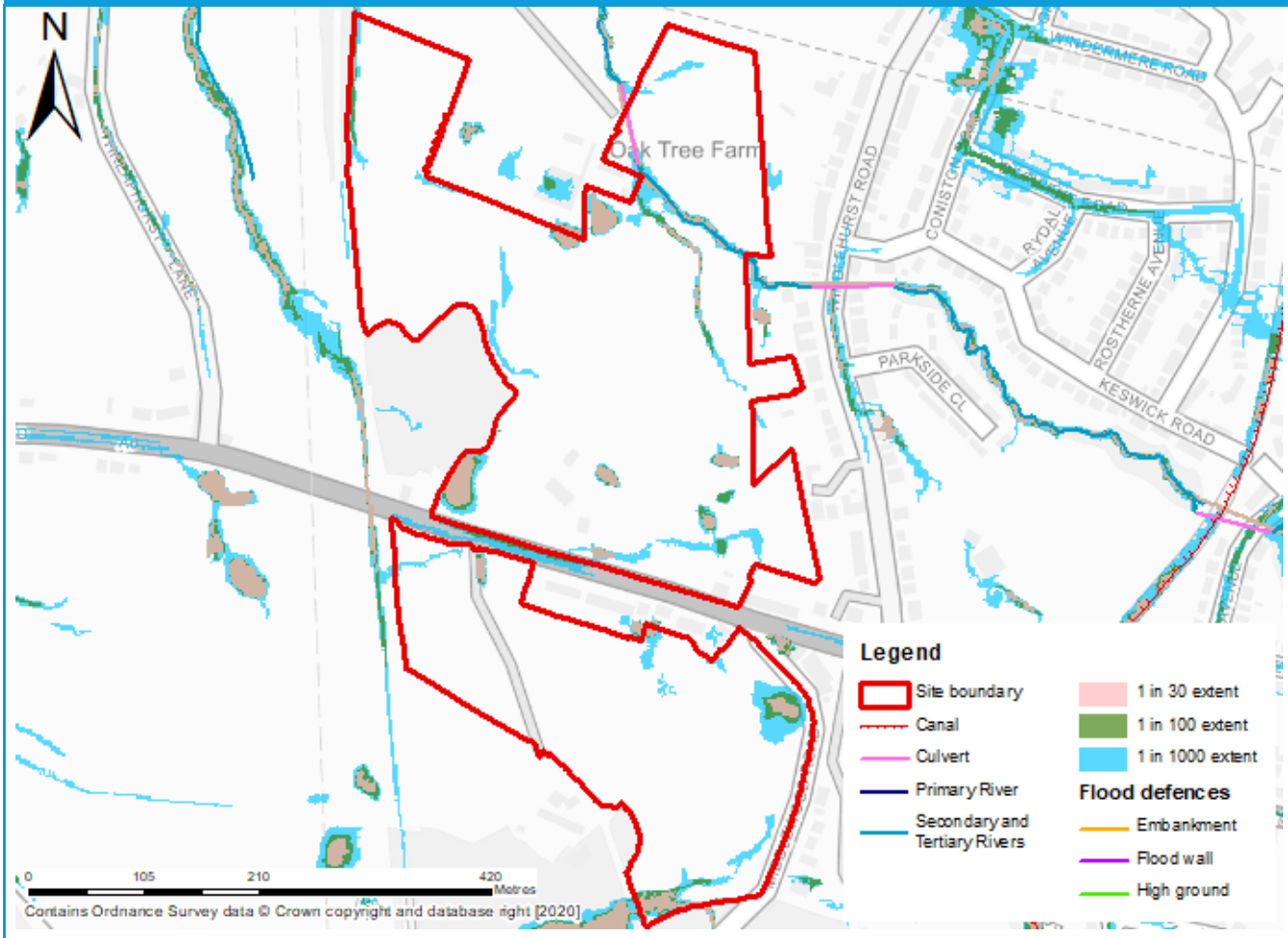

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**0.1% AEP**	**1% AEP**	**1% AEP +CC70**
	97.77	0.47	0.43	1.33
	• Fluvial risk (Figure 1) was modelled as part of this Level 2 SFRA using JBA's inhouse JFlow software. • JFlow is a broadscale 2D modelling tool that does not include detailed channel survey. The modelled outputs are not detailed enough to inform on risk in a site-specific Flood Risk Assessment. • The modelling shows considerably greater risk to the site than the EA's Flood Map for Planning, at the time of writing.			
Surface Water Risk (%)	**Low**	**Medium**	**High**	
	7.86	3.65	2.46	
Climate Change Considerations	• The 1% AEP +70% climate change uplift outline covers approximately 2% of the total site area with the average depth being approximately 620mm. This area is focused around High Lane Brook onsite. • The current surface water 0.1% AEP event outline provides an indication of the likely increase in extent of the more frequent events. This outline covers approximately 8% of the site which collects in localised pools across the site which are easily avoidable.			
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents.			

2019 GMSF Allocation:	GM Allocation 38 – High Lane
Reservoir Flood Risk	• The site is not within any EA reservoir flood outlines.
Historical Flooding	• There is a small section in the north of the site associated with High Lane Brook where there is a record of channel capacity exceedance in June 2016 included in the Environment Agency's Historic Flood Map (HFM) dataset. • The EA reports that there have been other instances of flooding to Oak Tree Farm dwelling in 2019 due to the culvert on High Lane Brook partially collapsing. The EA has been in discussion with both landowners trying to resolve the flooding issue.
Groundwater Flood Risk	• Due to the site's proximity to High Lane Brook, groundwater levels are likely to be similar to the corresponding levels in the river. Groundwater will follow topography and is unlikely to be an issue in this instance. Groundwater must be assessed as part of the FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • No part of this site is within a CDA.
Defended	• Based on the EA's Spatial Flood Defences dataset, there are no formal defences located within or close to the site.
Flood Warning	• The site lies outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes	• The site is almost entirely within areas of tree planting within the WwNP dataset. Additionally, there are areas of riparian planting alongside both banks of High Lane Brook in the north-east of the site. Both these areas can significantly delay the peak runoff in catchments as well enhancing floodplain roughness to obstruct significant flow paths.
Flood Risk Summary	• Judging by the level of fluvial and surface water risk to the site, allocation would be possible providing High Lane Brook and its risk can be incorporated into site layout. This includes for the 8 metre buffer that the EA request along Main River for access and maintenance purposes. The land here is additionally included in riparian tree planting areas from the WwNP dataset. • Approximately 98% of the site is within Flood Zone 1 where residential development should be allocated. • The EA recommends opening up parts of the High Lane Brook culvert, only retaining the section underneath the site access route, to help to reduce flood risk and to help meet WFD objectives. Enhancement of High Lane Brook should also look to increase Biodiversity Net Gain. • There is a culvert inspection report available from the EA which should be assessed at the FRA stage along with blockage scenario modelling. • Development should also avoid the localised pools of surface water risk during the 1% AEP event. As these are primarily located close the development site boundaries, this should be achievable. • A full drainage strategy will be required, to ensure there is no increase in surface water flood risk elsewhere as a result of new development. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. As the site is currently greenfield, infiltration SuDS should be possible, subject to ground investigation and contamination testing

2019 GMSF Allocation:	GM Allocation 47 – Land South of Pennington
Area (ha)	53.14
Catchment	Wheel Gutter Brook, Carr Brook
Proposed use	Industry and warehousing

Figures illustrating allocation and main risk sources

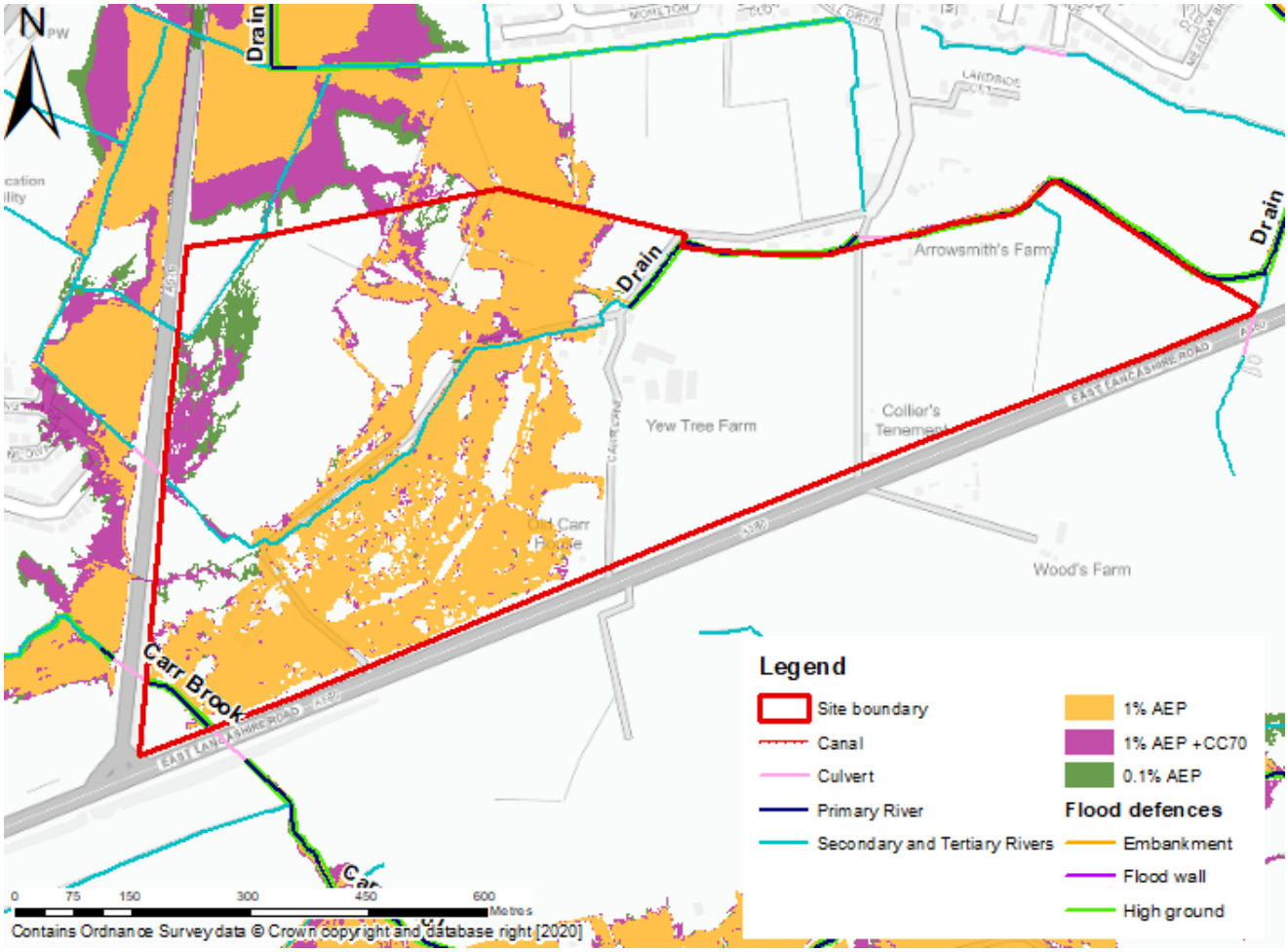

Figure 1: JFlow fluvial modelled flood outlines for the present day 1% and 0.1% AEP events and future risk 1% AEP event with +70% climate change uplift

2019 GMSF Allocation:	GM Allocation 47 – Land South of Pennington

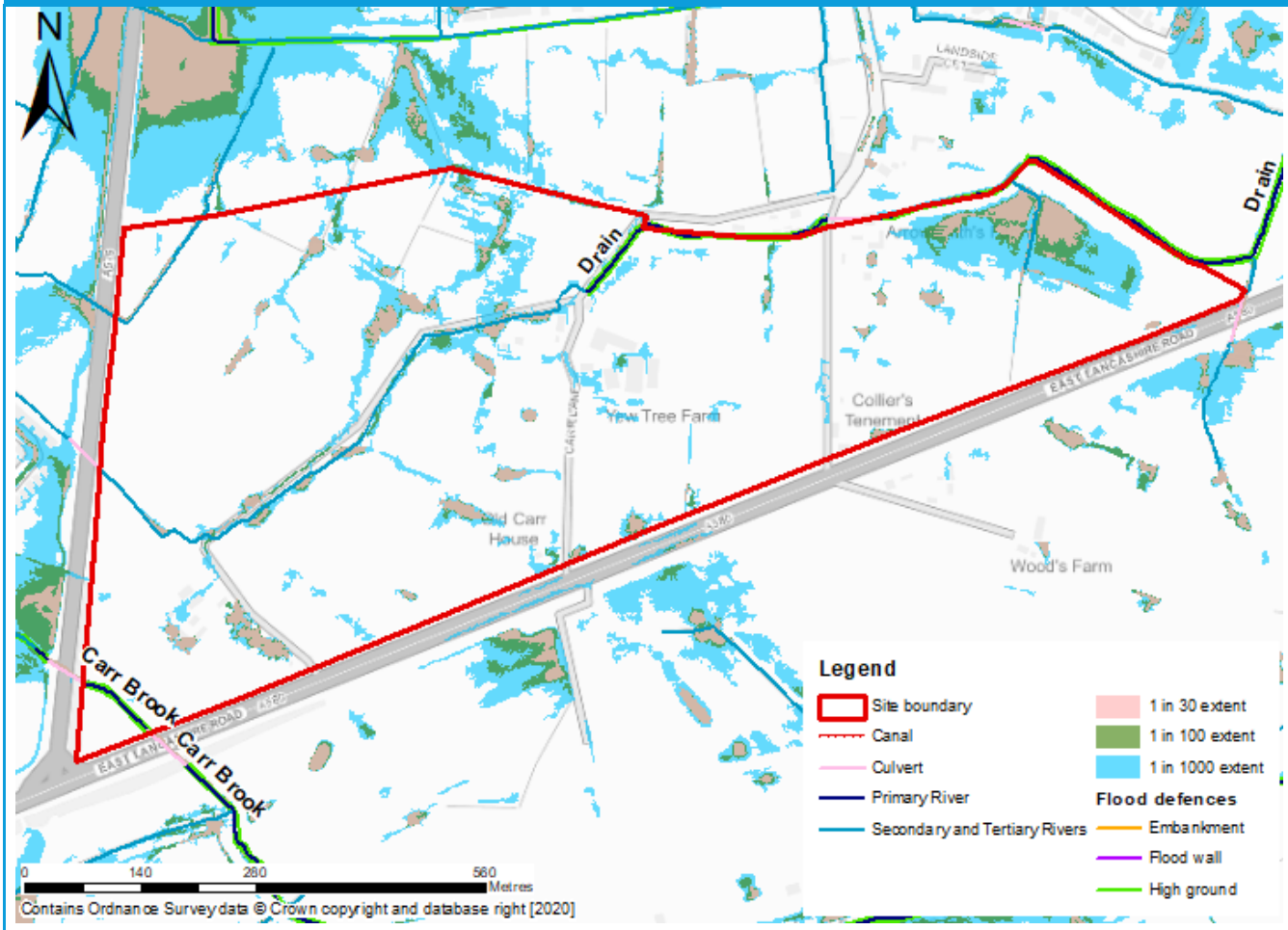

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**0.1% AEP**	**1% AEP**	**1% AEP +CC70**
	68.03	2.00	26.03	3.94
	• Fluvial risk (Figure 1) was modelled as part of this Level 2 SFRA using JBA's inhouse JFlow software. • JFlow is a broadscale 2D modelling tool that does not include detailed channel survey. The modelled outputs are not detailed enough to inform on risk in a site-specific Flood Risk Assessment. • The modelling shows considerably greater risk to the site than the EA's Flood Map for Planning, at the time of writing.			
Surface Water Risk (%)	**Low**	**Medium**	**High**	
	13.93	5.50	3.54	
Climate Change Considerations	• The 1% AEP +70% climate change uplift event outline covers approximately 30% of the site primarily to the west of the site boundary. The average depths are approximate at 100mm where small scale mitigation measures can be put in place to combat the risk. • The current surface water 0.1% AEP event outline provides an indication of the likely increase in extent of the more frequent events. The 0.1% AEP outline covers approximately 14% of the site which is primarily in the north-east corner of the site and along Wheel Gutter Brook.			
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents.			

2019 GMSF Allocation:	GM Allocation 47 – Land South of Pennington
Reservoir Flood Risk	• The site is not within any EA reservoir flood outlines.
Historical Flooding	• The site lies outside of any Environment Agency's Historic Flood Map (HFM) and historical records from Wigan Council.
Groundwater Flood Risk	• Due to the site's proximity to Wheel Gutter Brook, Carr Brook and Pennington Brook, groundwater levels are likely to be similar to the corresponding levels in the river. Groundwater will follow topography and is unlikely to be an issue in this instance. Groundwater must be assessed as part of a FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change.
Defended	• Based on the EA's Spatial Flood Defences dataset, Carr Brook and drains located on site are bound by areas of high ground that act as informal defences which are assessed at condition grades 2 and 3 meaning 'Good' and 'Fair' respectively (Table 1.1 Condition Assessment Manual[1]).
Flood Warning	• The site lies outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes	• Within the site there are multiple areas of riparian tree planting taken from the WwNP dataset. These areas are focused on watercourses through the centre of the site and along the northern border of the site boundary. These areas have the potential to significantly delay the peak runoff in catchments. Additionally, in the site's south-west corner is an area of tree planting on the floodplain. This appears to be from the floodplain of Carr Brook to the south and has the same potential for delaying runoff.
Flood Risk Summary	• Allocation of this site is likely to be possible due to the nature of fluvial and surface water risk to the site and safe access and egress is still achievable. • Any development should first be prioritised towards the east of the site, avoiding the areas located within the 1% AEP event fluvial outline; however, as the development is proposed for industrial use, allocation may still be possible for the whole site. Mitigation measures should still be put in place to protect from fluvial risk. • Development should easily avoid the localised ponding of surface water during the 1% AEP event; primarily in the north-eastern corner. • This is a large site with potential to create significant volumes of runoff if infiltration is not possible. The surrounding watercourses are relatively small and may not deal with significant volumes being added to them. This is especially so if water where to be directed north to Landside Brook. This is a pumped catchment and there would be significant costs associated with maintaining the station, which may require upgrading. • 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. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. As the majority of the site is currently greenfield, infiltration SuDS should be largely possible, subject to ground investigation and contamination testing.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf

2019 GMSF Allocation:	GM Allocation 41 – Woodford Aerodrome
Area (ha)	120.01
Catchment	River Dean, Red Brook, Red Brook Tributary
Proposed use	Residential

Figures illustrating allocation and main risk sources

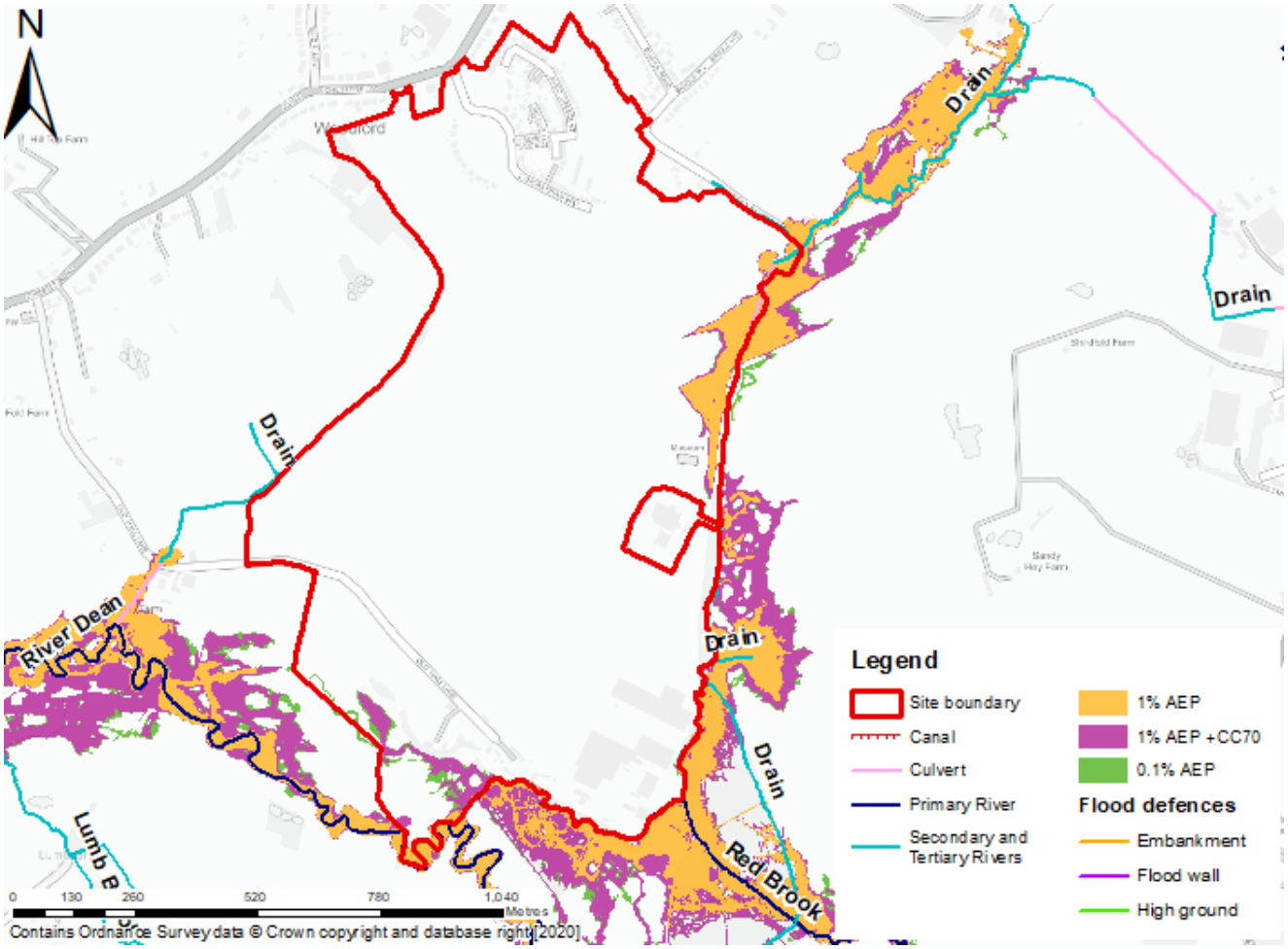

Figure 1: JFlow fluvial modelled flood outlines for the present day 1% and 0.1% AEP events and future risk 1% AEP event with +70% climate change uplift

2019 GMSF Allocation:	GM Allocation 41 – Woodford Aerodrome

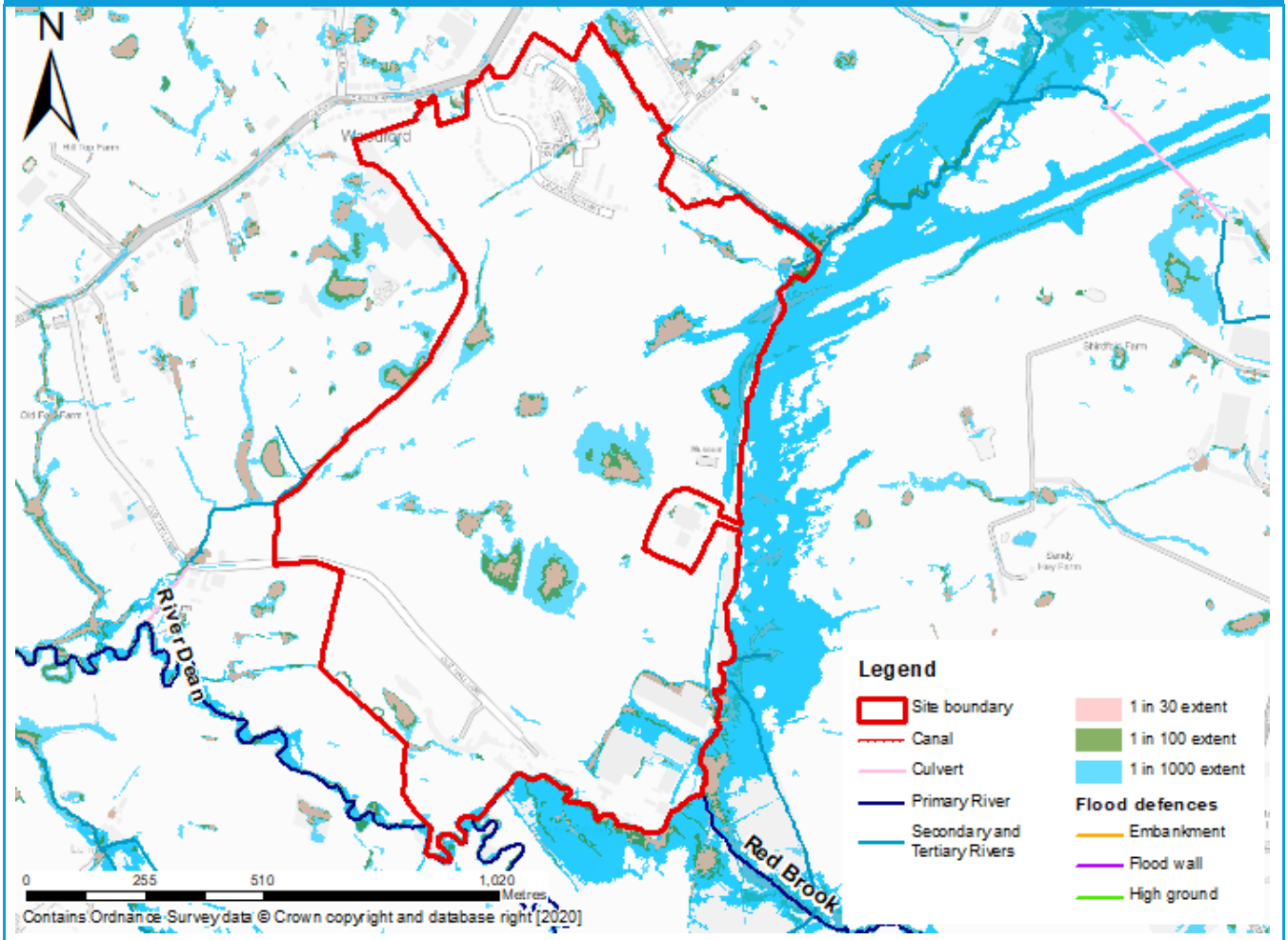

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**0.1% AEP**	**1% AEP**	**1% AEP +CC70**
	95.80	0.45	2.42	1.33
	• Fluvial risk (Figure 1) was modelled as part of this Level 2 SFRA using JBA's inhouse JFlow software. • JFlow is a broadscale 2D modelling tool that does not include detailed channel survey. The modelled outputs are not detailed enough to inform on risk in a site-specific Flood Risk Assessment. • The modelling shows considerably greater risk to the site than the EA's Flood Map for Planning, at the time of writing			
Surface Water Risk (%)	**Low**	**Medium**	**High**	
	12.14	4.57	2.65	
Climate Change Considerations	• The 1% AEP +70% climate change uplift outline covers approximately 4% of the total site area with the average depths being around 280mm. As the risk is primarily located around the west and southern site boundary, these areas can easily be avoided for development. • The current surface water 0.1% AEP event outline provides an indication of the likely increase in extent of more frequent events.			
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents.			

2019 GMSF Allocation:	GM Allocation 41 – Woodford Aerodrome
Reservoir Flood Risk	• A small part of the site is within the EA's reservoir flood outlines. The area at risk is around Dairyhouse Wood on far the southern boundary of the site. • The extent shows the worst credible area that is susceptible to dam breach flooding. The map should be used to prioritise areas for evacuation/early warning. • The chance of reservoir failure is very rare and there is an extremely good safety record in the UK with no loss of life due to reservoir flooding since 1925. • United Utilities confirms that ongoing maintenance and investment ensures that reservoirs do not pose any flood risk.
Historical Flooding	• The site lies outside of any Environment Agency's Historic Flood Map (HFM) and historical records from Stockport Metropolitan Borough Council.
Groundwater Flood Risk	• Due to the site's proximity to the River Dean and Red Brook, groundwater levels are likely to be similar to the corresponding levels in the river. Groundwater will follow topography and is unlikely to be an issue in this instance. Groundwater must be assessed as part of the FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • No part of this site is within a CDA.
Defended	• Based on the EA's Spatial Flood Defences dataset, there are no formal defences located within or close to the site.
Flood Warning	• The site lies outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes Flood Risk Summary	• The south western corner of the site is within areas of tree planting taken from the WwNP dataset. These areas can significantly delay the timing of peak runoff in catchments.
Flood Risk Summary	• Allocation of this site may be possible due to the nature of fluvial and surface water risk to the site. • It is known that residential development has already began in the north-west corner of the site. • 1% AEP and 1% AEP +70% climate change uplift fluvial outlines are focused along the site boundaries to the east and south. Further development should be achievable if it avoids these areas. • Average flood depths in the inundated areas are 280mm meaning mitigation measures may be feasible to allow development within these at-risk areas. However, 96% of the site is within Flood Zone 1 and development could be focused towards these areas. • Risk from surface water is focused into localised pools within the site, mitigation and/or sustainable drainage measures should be included to reduce risk in these locations. If development is to be continued, these areas could be set aside as potential green/blue space or left as/converted to open greenspace to flood naturally; this would provide multiple benefits including ecological value and social/amenity value for the community. • 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. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. As the majority of the site is currently greenfield, infiltration SuDS should be possible, subject to ground investigation and contamination testing.

2019 GMSF Allocation:	GM Allocation 22 – Woodhouses Cluster
Area (ha)	9.03
Catchment	Lord's Brook
Proposed use	Residential

Figures illustrating allocation and main risk sources

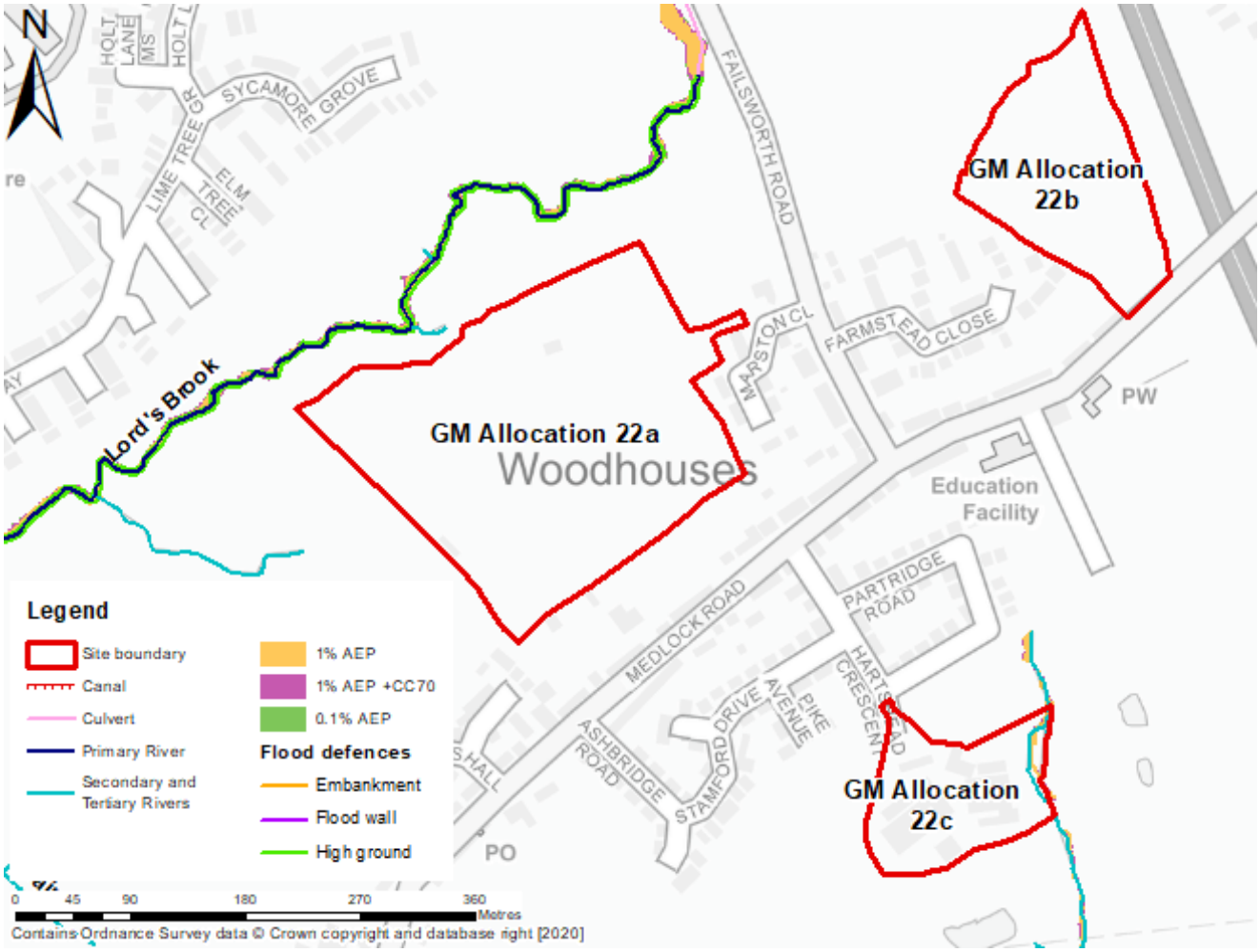

Figure 1: JFlow fluvial modelled flood outlines for the present day 1% and 0.1% AEP events and future risk 1% AEP event with +70% climate change uplift

2019 GMSF Allocation:	GM Allocation 22 – Woodhouses Cluster

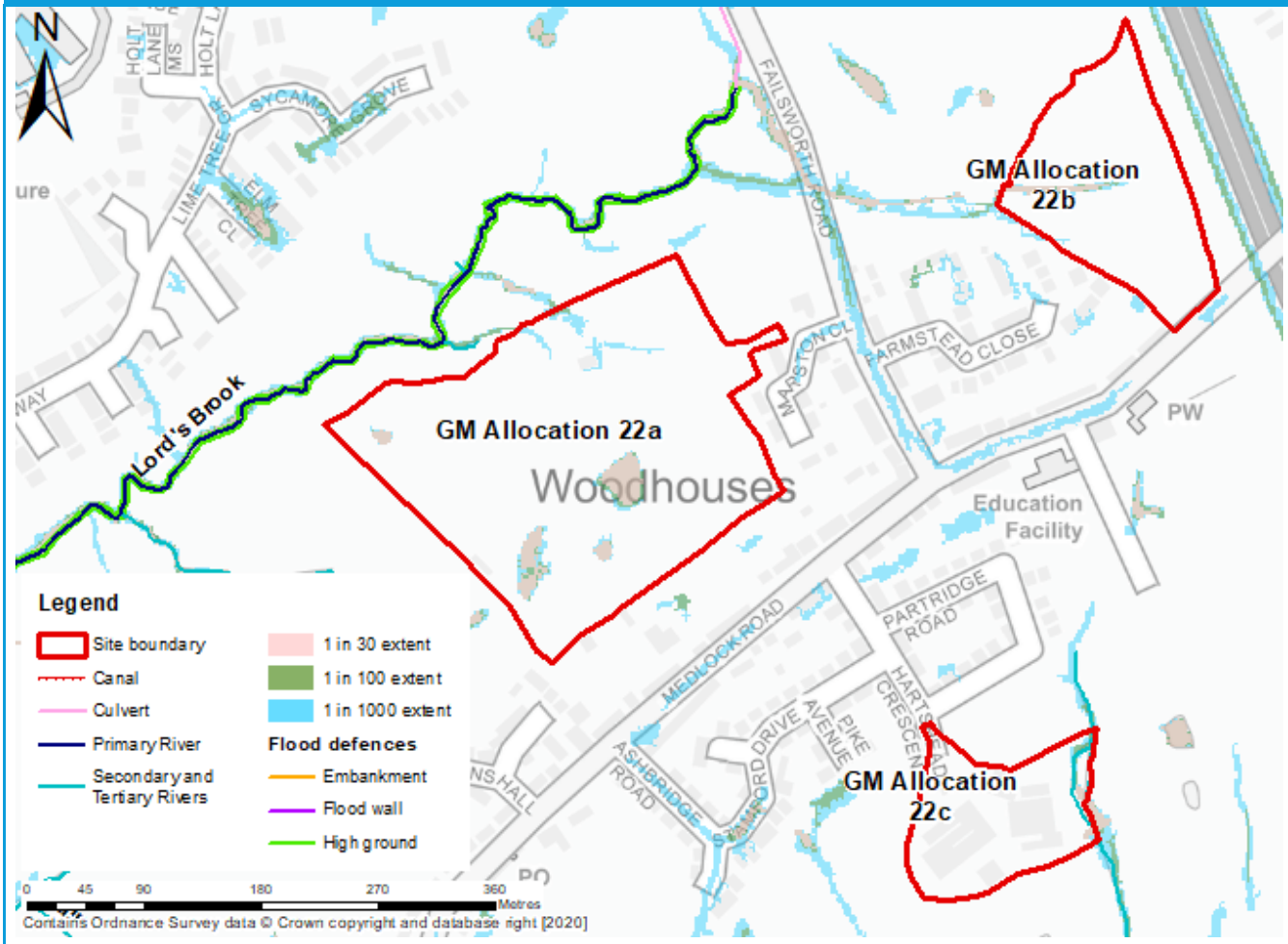

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**0.1% AEP**	**1% AEP**	**1% AEP +CC70**
	99.70	0.00	0.28	0.02
	• Fluvial risk (Figure 1) was modelled as part of this Level 2 SFRA using JBA's inhouse JFlow software. • JFlow is a broadscale 2D modelling tool that does not include detailed channel survey. The modelled outputs are not detailed enough to inform on risk in a site-specific Flood Risk Assessment.			
Surface Water Risk (%)	**Low**	**Medium**	**High**	
	12.16	8.48	6.35	
Climate Change Considerations	• The 1% AEP +70% climate change uplift event outline only covers 0.3% of the total site area and is focused within GM Allocation 22c surrounding the unnamed watercourse; as such this poses a minimal risk overall to the site and can easily be avoided. • The current surface water 0.1% AEP event outline provides an indication of the likely increase in extent of the more frequent events. The 0.1% AEP outline covers just over 12% of the site and forms localised pools of risk; these can be easily avoided.			

2019 GMSF Allocation:	GM Allocation 22 – Woodhouses Cluster
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents. • There are 4 recorded points where manholes saw flood volume stored on the surface during a 1% AEP event, but then was returned after storm subsidence.
Reservoir Flood Risk	• The site is not within any EA reservoir flood outlines.
Historical Flooding	• The site lies outside of the Environment Agency's Historic Flood Map (HFM) and historical records from Oldham Council.
Groundwater Flood Risk	• Due to the site's proximity to Lord's Brook and the unnamed onsite watercourse, groundwater is expected to be similar to the corresponding levels in the river. Groundwater will follow topography and is unlikely to be an issue in this instance. Groundwater must be assessed as part of the FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • 22a is fully within the Conurbation Core CDA and the majority of 22c is within the same CDA. A small area of the southern part of 22b is within the same CDA.
Defended	• Based on the EA's Spatial Flood Defences dataset, Lord's Brook that runs north of GM Allocation 22a is bound by areas of high ground that act as informal defences which are assessed at condition grade 3 meaning 'Fair' (Table 1.1 Condition Assessment Manual[1]).
Flood Warning	• The site lies outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes	• The site lies wholly within areas of tree planting in the WwNP dataset. Both the western and southern sites partially include areas of riparian tree planting. These areas can significantly delay peak runoff in catchments. There are smaller areas of runoff attenuation features also included. These are areas of high flow within the RoFSW maps based on the premise that runoff time may be influenced by temporary storage if designed correctly. • The majority of the sites are additionally within areas of urban loss improvement in the Irwell NFM dataset. These are locations where an increase in greenspace increase the overall permeability thereby improving soil moisture storage.
Flood Risk Summary	• Allocation of this site would be possible due to the level of fluvial and surface water risk to the site which can easily be avoided; development should focus towards areas of little risk. • GM Allocation 22c is the only land parcel that experiences any fluvial risk and it remains in the close vicinity of the onsite unnamed watercourse. Development should avoid this area and focus towards the areas located in Flood Zone 1. • During the 1% AEP surface water event, all three land parcels have localised pools of risk that are small and can easily be avoided. • Runoff rates should not exceed current rates and if possible, betterment of existing rates should be aimed for. • Given the WwNP dataset shows this site has great potential for slowing the flow, consideration should be given towards allocating parts of the site to WwNP techniques. • 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. This will require surface water modelling based on the proposed layout and

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf

2019 GMSF Allocation:	GM Allocation 22 – Woodhouses Cluster
	investigation into appropriate SuDS techniques. As the site is currently greenfield, infiltration SuDS should be possible, subject to ground investigation and contamination testing.

2019 GMSF Allocation:	GM Allocation 49 – North of Mosley Common
Area (ha)	64.64
Catchment	Honksford Brook
Proposed use	Residential

Figures illustrating allocation and main risk sources

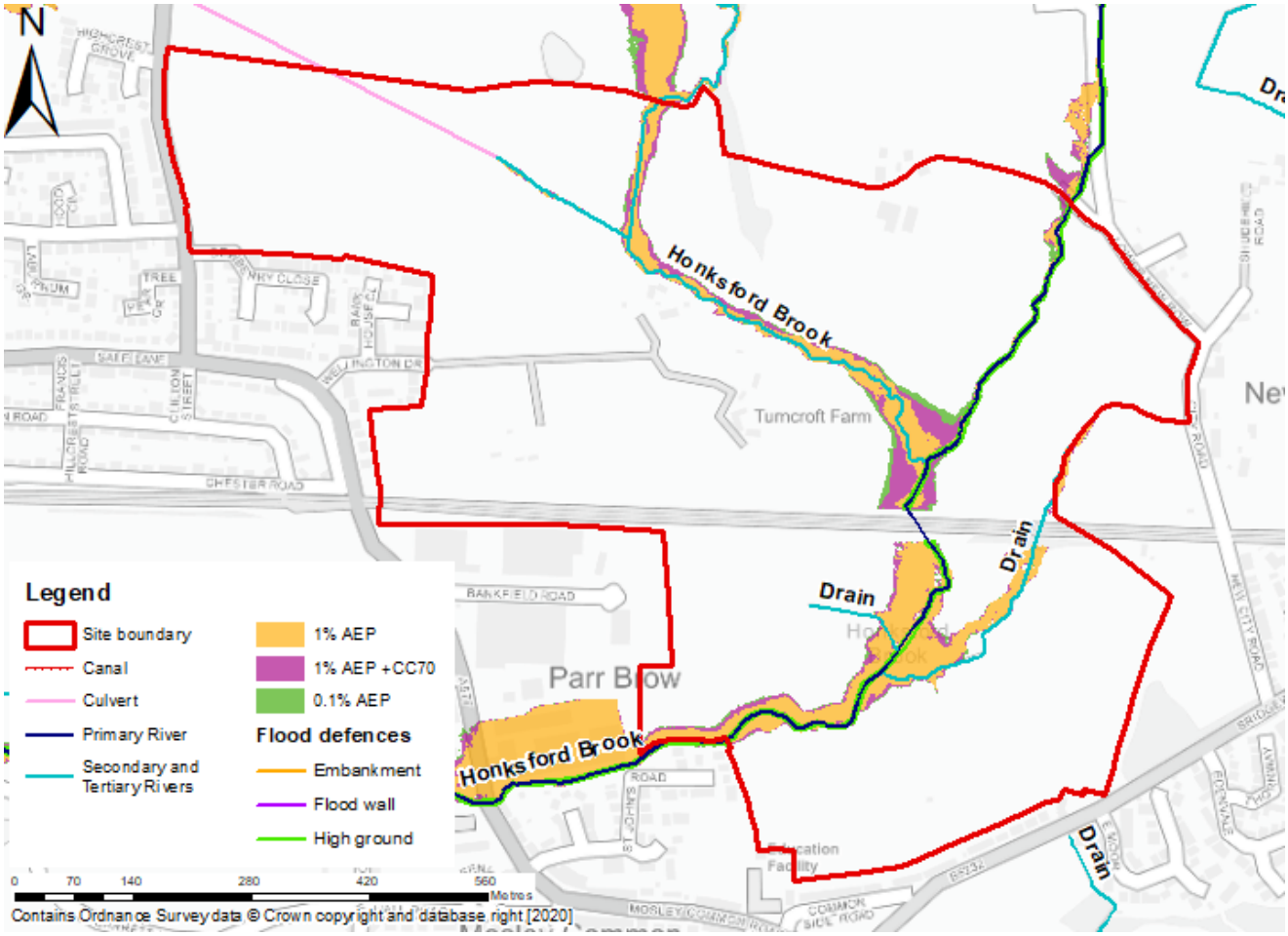

Figure 1: JFlow fluvial modelled flood outlines for the present day 1% and 0.1% AEP events and future risk 1% AEP event with +70% climate change uplift

2019 GMSF Allocation:	GM Allocation 49 – North of Mosley Common

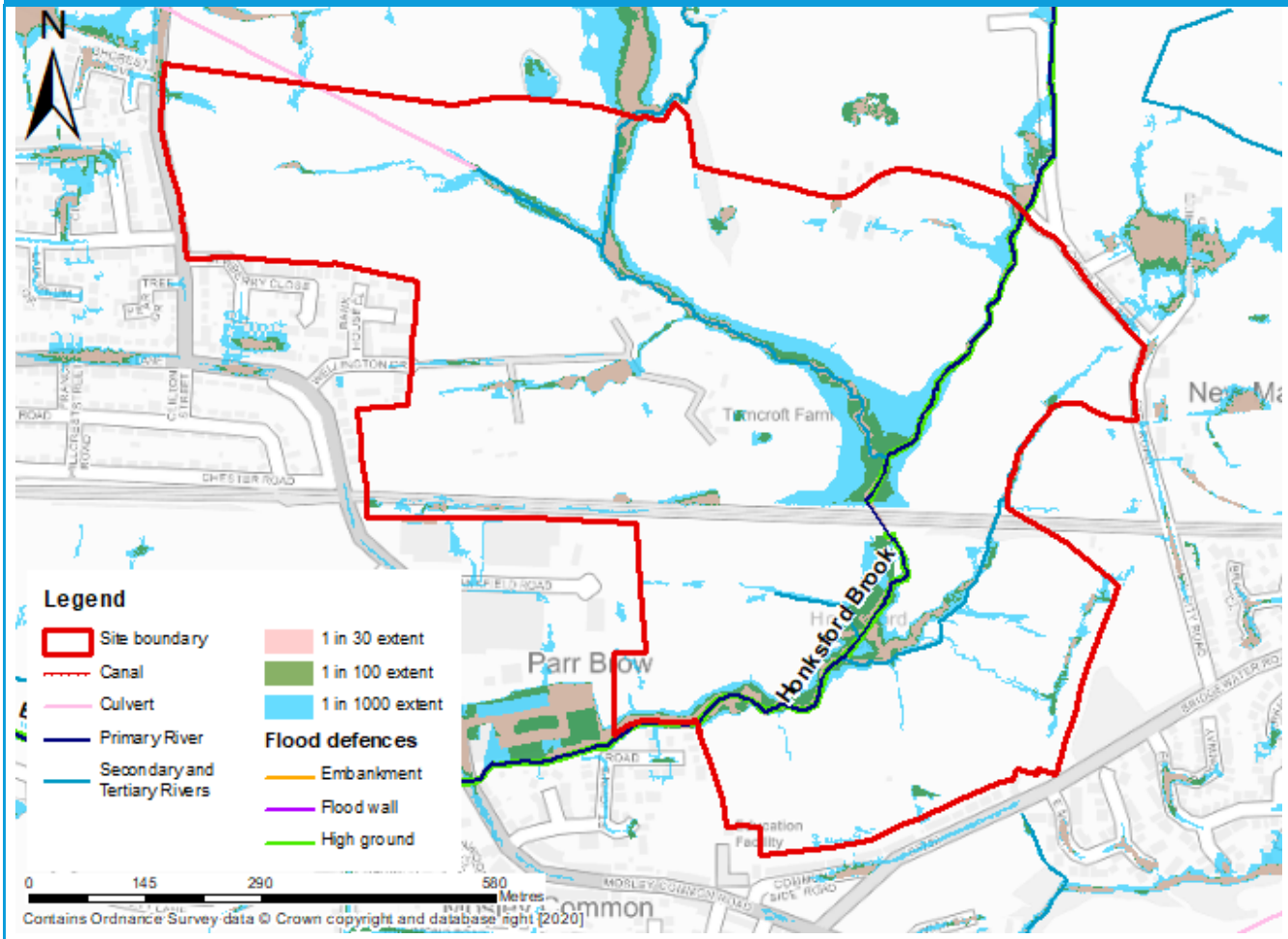

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**0.1% AEP**	**1% AEP**	**1% AEP +CC70**
	92.37	0.60	5.35	1.68
	• Fluvial risk (Figure 1) was modelled as part of this Level 2 SFRA using JBA's inhouse JFlow software. • JFlow is a broadscale 2D modelling tool that does not include detailed channel survey. The modelled outputs are not detailed enough to inform on risk in a site-specific Flood Risk Assessment. • The modelling shows considerably greater risk to the site than the EA's Flood Map for Planning, at the time of writing.			
Surface Water Risk (%)	**Low**	**Medium**	**High**	
	12.33	5.63	2.87	
Climate Change Considerations	• The 1% AEP +70% climate change uplift event outline covers approximately 7% of the total site area with the extent primarily following Honksford Brook. The average depth for this event is approximately 530mm. This area should be avoided so development is appropriate for the future. • The current surface water 0.1% AEP event outline provides an indication of the likely increase in extent of more frequent events. The 0.1% AEP outline covers approximately 12% of the site area and primarily remains within the area that is also at fluvial risk along Honksford Brook.			
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents.			

2019 GMSF Allocation:	GM Allocation 49 – North of Mosley Common
Reservoir Flood Risk	• The site is not within any EA reservoir flood outlines.
Historical Flooding	• The site lies outside of the Environment Agency's Historic Flood Map (HFM) and historical records from Wigan Council.
Groundwater Flood Risk	• Due to the site's proximity to Honksford Brook, groundwater levels are expected to be similar to the corresponding levels in the river. Groundwater will follow topography and is unlikely to be an issue in this instance. Groundwater must be assessed as part of an FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change.
Defended	• Based on the EA's Spatial Flood Defences dataset, Honksford Brook is bound by informal defences of areas of high ground which are assessed at condition grade 3 meaning 'Fair' (Table 1.1 Condition Assessment Manual[1]).
Flood Warning	• There is a small area on Honksford Brook in the south of the site that is included within an EA FWA; the FWA is for Honksford Brook at Worsley Business Park and Mosley Common Road.
Flood Storage Area / Potential for Working with Natural Processes	• The site lies almost wholly within areas of tree planting in the WwNP dataset. Additionally, both banks and the land alongside Honksford Brook, flowing through the centre of the site, are included as areas for riparian tree planting. Both of these can significantly delay peak runoff in catchments with the latter additionally enhancing floodplain roughness to obstruct significant flow paths.
Flood Risk Summary	• Allocation of this site may be possible due to the level of fluvial and surface water flood risk to the site as it remains focused around Honksford Brook. • The EA recommends a buffer around the watercourses to account for the flood risk and also the 8 metre no development strip recommended by the EA for maintenance and access purposes. • The area of site that is at surface water risk is primarily included within the areas at fluvial risk; therefore, if the fluvial areas are avoided then the surface water risk will be accounted for as well. • Additionally, as the land alongside the Brook is also within riparian tree planting areas, steering potential development away from these areas will further see sources of flood risk mitigated. • This is a large site with potential to create significant volumes of runoff if infiltration is not possible. Downstream areas at risk and additional volumes of water even if rate is controlled could increase scale or duration of flooding downstream. This development could reduce risk by safeguarding areas for flood storage and enhancement of storage areas to reduce flows downstream, as shown by the WwNP dataset. • 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. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. As the site is currently greenfield, infiltration SuDS should be possible, subject to ground investigation and contamination testing

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf

2019 GMSF Allocation:	Land South of Hyde
Area (ha)	32.36
Catchment	Bowlacre Brook
Proposed use	Residential

Figures illustrating allocation and main risk sources

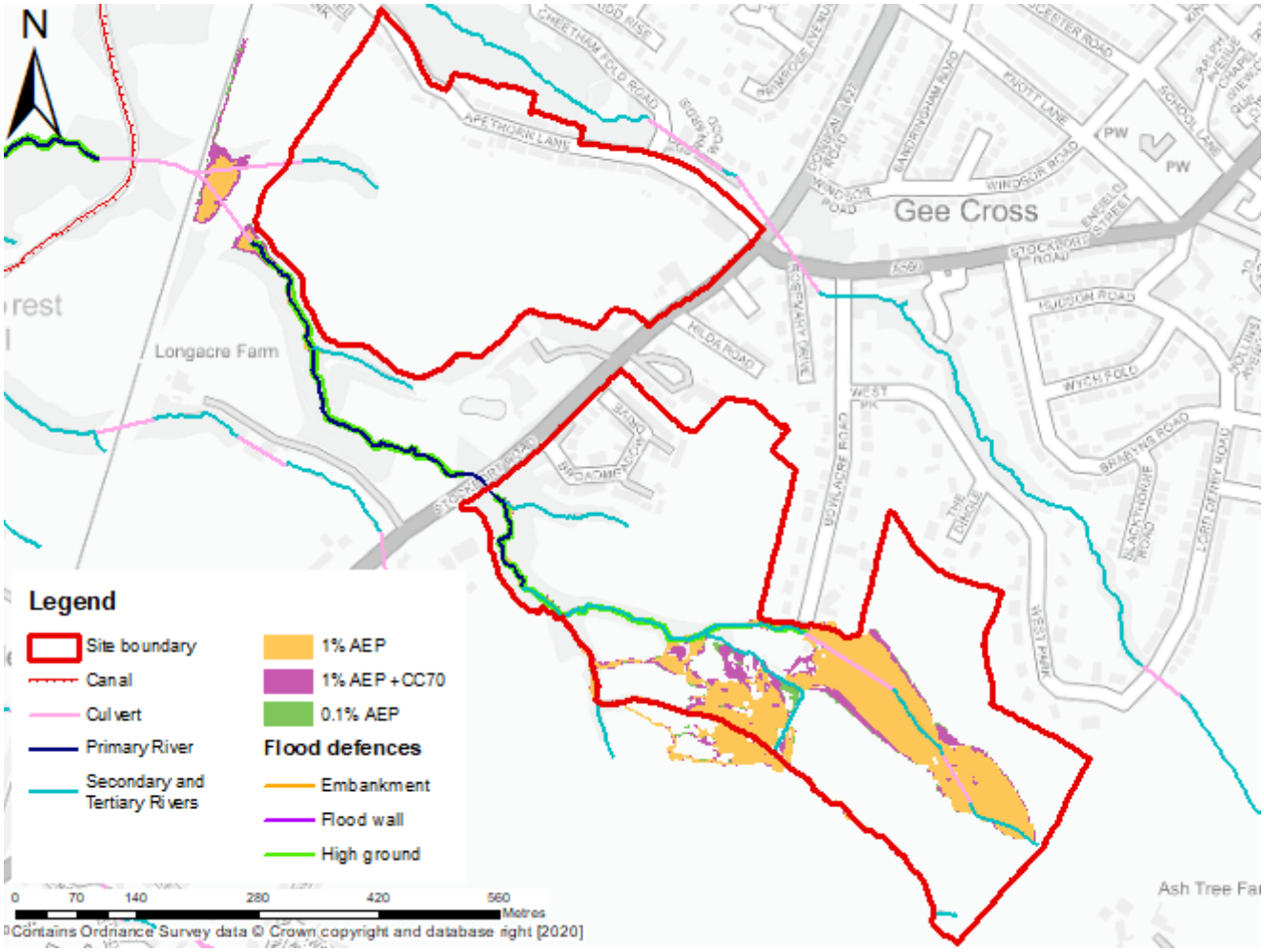

Figure 1: JFlow fluvial modelled flood outlines for the present day 1% and 0.1% AEP events and future risk 1% AEP event with +70% climate change uplift

2019 GMSF Allocation:	Land South of Hyde

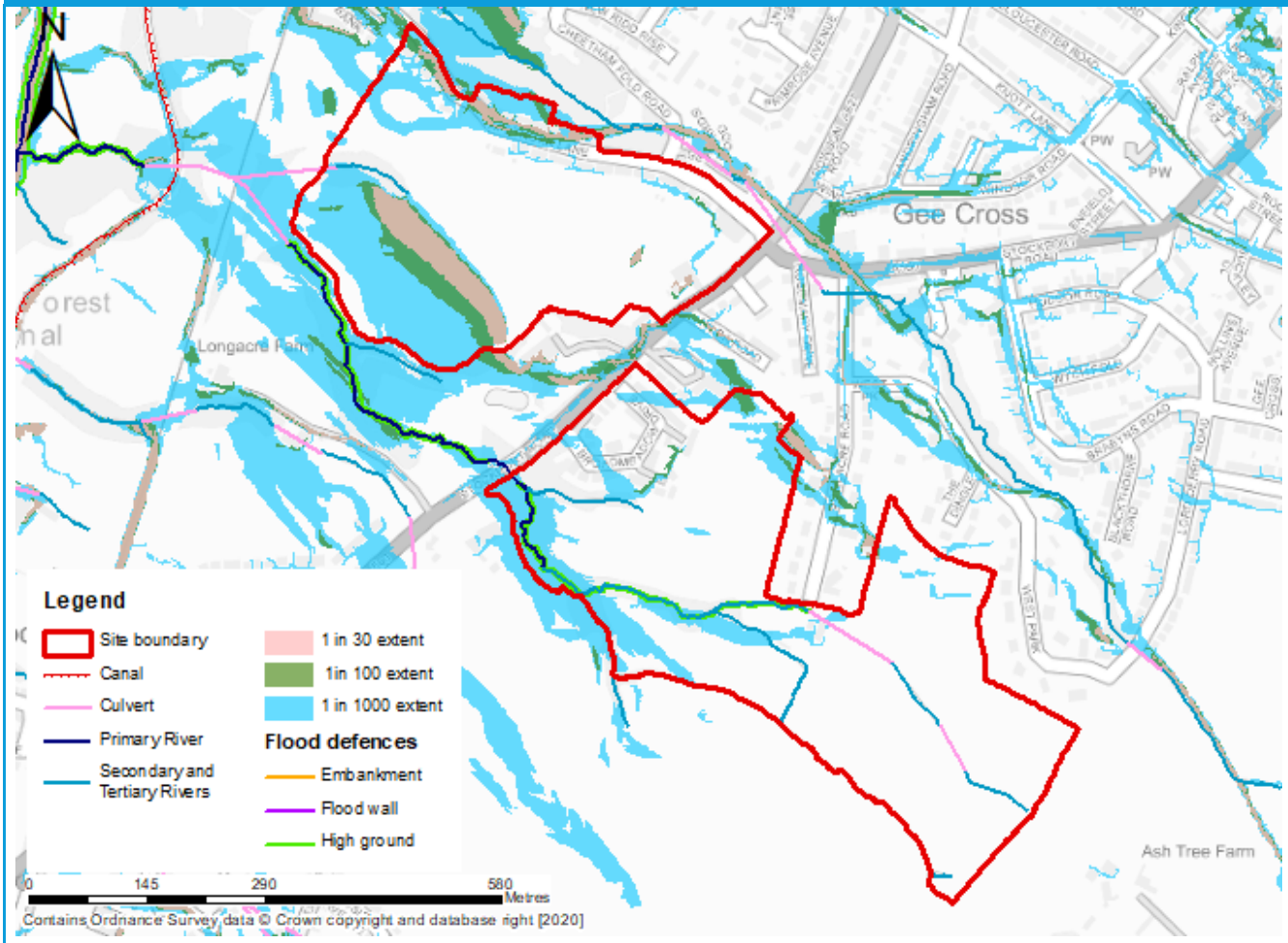

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**0.1% AEP**	**1% AEP**	**1% AEP +CC70**
	89.00	0.31	9.00	1.69
	• Fluvial risk (Figure 1) was modelled as part of this Level 2 SFRA using JBA's inhouse JFlow software. • JFlow is a broadscale 2D modelling tool that does not include detailed channel survey. The modelled outputs are not detailed enough to inform on risk in a site-specific Flood Risk Assessment. • The modelling shows considerably greater risk to the site than the EA's Flood Map for Planning, at the time of writing.			
Surface Water Risk (%)	**Low**	**Medium**	**High**	
	50.24	13.64	7.25	
Climate Change Considerations	• The 1% AEP +70% climate change uplift event outline covers approximately 11% of the total site area with the average depth being around 50mm with the maximum reaching approximately 1.7m. The risk is primarily within the southern land parcel. • The current surface water 0.1% AEP event outline provides an indication of the likely increase of extent of more frequent events. The 0.1% AEP event outline covers over 50% of the site and primarily follows the course of Bowlacre Brook onsite. • However, the Risk of Flooding from Surface Water dataset is not representative of risk on the site. See flood risk summary below.			

2019 GMSF Allocation:	Land South of Hyde
Sewer Flood Risk	• The site lies outside of United Utilities recorded surface water flooding incidents. • There are two locations where manholes saw flood volume stored on the surface during a 1% AEP event, but then was returned to the drainage system following storm subsidence.
Reservoir Flood Risk	• The site is not within any EA reservoir flood outlines.
Historical Flooding	• The site lies outside of the Environment Agency's Historic Flood Map (HFM). • According to the DG5 register, the site experienced external sewer flooding during June 2009 that covers the whole site.
Groundwater Flood Risk	• Due to the site's proximity to the River Tame and Bowlacre Brook onsite, groundwater levels are likely to be similar to the corresponding levels in the watercourses. Groundwater will follow topography and is unlikely to be an issue in this instance. However, groundwater must be assessed as part of the FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • Parts of this site are within the Hyde Opportunity Area for Critical Drainage Management, which are areas additional to the CDAs that should be considered for CDA designation in the future.
Defended	• Based on the EA's Spatial Flood Defences dataset, Bowlacre Brook is bound by areas of high ground that act as informal defences. Towards the south the defences are assessed at condition grade 3 meaning 'Fair'; those towards the north are assessed at condition grade 5 meaning 'Very Poor' (Table 1.1 Condition Assessment Manual[1]).
Flood Warning	• The site lies outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes	• The site lies within areas of tree planting as well as riparian tree planting; taken from the WwNP dataset. Both these parts can significantly delay peak runoff in catchments with the latter enhancing floodplain roughness to obstruct significant flow paths.
Flood Risk Summary	• LIDAR was unavailable for this site therefore a LIDAR survey was carried out as part of the Level 2 SFRA. The JFlow fluvial modelling was then carried out using this LIDAR. • The national Risk of Flooding from Surface Water map, shown in Figure 2, was modelled using less detailed photogrammetry terrain data. This has resulted in an inaccurate representation of surface water risk. It is expected that surface water risk would be similar to that of the modelled fluvial risk, though this should be fully quantified at the FRA stage. • 9% of the site is located within the fluvial 1% AEP outline where the average depths are very shallow at approximately 40mm and only reach 50mm in the 1% AEP +70% climate change uplift event. Employing a managed overland route with management and control measures could potentially reduce the extent of the 1% AEP event. • The development should be directed to areas within Flood Zone 1 which is primarily the northern land parcel and the north west of the southern parcel. • The risk in the southern parcel should be maintained as an overland flow route with various management and control mechanisms implemented to enable safe development around the risk. • There should be an 8 metre no development buffer strip on Bowlacre Brook running through the centre of the site for EA access and maintenance

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf

2019 GMSF Allocation:	Land South of Hyde
	purposes; development should avoid this area. • To consider development within the 1% AEP event outline, the developer would need to find room for compensatory storage. There may be areas surrounding the site that may be suitable; these would need to be investigated further. • Onsite culverts should be removed, and the channels opened up to reduce residual flood risk and to enhance WFD targets. • 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. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. As the site is currently greenfield, infiltration SuDS should be possible, subject to ground investigation and contamination testing.

2019 GMSF Allocation:	GM Allocation 1a – Northern Gateway
Area (ha)	640.42
Catchment	Whittle Brook, Castle Brook
Proposed use	Mixed use

Figures illustrating allocation and main risk sources

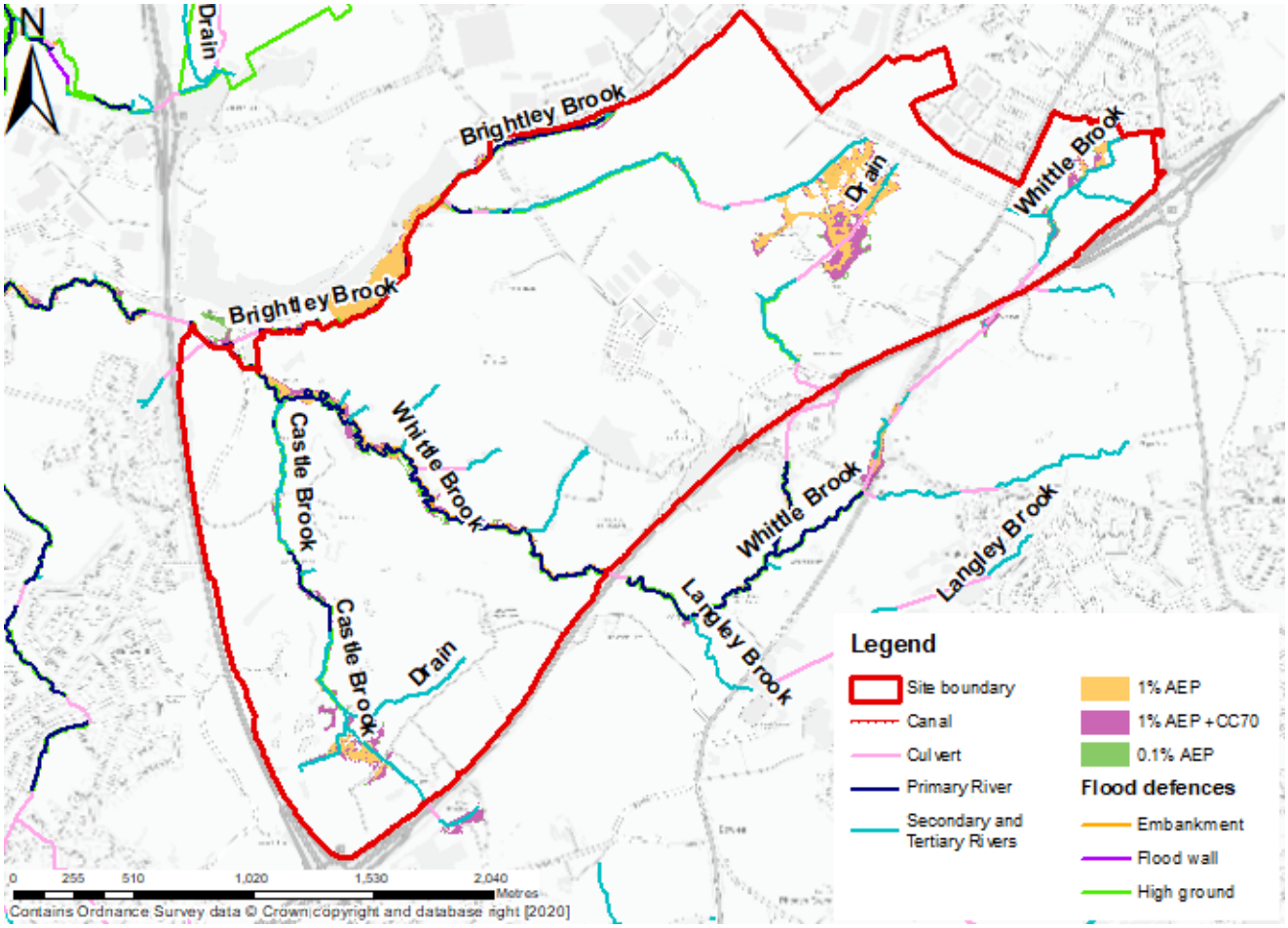

Figure 1: JFlow fluvial modelled flood outlines for the present day 1% and 0.1% AEP events and future risk 1% AEP event with +70% climate change uplift

2019 GMSF Allocation:	GM Allocation 1a – Northern Gateway

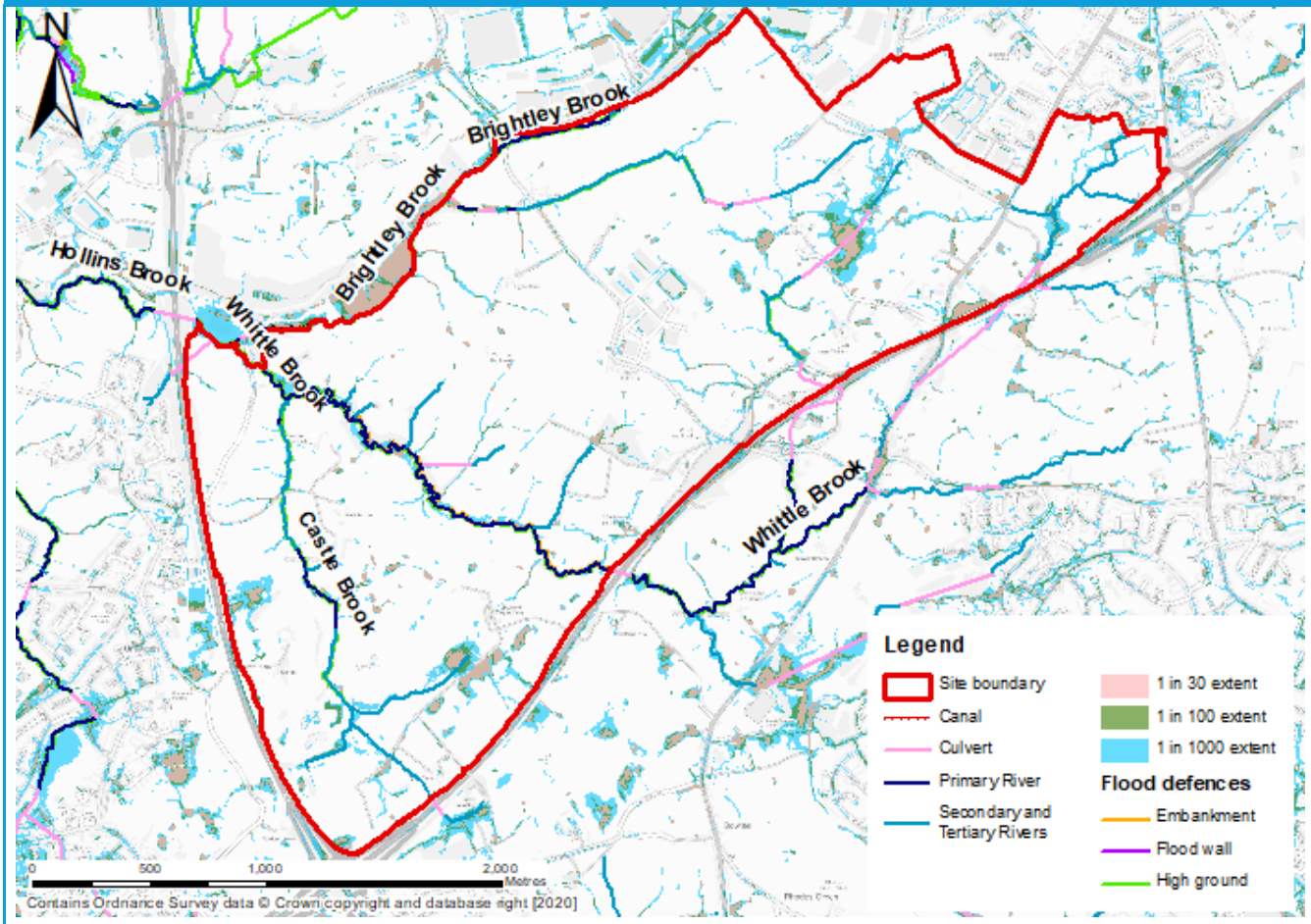

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**0.1% AEP**	**1% AEP**	**1% AEP +CC70**
	96.92	0.24	2.84	4.10
	• Fluvial risk (Figure 1) was modelled as part of this Level 2 SFRA using JBA's inhouse JFlow software. • JFlow is a broadscale 2D modelling tool that does not include detailed channel survey. The modelled outputs are not detailed enough to inform on risk in a site-specific Flood Risk Assessment. • The modelling shows greater risk to the site than the EA's Flood Map for Planning, at the time of writing.			
Surface Water Risk (%)	**Low**	**Medium**		**High**
	9.53	4.37		2.91
Climate Change Considerations	• The 1% AEP +70% climate change uplift event outline covers approximately 4% of the total site area and stays primarily around the onsite watercourses with a small pool in the north-eastern corner of the site. The average depths are around 400 mm. • The current surface water 0.1% AEP event outline covers almost 10% of the site that mainly keeps with the onsite watercourses and has small areas of localised ponding that can be avoided.			
Sewer Flood Risk	• The site is outside United Utilities recorded surface water flooding incidents.			
Reservoir Flood Risk	• Parts of the western area of the site are within the EA's reservoir flood map extent, showing the maximum extent of flooding possible in the unlikely event of a reservoir dam failure.			

2019 GMSF Allocation:	GM Allocation 1a – Northern Gateway
	• The extent shows the worst credible area that is susceptible to dam breach flooding. The map should be used to prioritise areas for evacuation/early warning. • The chance of reservoir failure is very rare and there is an extremely good safety record in the UK with no loss of life due to reservoir flooding since 1925. • United Utilities confirms that ongoing maintenance and investment ensures that reservoirs do not pose any flood risk.
Historical Flooding	• The site lies outside of the Environment Agency's Historic Flood Map (HFM) and historical records from the local authorities.
Groundwater Flood Risk	• Due to a number of watercourses running through the site, groundwater levels are likely to be similar to the corresponding levels in the river. Groundwater will follow topography and is unlikely to be an issue in this instance. Groundwater must be assessed as part of the FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • No part of the site is within a CDA.
Defended	• The numerous watercourses that flow through the site are bound by areas of high ground that act as informal defences which are assessed at condition grades 2, 3 and 4 meaning 'Good', 'Fair', and 'Poor' respectively (Table 1.1 Condition Assessment Manual[1]). • There is an embankment on the southern bank of the large waterbody on Brightley Brook at Pilsworth Fisheries on the northern border of the site which has been assessed at condition grade 4 meaning 'Poor'. • There is another embankment located on Langley Brook which flows through the centre of the site; the embankment has been assessed at condition grade 3 meaning 'Fair'.
Flood Warning	• The site lies outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes	• Large parts of the site lie within areas recommended for tree planting and targeted tree planting on floodplains, as shown by the WwNP dataset. There are also numerous areas recommended for riparian tree planting alongside both banks of Whittle Brook and other drains within the site boundary. These WwNP techniques can significantly delay the timing of peak runoff in catchments and can also provide obstructions to significant flow paths. • The site also includes parts of urban and rural loss improvement areas within the Irwell NFM dataset. Both of these include scenarios where soil structure is improved, thereby making the land more permeable and thus increasing the soil moisture storage capacity of these areas. In the urban loss parts, this also includes an increase in overall greenspace.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf

2019 GMSF Allocation:	GM Allocation 1a – Northern Gateway
Flood Risk Summary	• Over 95% of the development site lies within Flood Zone 1 and development should be directed into these areas, if possible. • The 1% AEP +70% climate change event flood extent is localised to two main areas, with these areas of land also at risk of surface water. • There is additional surface water risk across the site though locations are sporadic and in small pockets when compared to the entirety of the proposed site allocation. • However, this is a large site with potential to create significant volumes of runoff if infiltration is not possible. Downstream areas at risk and additional volumes of water, even if the runoff rate is controlled, could increase scale or duration of flooding downstream. This development could reduce risk by safeguarding areas for flood storage and enhancement of storage areas to reduce flows downstream. The WwNP dataset, discussed above, should provide a start for assessing possible areas for storage or tree planting. • A drainage strategy would be required to ensure current onsite risk can be managed effectively with no increase in surface water flood risk elsewhere as a result of new development. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. Infiltration SuDS may be feasible on parts of the site, subject to ground investigation and contamination testing at the FRA stage. • Development should avoid the 8m no-development buffer that the EA requires alongside watercourses (for access and maintenance requirements).

2019 GMSF Allocation:	GM Allocation 7 – Elton Reservoir Area
Area (ha)	251.67
Catchment	Manchester, Bolton and Bury Canal, Crows Tree Brook
Proposed use	Residential

Figures illustrating allocation and main risk sources

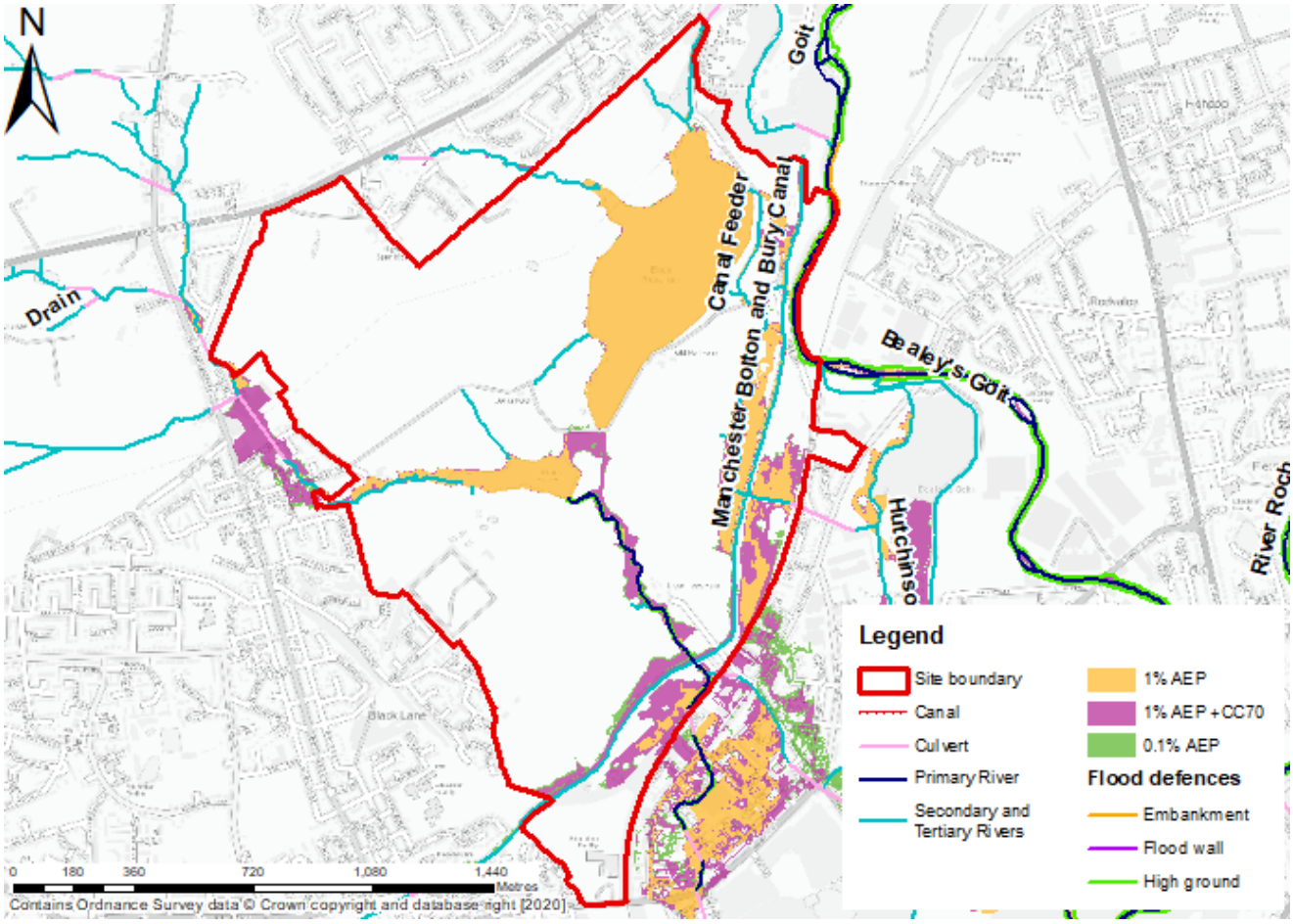

Figure 1: JFlow fluvial modelled flood outlines for the present day 1% AEP event and the future risk 1% AEP +70% climate change uplift

2019 GMSF Allocation:	GM Allocation 7 – Elton Reservoir Area

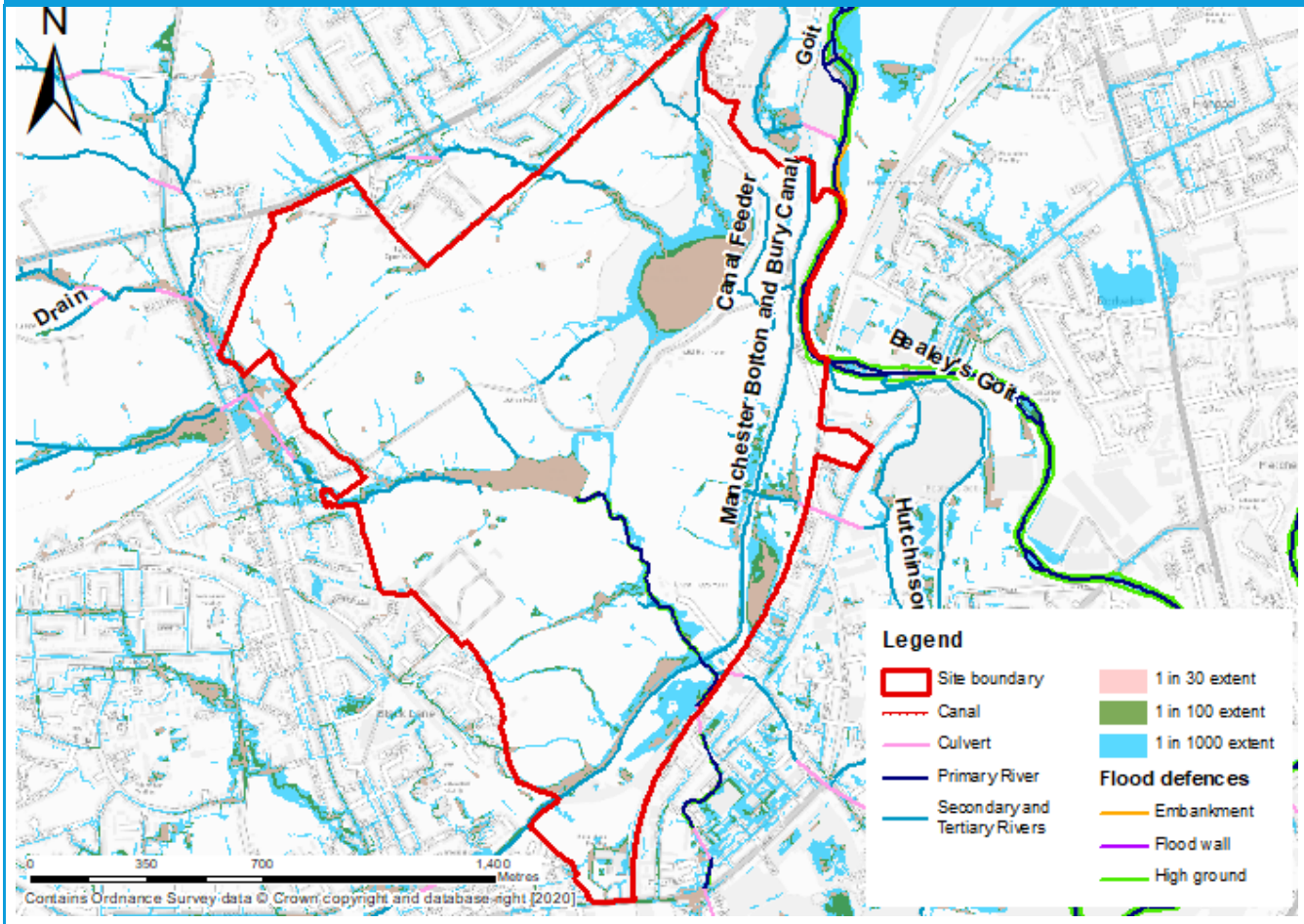

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**0.1% AEP**	**1% AEP**	**1% AEP +CC70**
	79.08	0.77	15.29	4.86
Surface Water Risk (%)	**Low**	**Medium**		**High**
	11.07	8.90		6.67
Climate Change Considerations	• The 1% AEP +70% climate change uplift event outline covers approximately 20% of the site primarily in the north-east of the site and following the onsite watercourse. The average depth is 400 mm. • The current surface water 0.1% AEP event outline covers just over 11% of the total site area and is consistent with the fluvial 1% AEP +70% climate change uplift outline.			
Historical Flooding	• The site lies outside of the Environment Agency's Historic Flood Map (HFM). • Bury Council records an incident of flooding from reservoir drawdown in April 2010 when a small slip in the dam prompted a precautionary drawdown of the reservoir. Water levels built up against the Metrolink embankment and then flooded properties on the west side of Bury Road. • The Council also has several records of fluvial flooding, most notably in 2015 and February 2020, just outside the site area, which are linked to watercourses within the site area. During Storm Eva and Storm Ciara, water overtopped the river at Warth and flowed underneath the Metrolink arches and flooded properties on Openshaw Fold Road, Warth Road, Warth Industrial Estate. During Storm Eva, the water flowed over Bury Road and onto Keswick Drive.			

2019 GMSF Allocation:	GM Allocation 7 – Elton Reservoir Area
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents.

Reservoir Flood Risk	• A Dam Break and Flood Inundation Assessment has been completed for the site which models for a range of return periods the extent, depths and flows of flooding if a dam failure occurred. The outputs of the report indicate that the land around the eastern boundary of the site - adjacent to the Manchester, Bolton, Bury Canal and Metrolink line, and the urbanised area of North Radcliffe would be at risk of flooding if a breach occurred.
	• A Risk Assessment and Reservoir Safety Report has been completed for the site which assesses the likelihood of a dam failure of Elton Reservoir. The outputs of the report indicate:
	  ○ that the annual probability of failure for the reservoir is 1 in 5,500 years;
	  ○ the annual probability of failure is heavily influenced by failure of the internal structures and embankment, rather than external factors; and
	  ○ Measures should be taken to reduce the risk to a level that is 'as low as reasonably practical'.
	• An updated Risk Assessment and Reservoir Safety Report[1] has been completed which, building on the reports mentioned above, assesses the impact of the reservoir on the proposed development on the site. The outputs of the report indicate that:
	  ○ There would be a marginal increase in the Population at Risk (PAR) and Average Social Life Loss (ASLL) should there be a breach in the reservoir; and
	  ○ The dam categorisation is likely to be impacted by the construction of development downstream which would require significant work to the reservoir structure and / or associated downstream channels to implement a more onerous safety check and design flood event conditions.
	• Large areas of the site are within the EA Reservoir Flood Map (RFM) outlines, indicating the maximum extent of flooding. These areas are downstream of Elton Reservoir and are based on a breach of the dam.
	• The extent shows the worst credible area that is susceptible to dam breach flooding. The map should be used to prioritise areas for evacuation/early warning.
	• The chance of reservoir failure is very rare and there is an extremely good safety record in the UK with no loss of life due to reservoir flooding since 1925.
	• Elton Reservoir is owned and managed by Canal & River Trust, who monitor and maintain the reservoir as required.

Groundwater Flood Risk	• Due to the site's proximity to Crows Tree Brook and the Elton watercourse, groundwater is likely to be similar to the corresponding levels. Groundwater will follow topography and is unlikely to be an issue in this instance. Groundwater must be assessed as part of the FRA.
Defended	• Based on the EA's Spatial Flood Defences dataset, Crows Tree Brook in the south of the site and Bealey's Goit to the north-east are bound by areas of high ground which act as informal defences
Flood Warning	• The site lies outside of any current EA FWAs. There are two FWAs located outside of the site to the east for the River Irwell at Radcliffe and Redvales.

[1] HR Wallingford, Elton Reservoir Flood Studies – Phase 2: Impact of Proposed Development, September 2020

2019 GMSF Allocation:	GM Allocation 7 – Elton Reservoir Area
Flood Storage Area / Potential for Working with Natural Processes	• According to the WwNP dataset, the site to the west of Elton Reservoir is recommended for tree planting whilst there are also areas recommended for riparian tree planting along the canal and Crows Tree Brook. Tree planting can significantly delay the timing of peak runoff from catchments whilst riparian planting can also enhance floodplain roughness to cause obstructions to significant flow paths. • Much of the site is also within areas of rural and urban loss improvement parts of the Irwell NFM scheme. Both of these include scenarios where soil structure is improved, thereby making the land more permeable and thus increasing the soil moisture storage capacity of these areas. In the urban loss parts, this also includes an increase in overall greenspace.

Flood Risk Summary	• Almost 80% of the site is located within Flood Zone 1 and development should be directed towards these areas. The areas at surface water risk are encompassed within the fluvial risk areas and thus if these areas are avoided then both sources of risk could be accommodated.
	• Based on a broad assessment of fluvial risk, it is likely this site can pass the Exception Test, given 79% of the site is within Flood Zone 1.
	• To consider development within the 1% AEP event outline, solutions to mitigate the risk of flooding such as raising floor levels, which must also entail compensatory storage, and building on stilts would need to be considered.
	• This is a large site with potential to create significant volumes of runoff if infiltration is not possible. The surrounding watercourses are relatively small and may not deal with significant volumes being added to them. There are also areas at risk downstream so additional volumes could also increase flooding downstream. Crow Trees Farm Brook has areas at risk downstream. This development could reduce risk by safeguarding areas for flood storage and enhancement to reduce flows downstream. The WwNP dataset, discussed above, should provide a start for assessing possible areas for storage or tree planting.
	• A series of studies into the risk of flooding from the reservoir have been completed. The recommendations from these studies should be implemented.
	• A drainage strategy would be required to ensure current onsite risk can be managed effectively with no increase in surface water flood risk elsewhere as a result of new development. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. Infiltration SuDS may be feasible on parts of the site, subject to ground investigation and contamination testing.
	• A Flood Risk Assessment and Outline Drainage Strategy[2] have been prepared for the site to assess the risk of flooding in more detail. To develop the site safely it recommends:
	  ○ Setting finished floor levels 600 mm above the 1% plus climate change flood level;
	  ○ Safe emergency access and egress to the site to be provided to the north of the site;
	  ○ An evacuation plan should be developed in consultation with the LPA;
	  ○ Potential for soakaway use for rainwater disposal is low; but could be investigated further at the detailed design phase;
	  ○ Foul sewage could be discharged into the existing public foul sewer system but may need reinforcement subject to the agreement of United Utilities;
	  ○ Surface water flows will likely need attenuating to the greenfield runoff rate or a rate agreed with the LLFA/EA/UU. There are potential capacity issues to the south of Radcliffe Road so there may

[2] Peel Investments (North) Limited, Land at Elton Parklands, Radcliffe, Greater Manchester – Flood Risk Assessment & Outline Drainage Strategies July 2020

2019 GMSF Allocation:	GM Allocation 7 – Elton Reservoir Area
	be further restrictions on any discharges from Parcels D & G; ○ Surface water arising from the site could potentially discharge into the watercourses or a surface water culvert, with the exception of the Link Road to the southeast of the canal at the junction with Spring Lane which may need a sewer connection.

2019 GMSF Allocation:	GM Allocation 15a – Broadbent Moss
Area (ha)	6.60
Catchment	River Beal
Proposed use	Employment

Figures illustrating allocation and main risk sources

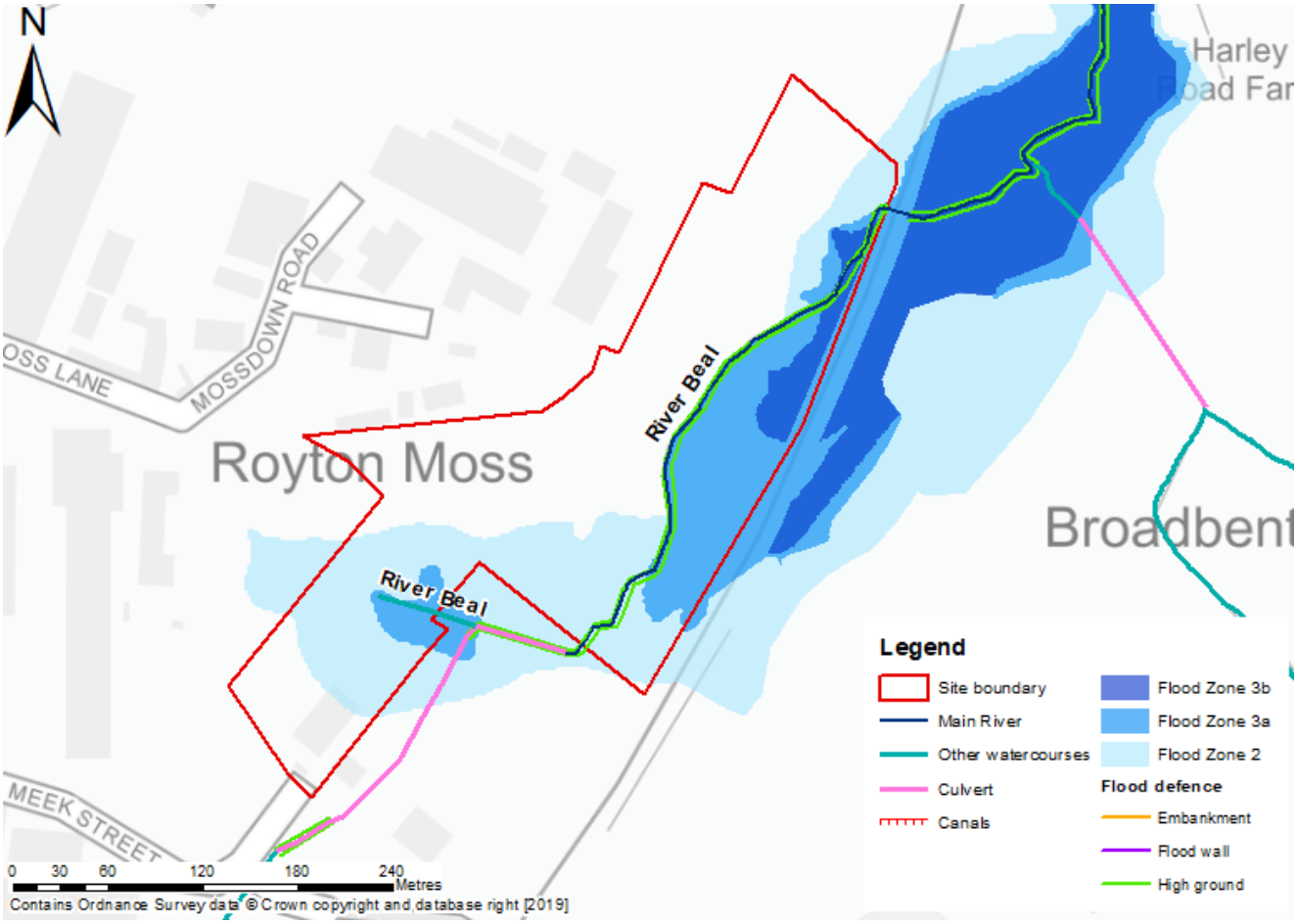

Figure 1: Site boundary with flood zone mapping (Flood Map for Planning) and flood defences (Note: The Flood Map for Planning is subject to change based on the updated River Beal model – at the time of writing this model is due to be finalised late 2020.)

2019 GMSF Allocation:	GM Allocation 15a – Broadbent Moss

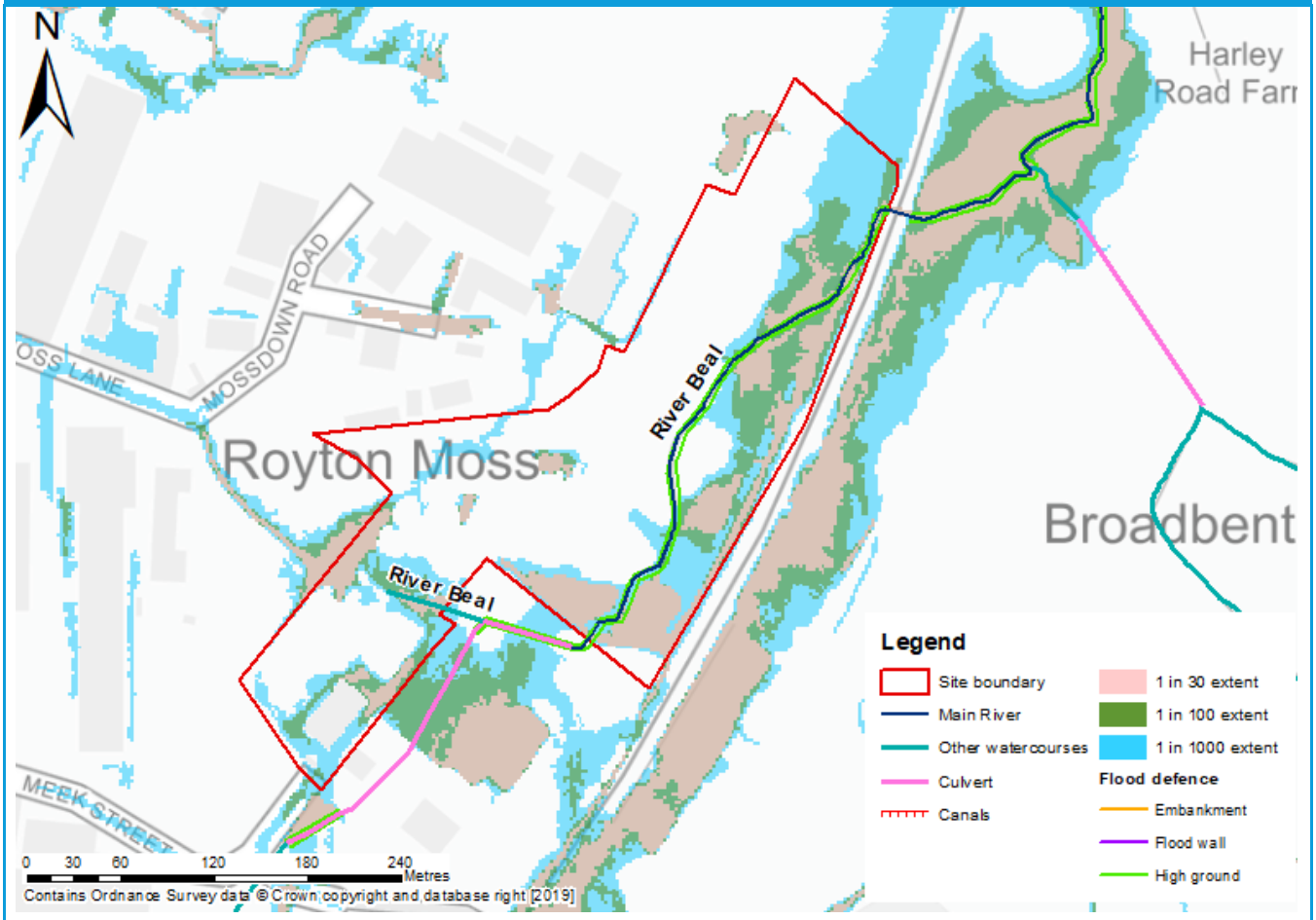

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**Flood Zone 2**	**Flood Zone 3a**	**Flood Zone 3b**
	52.18	26.73	16.73	4.36
Surface Water Risk (%)	**Low**	**Medium**		**High**
	40.73	24.01		13.96
Climate Change Considerations	• The 1% AEP +70% climate change uplift event outline covers the majority of the east and south of the site. There are no depth grids available for the climate change uplift and thus it is difficult to determine a full assessment of the risk during this event. • The current surface water 0.1% AEP event outline covers approximately 40% of the site with maximum depths reaching over 1.2m. These areas of risk are located in the same area as the fluvial risk.			
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents.			
Reservoir Flood Risk	• No part of the site is within the EA reservoir flood outlines.			
Historical Flooding	• The site lies outside of the Environment Agency's Historic Flood Map (HFM) and historical records for Oldham Council.			
Groundwater Flood Risk	• Due to the site's proximity to the River Beal, groundwater levels are likely to be similar to the corresponding levels in the river. Groundwater will follow topography and may be an issue in this instance. Groundwater should be assessed as part of the FRA.			

2019 GMSF Allocation:	GM Allocation 15a – Broadbent Moss
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • No part of the site is within a CDA.
Defended	• Based on the Environment Agency's Spatial Flood Defences dataset, the river is bound by informal defences of high ground which have been assessed at condition grade 3 meaning 'Fair' (Table 1.1 Condition Assessment Manual[1]).
Flood Warning	• The site lies outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes	• Parts of the site in the north are within areas of tree planting in the WwNP dataset. These areas can significantly delay the timing of peak runoff in catchments. In the south of the site boundary, there are additional areas of floodplain reconnection. • Large parts of the site are also within areas of urban loss improvement in the Irwell NFM scheme. These are parts where improved soil structure can lead to increased permeability and greater soil moisture storage. Within these areas it is also assumed that green spaces are increased, and overall landscape made more permeable. • The site also contains large parts of land safeguarded for flood storage.
Flood Risk Summary	• A detailed Level 2 site assessment has been carried out for this site. Refer to this report for more detail: 'BKQ-JBAU-XX-XX-RP-Z-0193-A6-P03-Site_Summary_GM_Allocation_15a' • Ongoing modelling updates of the Beal, when made available, should be used to reassess the site. At the time of writing, the River Beal model is expected to be finalised late 2020. • Due to the high level of surface water risk, a detailed drainage strategy would therefore be required to ensure current onsite risk can be managed effectively with no increase in surface water flood risk elsewhere as a result of new development. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. Infiltration SuDS may be feasible on parts of the site, subject to ground investigation and contamination testing at the FRA stage. • Land at the east of the site between the River Beal and railway is at high risk of both fluvial and surface water flooding. This part could be recommended to be kept as open greenspace to flood naturally and to provide benefits like flood storage, ecological benefits, and social/amenity benefits to the community.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf

2019 GMSF Allocation:	GM Allocation 18: Robert Fletchers
Area (ha)	32.27
Catchment	Chew Brook
Proposed use	Residential

Figures illustrating allocation and main risk sources

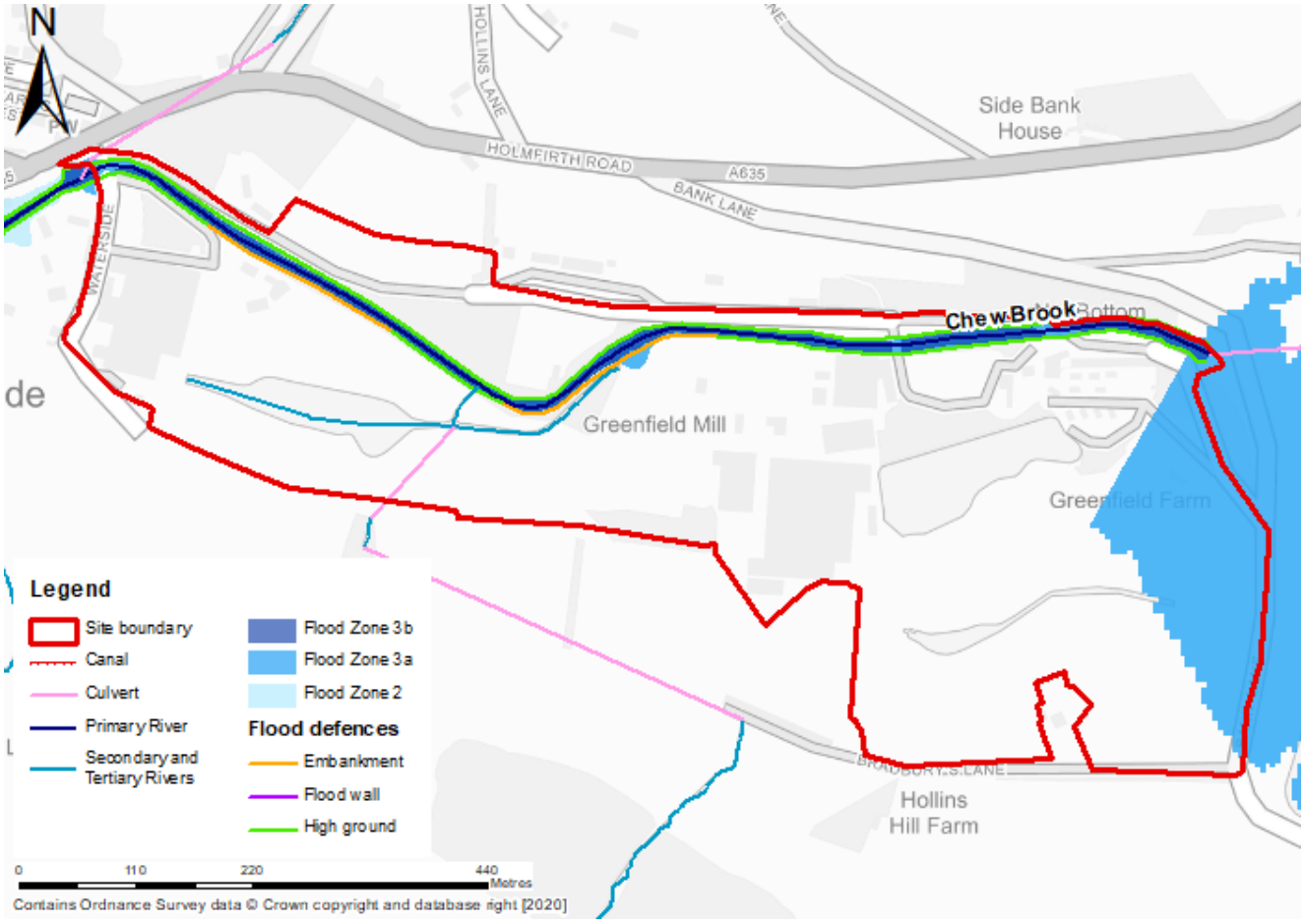

Figure 1: Site boundary with flood zone mapping (Flood Map for Planning) and flood defences

- The Flood Map for Planning Flood Zone 3 abruptly cuts across the site. It is thought this section of the flood zone is erroneous and is not representative of actual risk in this area. The Tame 2018 model upstream boundary for Chew Brook is located on the spillway of the reservoir, upstream of the eastern site boundary.
- Note, the Flood Map is due to be updated to incorporate updated model outputs for Chew Brook in September 2020, at the time of writing.

2019 GMSF Allocation: **GM Allocation 18: Robert Fletchers**

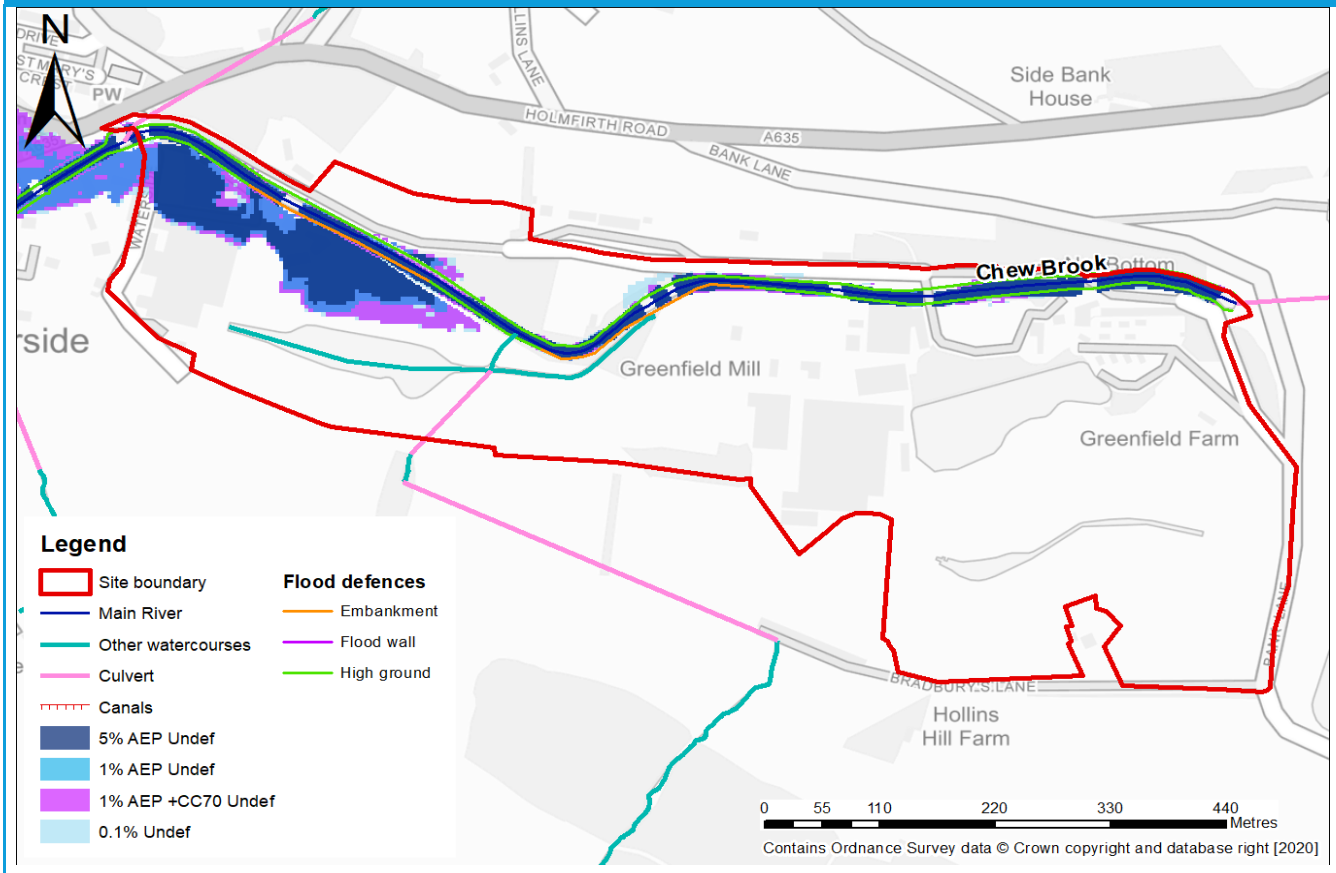

Figure 2: Undefended modelled fluvial flood outlines for existing risk and future risk

- The risk largely remains in-channel until downstream of the ordinary watercourse tributary, where the flood defence embankment is situated on the left bank.
- This embankment has not been modelled as a formal EA flood defence, though its condition is known to be fair.
- The 5% AEP event outline should be included in a revision of the functional floodplain, making the areas within this outline undevelopable. This will affect land parcels A, B and C, shown on the concept plan in this sites Level 2 assessment report: BKQ-JBAU-XX-XX-RP-Z-0054-A6-P03-Site_Summary_GM_Allocation_18.

2019 GMSF Allocation:	GM Allocation 18: Robert Fletchers

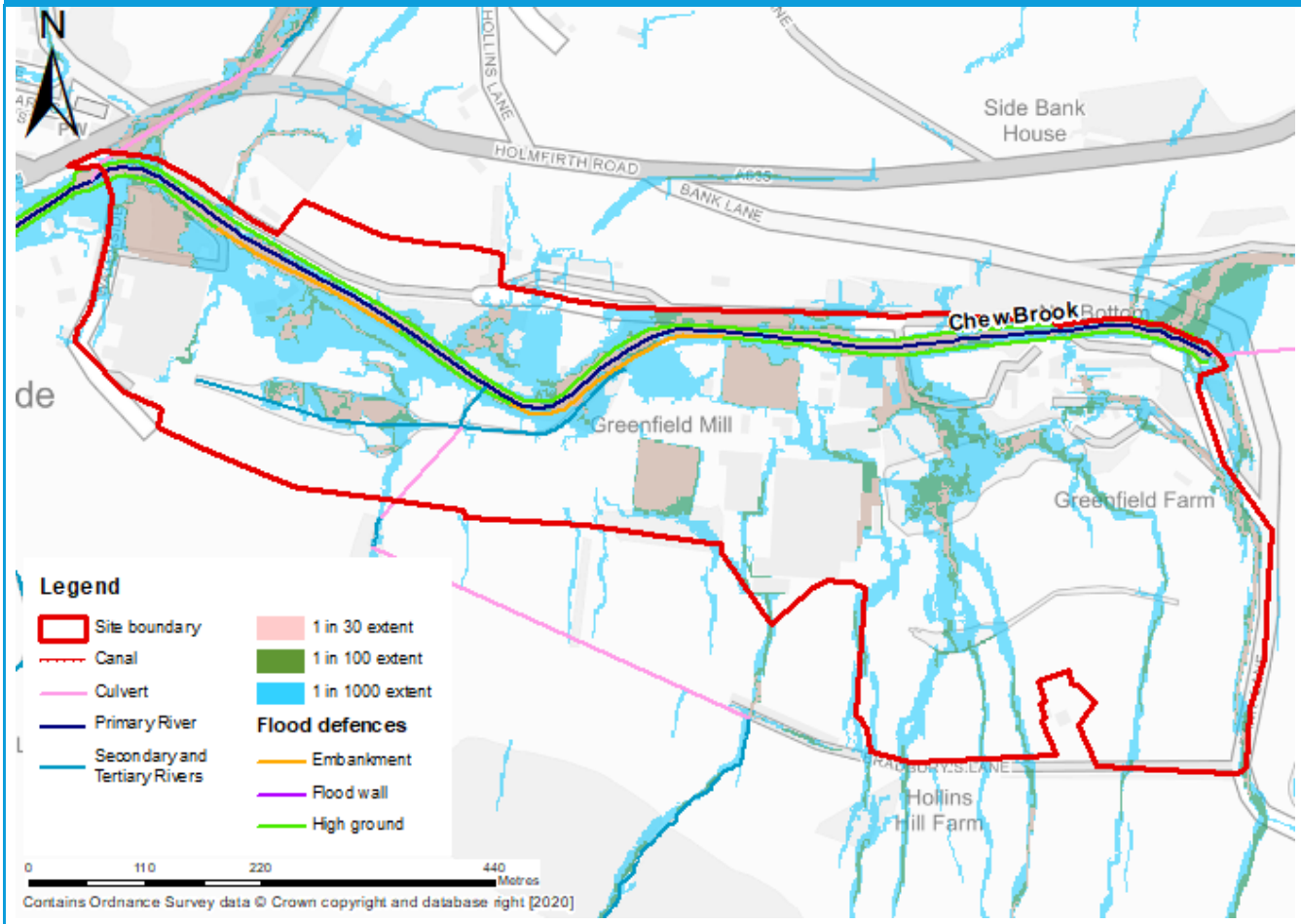

Figure 3: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**Flood Zone 2**	**Flood Zone 3a**	**Flood Zone 3b**
	8.5	1.1	2.3	11.5
Surface Water Risk (%)	**Low**	**Medium**		**High**
	33.4	14.9		10.1
Climate Change Considerations	• The 1% AEP +70% climate change event outline, shown in Figure 2, extends out of bank of Chew Brook in the same area as the other events. The climate change event does not extend further than the 0.1% AEP event. • The current surface water 0.1% AEP event outline provides an indication of the likely increase in extent of the more frequent events. The outline covers 33% of the site with additional flow paths being created from the south and running down to the ponded areas and Chew Brook.			
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents. • There are 24 recorded locations where manholes saw flood volume stored on the surface during a 1% AEP event, but then was returned after storm subsidence. Additionally, UU modelling shows that 2 onsite manholes can surcharge during a simulated 1% AEP event where water is lost from the drainage system to adjacent water systems via overland flow routes.			

2019 GMSF Allocation:	GM Allocation 18: Robert Fletchers
Reservoir Flood Risk	• Approximately 79% of the area is located within the maximum extent of flooding risk from reservoirs according to the EA's reservoir flood map with the average depth being over 2m. • The extent shows the worst credible area that is susceptible to dam breach flooding. The map should be used to prioritise areas for evacuation/early warning. • The site is located next to the Dove Stone Reservoir with Chew Brook flowing from the reservoir through the north of the site towards the west. This will be the greatest source of reservoir risk to the site. • The extent of reservoir inundation comes from three United Utilities owned reservoirs - Dove Stone Reservoir, Greenfield Reservoir and Chew Reservoir. • Much of the reservoir network is owned and managed by United Utilities who monitor and maintain reservoirs as required. United Utilities own 43 reservoirs within Greater Manchester. • The chance of reservoir failure is very rare and there is an extremely good safety record in the UK with no loss of life due to reservoir flooding since 1925. • United Utilities' ongoing management of reservoirs ensures they do not cause flooding as their presence within the network of surrounding watercourses actually reduces the impact of excess rainfall. • All United Utilities operated reservoirs are managed in accordance with the Reservoirs Act and relevant Health and Safety legislation to ensure they do not fail such requirements. United Utilities also notes that the Environment Agency is responsible for ensuring compliance with the highlighted legislation. • United Utilities also wishes to highlight the drive for continued constructive communication with the relevant local authorities to ensure a coordinated approach to the delivery of site allocations. United Utilities are committed to continuing to work with the relevant Local Authorities and the Greater Manchester Combined Authority as site allocations progress further. • With regards Dove Stone Reservoir, the EA has stated that: ○ *'Dove Stone Reservoir is a Category A Dam, which is the highest category based on current downstream receptors. As UU has confirmed the proposed development will not impact their operation/maintenance liabilities, and based on the current dam categorisation, the view of our Reservoir Specialist is that the opinion of an All Reservoir Panel Engineer is not required'.*
Historical Flooding	• The site lies outside of the Environment Agency's Historic Flood Map (HFM) and historical data from Oldham Council.
Groundwater Flood Risk	• Due to the site's proximity to Chew Brook, the groundwater levels are likely to be similar to the corresponding levels in the river. Groundwater follows topography and is unlikely to be an issue in this instance. Groundwater must be assessed as part of an FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • No part of the site is within a CDA.

2019 GMSF Allocation:	GM Allocation 18: Robert Fletchers
Defended	• Based on the EA's Spatial Flood Defences dataset, Chew Brook is bound by areas of high ground which act as informal defences which are assessed at condition grade 3 meaning 'Fair' (Table 1.1 Condition Assessment Manual[1]). • In the north and centre of the site, Chew Brook is bound by two embankments which have been assessed at condition grade 3. • There is also an embankment in the north-western corner of the site lining Chew Brook that has been assessed at condition grade 3. It is at this point where the majority of the risk comes out of bank. • None of these defence were included in a defended scenario in the 2018 Tame modelling.
Flood Warning	• The site lies outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes	• The site is within areas of tree planting, floodplain tree planting and riparian tree planting taken from the WwNP dataset. The last of these is focused along the southern bank of Chew Brook. These all have the benefits of significantly delaying peak runoff from catchments whilst riparian planting can also enhance floodplain roughness whilst creating obstructions to significant flow paths.
Flood Risk Summary	• A detailed Level 2 site assessment has been carried out for this site. Refer to this report for more detail: 'BKQ-JBAU-XX-XX-RP-Z-0054-A6-P03-Site_Summary_GM_Allocation_18' • The 5% AEP event outline should be included in a revision of the functional floodplain, making the areas within this outline undevelopable. This revision should inform an update to this Level 2 SFRA. • This would rule out development to land parcels A, B and C of the site's concept plan, shown in the Level 2 site assessment report. The concept plan should be revisited based on the Tame 2018 modelling outputs. • The unnamed watercourse on site should be modelled, and risk quantified, including latest EA allowances for climate change. • Due to the high level of surface water risk, a detailed drainage strategy would therefore be required to ensure current onsite risk can be managed effectively with no increase in surface water flood risk elsewhere as a result of new development. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. Infiltration SuDS may be feasible on parts of the site, subject to ground investigation and contamination testing at the FRA stage. • Residual risk from the culverts and onsite waterbodies should be quantified and options for culvert removal should be explore.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf

2019 GMSF Allocation:	GM Allocation 25 – Crimble Mill
Area (ha)	16.81
Catchment	River Roch
Proposed use	Residential

Figures illustrating allocation and main risk sources

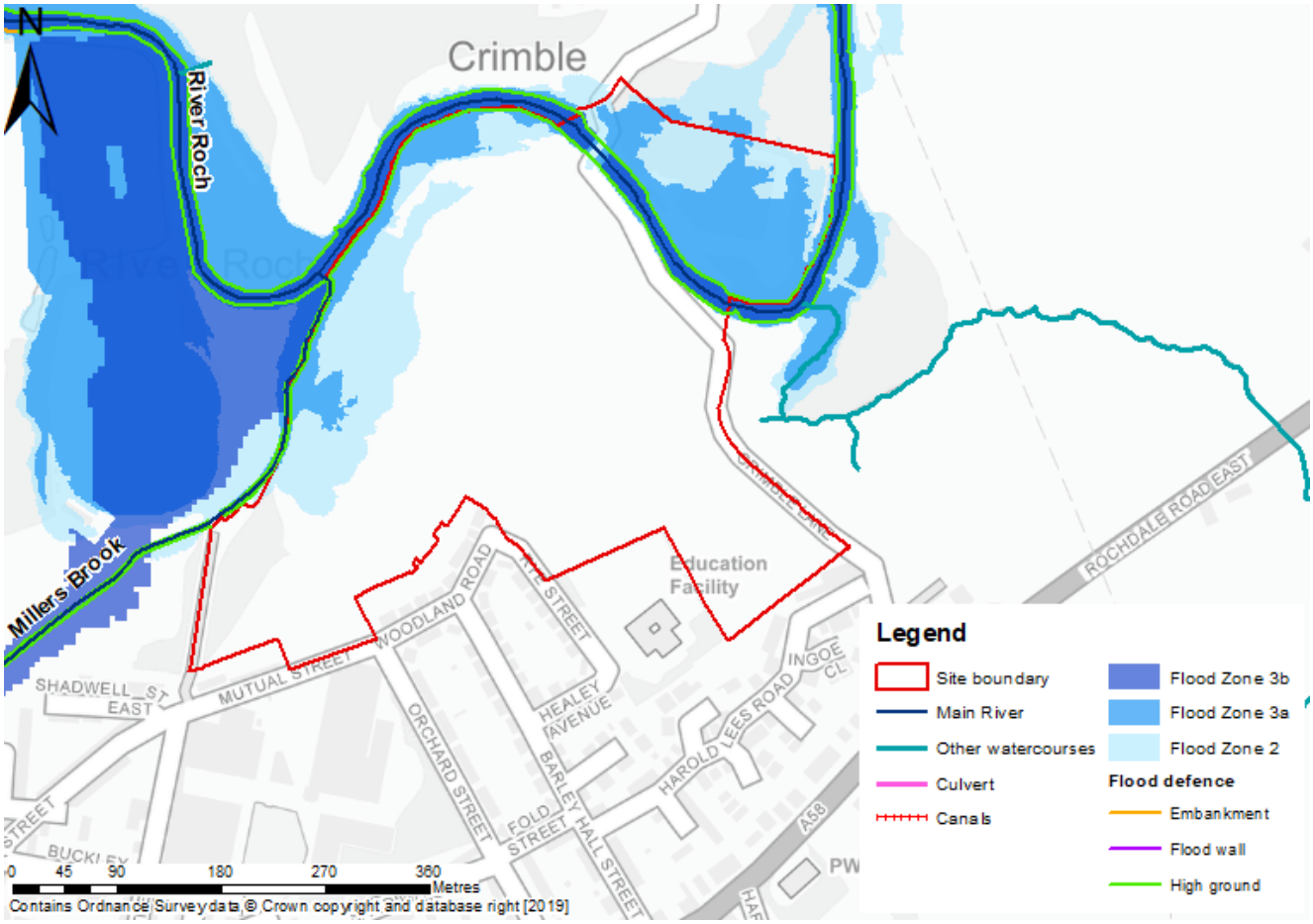

Figure 1: Site boundary with flood zone mapping (Flood Map for Planning) and flood defences

2019 GMSF Allocation:	GM Allocation 25 – Crimble Mill

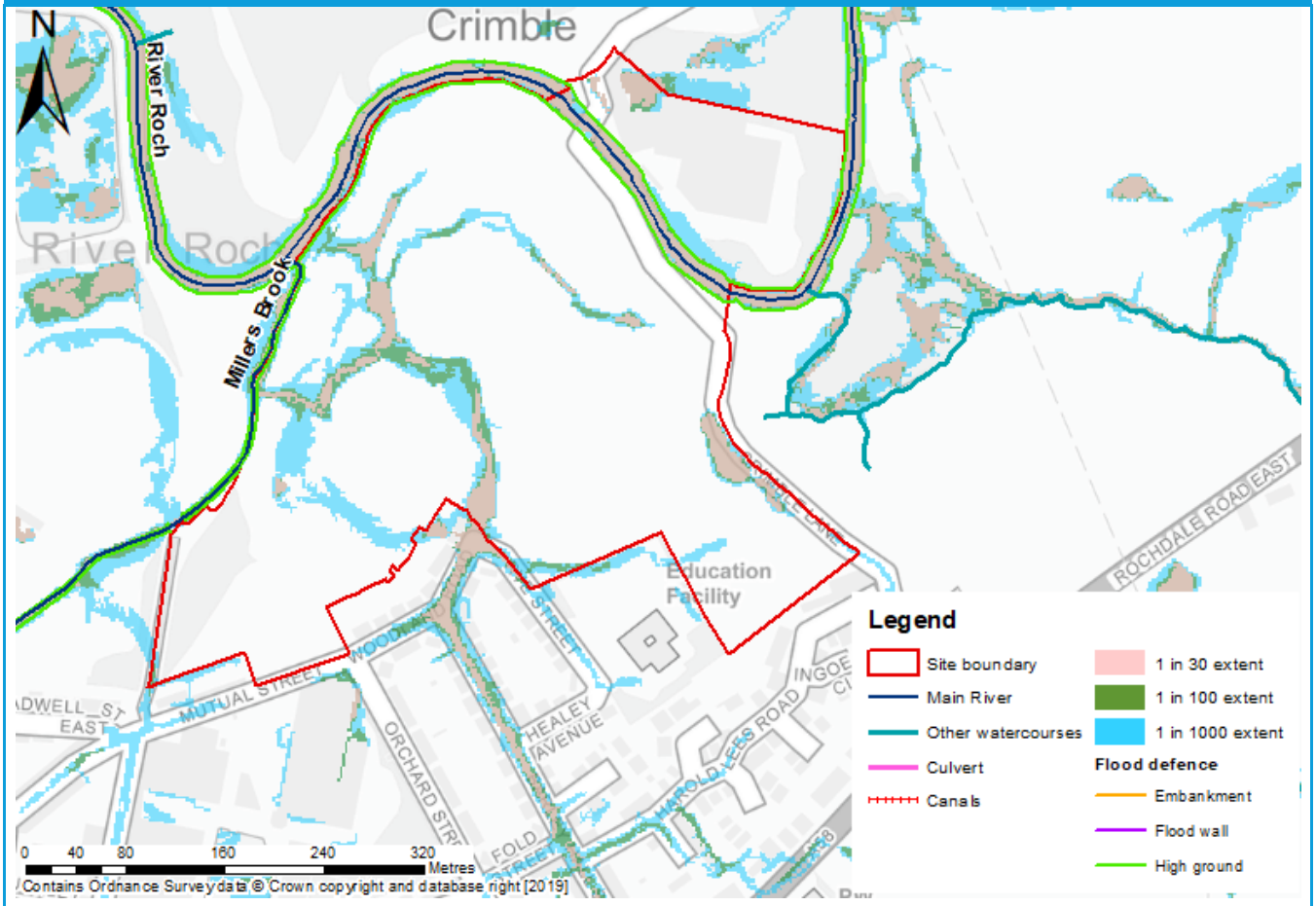

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map

Fluvial Risk (%)	**Flood Zone 1**	**Flood Zone 2**	**Flood Zone 3a**	**Flood Zone 3b**
	69.17	10.11	17.99	2.73
Surface Water Risk (%)	**Low**	**Medium**		**High**
	15.42	7.73		5.31
Climate Change Considerations	• The 1% AEP +70% climate change uplift event outline is similar in extent to Flood Zone 2. • The current surface water 0.1% AEP event outline provides an indication of the likely increase in extent of the more frequent events; the event outline covers approximately 15% of the total site area and creating a flow path between the River Roch and the residential streets to the south of the site.			
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents.			
Reservoir Flood Risk	• Approximately 41% of the site is located within the maximum extent of flooding risk from reservoirs according to the EA's reservoir flood map (RFM) with the average depth being above 2m. • The extent shows the worst credible area that is susceptible to dam breach flooding. The map should be used to prioritise areas for evacuation/early warning. • The extent of reservoir inundation comes from 12 United Utilities Owned reservoirs - Naden Higher, Naden Middle, Spring Mill, Hollingworth Lake, Piethorne, Greenbooth, Ashworth Moor, Kitcliffe, Ogden (Milnrow), Cowm, Watergrove and Rooden.			

2019 GMSF Allocation:	GM Allocation 25 – Crimble Mill
	• Much of the reservoir network is owned and managed by United Utilities who monitor and maintain reservoirs as required. United Utilities own 43 reservoirs within Greater Manchester. • The chance of reservoir failure is very rare and there is an extremely good safety record in the UK with no loss of life due to reservoir flooding since 1925. • United Utilities confirm that their ongoing management of reservoirs ensures they do not cause flooding as their presence within the network of surrounding watercourses actually reduces the impact of excess rainfall. • All United Utilities operated reservoirs are managed in accordance with the Reservoirs Act and relevant Health and Safety legislation to ensure they do not fail such requirements. United Utilities also notes that the Environment Agency is responsible for ensuring compliance with legislation. • United Utilities also wishes to highlight the drive for continued constructive communication with the relevant local authorities to ensure a coordinated approach to the delivery of site allocations. United Utilities are committed to continuing to work with the relevant local authorities and the GMCA as GM site allocations progress further.
Historical Flooding	• The site is located outside of the Environment Agency's Historic Flood Map (HFM) and historical data from Rochdale Borough Council.
Groundwater Flood Risk	• Due to the site's proximity to the River Roch, groundwater levels are likely to be similar to the corresponding levels in the river. Groundwater will follow topography and may be an issue for the north of this site. Groundwater must be assessed as part of an FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • The south western part of the site is within the Heywood CDA. However, no surface water risk is very low in this area.
Defended	• Based on the EA's Spatial Flood Defences dataset, Millers Brook and River Roch are bound by areas of high ground which act as informal defences which are assessed at condition grade 3 meaning 'Fair' (Table 1.1 Condition Assessment Manual[1]).
Flood Warning	• The site is located outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes	• Land alongside the northern boundary with the River Roch is within areas for tree planting, riparian tree planting and floodplain reconnection. These WwNP techniques can significantly delay the timing of peak runoff in catchments with the riparian planting also enhancing floodplain roughness to create obstacles to significant flow paths. • The site is also within areas of urban loss improvement and woodland planting in the Irwell NFM scheme. The tree planting areas are within the same areas as the riparian planting in the WwNP dataset. Urban loss improvement areas are where improved soil structure causing increased permeability and a greater soil moisture storage capacity. These areas also assume an increase in greenspace as well overall improved land permeability.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf

2019 GMSF Allocation:	GM Allocation 25 – Crimble Mill
Flood Risk Summary	• A detailed Level 2 site assessment has been carried out for this site. Refer to this report for more detail: 'BKQ-JBAU-XX-XX-RP-Z-0195-A6-P03-Site_Summary_GM_Allocation_25'. • Fluvial flood risk to the site is focused at the northern boundary of the site, in particular north of the Roch in the north east of the site where the existing Crimble Mill is located. Initial plans are for the conversion and refurbishment of the existing mill and for new dwelling to be developed in the larger greenfield area south of the Roch. • It is advised a 2D model is created for the Roch to better quantify risk and further inform the Exception Test for the site. • Redevelopment plans for Crimble Mill should avoid any increase in the current development footprint and where possible integrate the current risk into the site design. Design should also entail property flood resilience measures and appropriate emergency planning and escape routes in times of flood. • The Roch flows under Crimble Lane via a road bridge. It is assumed that this bridge will remain in the new site layout as it connects the A58 Rochdale Road East from Heywood to the B6222 Bury Road and the settlements of Bamford, Broadhalgh and beyond. Blockage scenario modelling of the road bridge shows increased flood risk in this area. • Due to the high level of surface water risk, a detailed drainage strategy would therefore be required to ensure current onsite risk can be managed effectively with no increase in surface water flood risk elsewhere as a result of new development. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. Infiltration SuDS may be feasible on parts of the site, subject to ground investigation and contamination testing at the FRA stage.

2019 GMSF Allocation:	GM Allocation 28 – Roch Valley
Area (ha)	14.05
Catchment	River Roch
Proposed use	Residential

Figures illustrating allocation and main risk sources

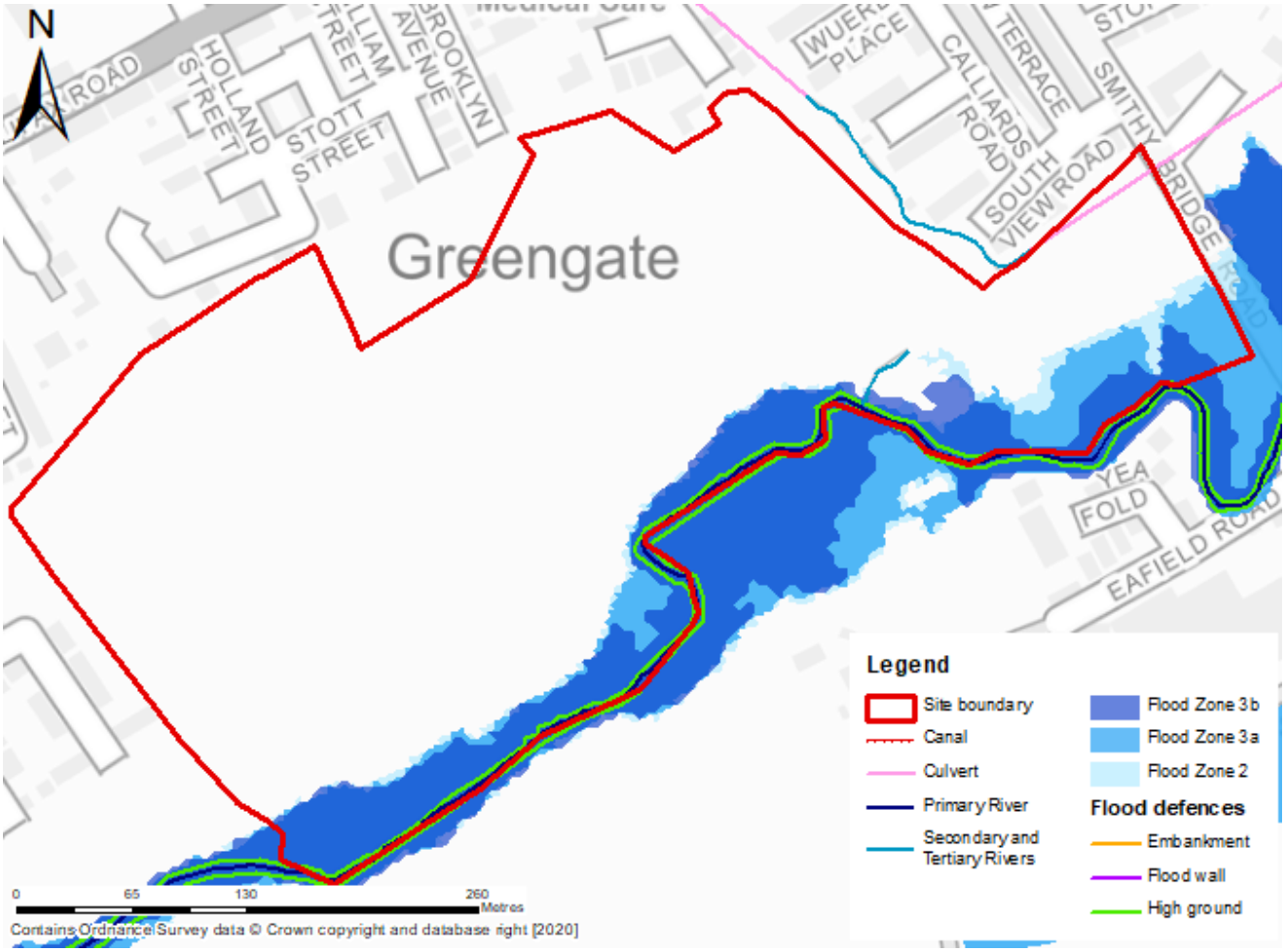

Figure 1: Site boundary with flood zone mapping (Flood Map for Planning) and flood defences

2019 GMSF Allocation:	GM Allocation 28 – Roch Valley

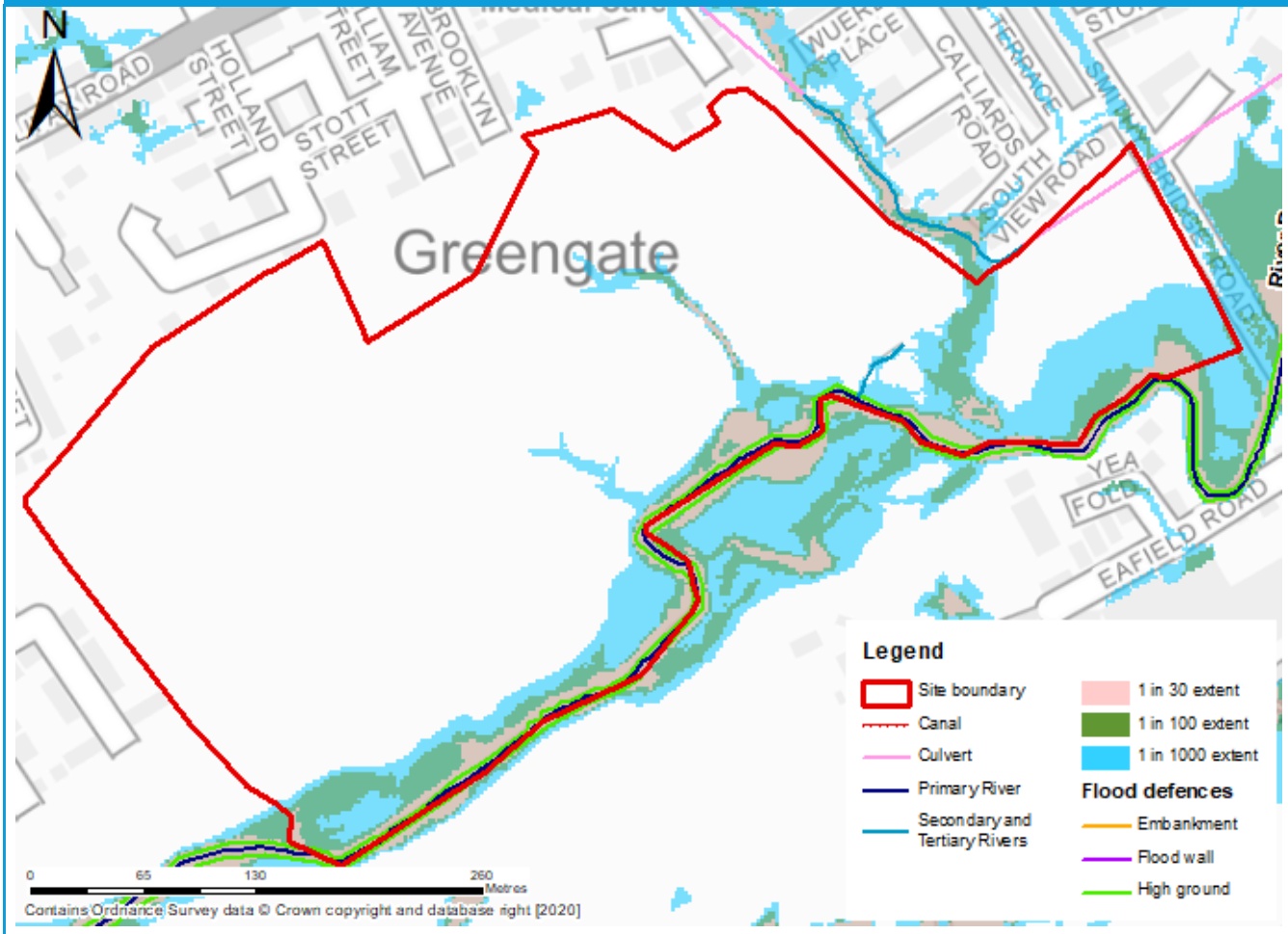

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**Flood Zone 2**	**Flood Zone 3a**	**Flood Zone 3b**
	84.11	1.38	3.38	11.13
Surface Water Risk (%)	**Low**	**Medium**		**High**
	17.69	9.07		4.47
Climate Change Considerations	• The 1% AEP +70% climate change outline covers approximately 17% of the site with the maximum depths reaching 1.6m with average depths being at approximately 1m. • The current surface water 0.1% AEP event outline provides an indication of the likely increase in extent of the more frequent events. The 0.1% AEP event increase to cover approximately 18%, increasing the extent of the areas covered by the 1% AEP fluvial outline.			
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents. • There are 27 recorded locations where UU modelling shows surcharging of manholes during the 1% AEP event, with floodwaters then returned following storm subsidence.			
Reservoir Flood Risk	• Approximately 78% of the site is located within the maximum extent of flooding risk from reservoirs according to the EA's Reservoir Flood Map (RFM) with the average depth ranging across the site from over 2m closer to the River Roch and decreasing to lower depths further north. • The extent shows the worst credible area that is susceptible to dam breach flooding. The map should be used to prioritise areas for evacuation/early			

2019 GMSF Allocation:	GM Allocation 28 – Roch Valley
	warning. • The extent of reservoir inundation comes from 4 United Utilites owned reservoirs (Hollingworth Lake, Chelburn Upper, Blackstone Edge and Watergrove). • Much of the reservoir network is owned and managed by United Utilities who monitor and maintain reservoirs as required. United Utilities own 43 reservoirs within Greater Manchester. • United Utilities' ongoing management of reservoirs ensures they do not cause flooding as their presence within the network of surrounding watercourses actually reduces the impact of excess rainfall. • All United Utilities operated reservoirs are managed in accordance with the Reservoirs Act and relevant Health and Safety legislation to ensure they do not fail such requirements. United Utilities also notes that the Environment Agency is responsible for ensuring compliance with the highlighted legislation. • United Utilities also wishes to highlight the drive for continued constructive communication with the relevant local authorities to ensure a coordinated approach to the delivery of site allocations. United Utilities are committed to continuing to work with the relevant Local Authorities and the Greater Manchester Combined Authority as site allocations progress further.
Historical Flooding	• The site lies outside of the Environment Agency's Historic Flood Map (HFM) and historical data from Rochdale Borough Council.
Groundwater Flood Risk	• Due to the site's proximity to the River Roch, groundwater levels are expected to be similar to the corresponding levels in the river. Groundwater will follow topography and should not be an issue for the planned development. Groundwater should however be assessed as part of the FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • The northern two thirds of the site is within the Littleborough CDA.
Defended	• Based on the EA's Spatial Flood Defences dataset, the southern boundary of the site runs along the River Roch which has areas of high ground on either bank. The high ground has been assessed at condition grade 3 meaning 'Fair' (Table 1.1 Condition Assessment Manual[1]).
Flood Warning	• The site lies outside of any current EA FWAs.
Flood Storage Area / Potential for Working with Natural Processes	• The site lies within areas of tree planting, floodplain planting and riparian tree planting taken from the WwNP dataset. These can both cause significant delays to peak runoff from catchments with the latter additionally enhancing floodplain roughness to create obstacles for significant flow paths. • The site is also within areas of urban loss improvement, rural loss improvement and woodland planting in the Irwell NFM scheme. The woodland planting areas are within the same areas as the riparian planting in the WwNP dataset. Urban loss improvement areas are where improved soil structure causing increased permeability and a greater soil moisture storage capacity. These areas also assume an increase in greenspace as well overall improved land permeability.
Flood Risk Summary	• A detailed Level 2 site assessment has been carried out for this site. Refer to this report for more detail: 'BKQ-JBAU-XX-XX-RP-Z-0196-A6-P03-Site_Summary_GM_Allocation_28'. • The EA and Rochdale Council are proposing to create a formal Flood Storage Area (FSA) to cover the southern length of the site along the course of the River Roch. At the time of writing, plans for the FSA are at an early point in the design process, however, it is thought that the design top water level for

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf

2019 GMSF Allocation:	GM Allocation 28 – Roch Valley
	the FSA is higher than Flood Zone 3 levels therefore the extent of the FSA is likely to be larger than the current extent of Flood Zone 3. As part of the planned new development, an access road is to be constructed through the southern third of the site. Current plans show the road passing through the proposed FSA which would result in a slight loss in storage area. The developer is to assess where the potential loss in storage could be compensated for onsite. • It is understood that the main development proposals are limited to the northern parts of the site in Flood Zone 1. There are also plans for surface water detention basins at three locations alongside the proposed access road, designed to mitigate increased runoff from the new development and to provide water quality treatment and amenity value to the local community. These basins will be fed by gravity via a series of road drains and swales from the new development. There will be no development in Flood Zone 3. • Risk from the unmodelled unnamed watercourse at the north east corner of the site should be quantified through fluvial modelling, accounting for climate change as part of an FRA at the planning application stage. Any new information can be used to retrospectively update this Level 2 assessment. Judging from the surface water risk shown in Figure 4, the site may not be at significant additional risk from this watercourse. However, a surface water flow route forms at the culvert inlet and down to the Roch. • The culverted section of this watercourse should be assessed for condition and capacity and also for residual risk through blockage scenario modelling. Options for culvert removal and opening up of the channel should be investigated. This would remove the residual risk and also any uncertainties over maintenance requirements.

2019 GMSF Allocation:	GM Allocation 14 – Beal Valley
Area (ha)	51.20
Catchment	River Beal
Proposed use	Residential

Figures illustrating allocation and main risk sources

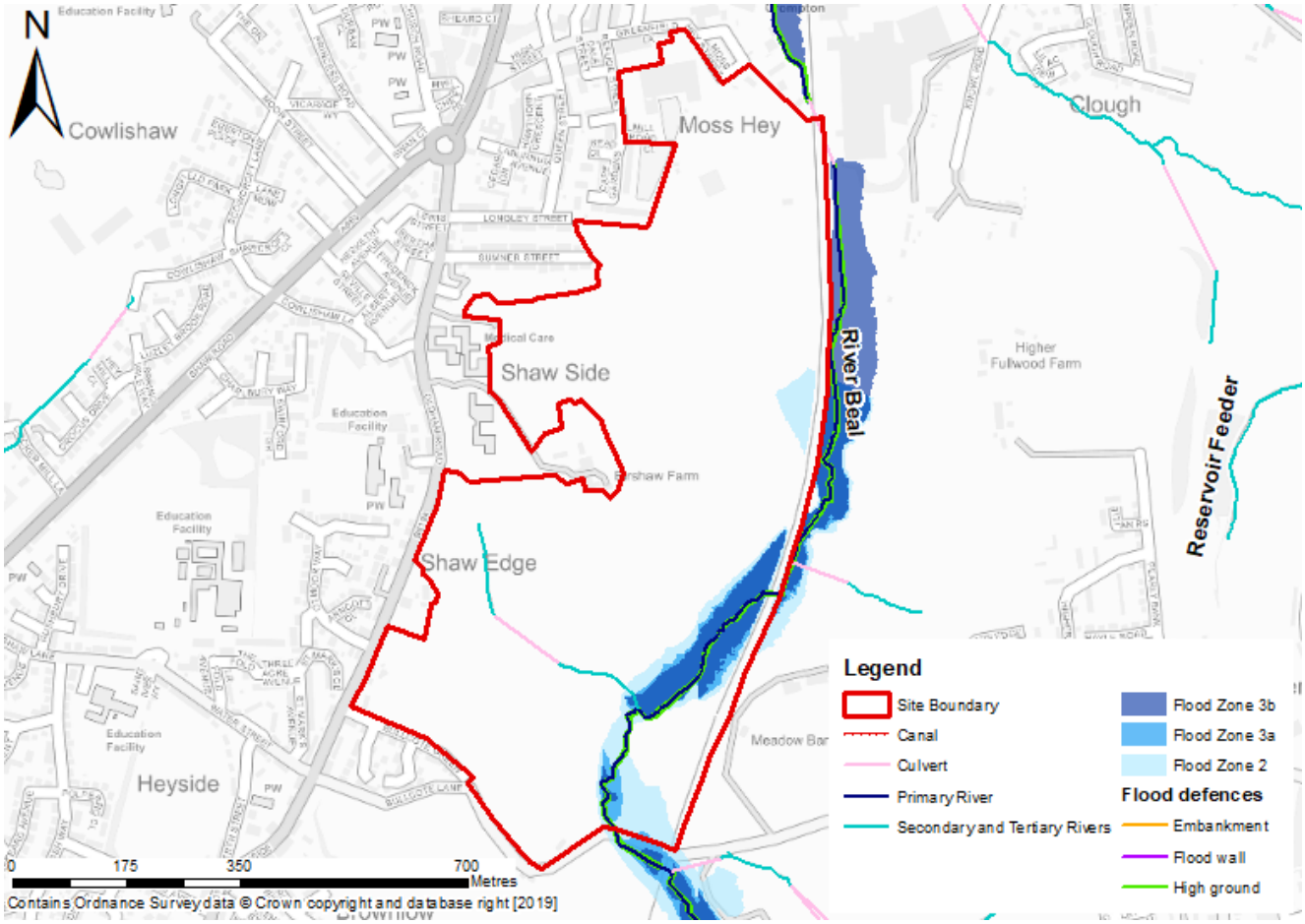

Figure 1: Site boundary with flood zone mapping (Flood Map for Planning) and flood defences (Note: The Flood Map for Planning is subject to change based on the updated River Beal model)

2019 GMSF Allocation:	GM Allocation 14 – Beal Valley

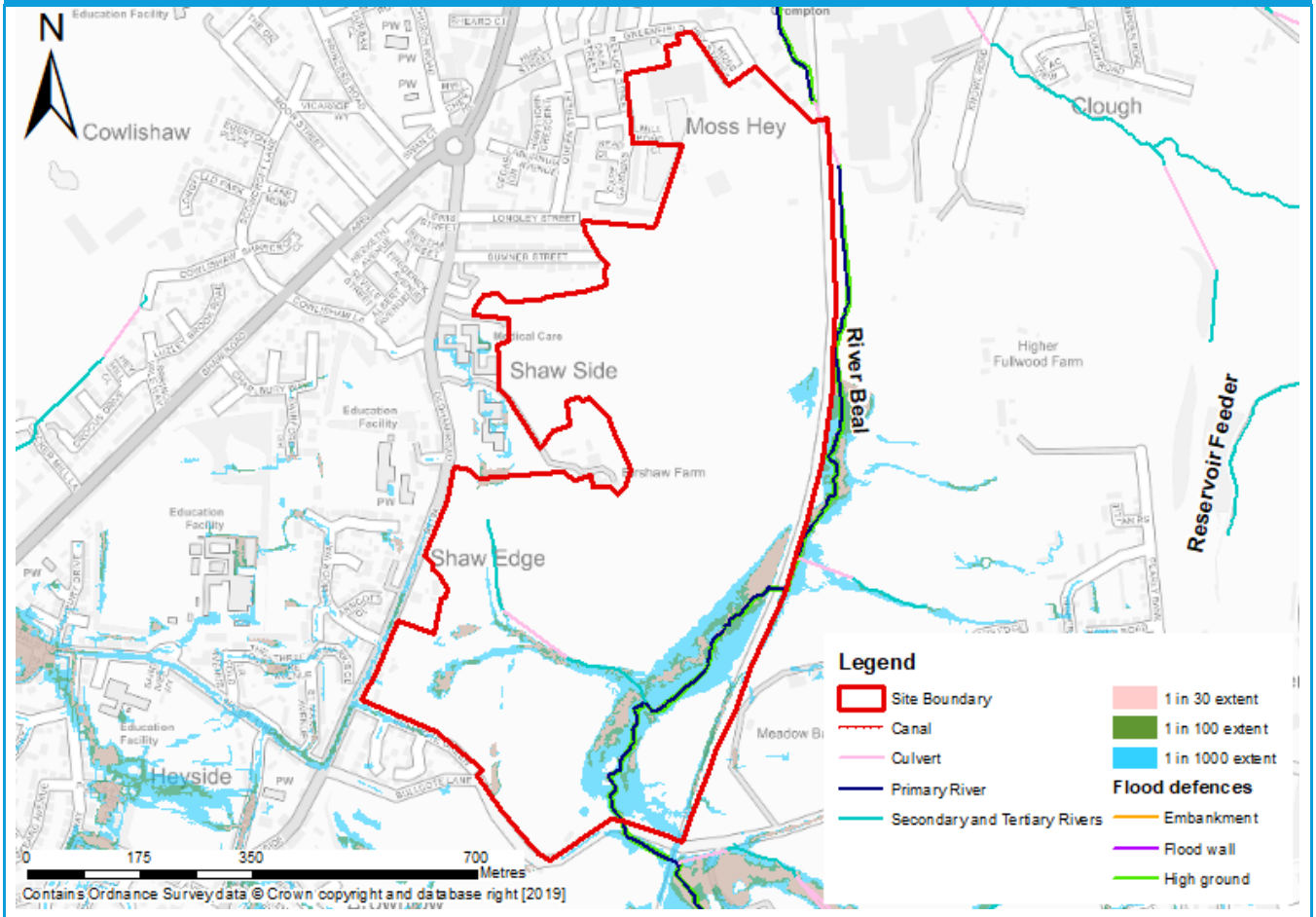

Figure 2: Surface water risk to the site (Risk of Flooding from Surface Water map)

Fluvial Risk (%)	**Flood Zone 1**	**Flood Zone 2**	**Flood Zone 3a**	**Flood Zone 3b**
	81.39	14.33	0.98	3.30
Surface Water Risk (%)	**Low**	**Medium**		**High**
	16.08	6.61		3.65
Climate Change Considerations	• As the current River Beal model is 1D only and has not been updated, there are no climate change uplift outlines to gauge future fluvial risk from. Flood Zone 2 from the Flood Map for Planning should be used as a proxy; this covers approximately 14% of the site and follows the River Beal. • The current surface water 0.1% AEP event outline provides an indication of the likely increase of extent of more frequent events. The outline covers approximately 16% of the site which primarily keeps in the riparian buffer of the River Beal with an additional flow path extending into the south-west of the site.			
Sewer Flood Risk	• The site lies outside United Utilities recorded surface water flooding incidents.			
Reservoir Flood Risk	• The site is not within any EA reservoir flood outlines.			
Historical Flooding	• The site lies outside of the Environment Agency's Historic Flood Map (HFM) and historical records for Oldham Council.			

2019 GMSF Allocation:	GM Allocation 14 – Beal Valley
Groundwater Flood Risk	• Due to the site's proximity to the River Beal, groundwater levels are likely to be similar to the corresponding levels in the river. Groundwater will follow topography and may be an issue in this instance. Groundwater should be assessed as part of the FRA.
Critical Drainage Areas	• CDAs, as presented in the GMCA Level 1 SFRA (2019), are subject to change. • The extreme northern area of the site at Moss Hay is within the Rochdale Opportunity Area for Critical Drainage Management, which are areas additional to the CDAs that should be considered for CDA designation in the future.
Defended	• Based on the Environment Agency's Spatial Flood Defences dataset, the river is bound by informal defences of high ground which have been assessed at condition grades 2 and 3 meaning 'Good' and 'Fair' (Table 1.1 Condition Assessment Manual[1]).
Flood Warning	• There is an EA FWA located just outside the northern boundary of the site which only protrudes slightly into the boundary itself. The FWA is for the River Beal at Shaw from Jubilee to Dunwood.
Flood Storage Area / Potential for Working with Natural Processes	• Land at the east of the site and along both banks of the River Beal are within WwNP areas for tree planting, riparian tree planting and floodplain reconnection, which can significantly delay the timing of peak runoff in catchments with the riparian planting also enhancing floodplain roughness to create obstacles to significant flow paths. • The site is also within areas of urban loss improvement and woodland planting in the Irwell NFM scheme. The tree planting areas are within the same areas as the riparian planting in the WwNP dataset. Urban loss improvement areas are where improved soil structure causing increased permeability and a greater soil moisture storage capacity. These areas also assume an increase in greenspace as well overall improved land permeability.
Flood Risk Summary	• Ongoing modelling updates of the Beal, when made available, should be used to reassess the site. At the time of writing, the River Beal model is expected to be finalised late 2020. However, based on the current modelling, it is likely the site could pass the Exception Test given that 81% of the site is within Flood Zone 1. • This is a large site with potential to create significant volumes of runoff if infiltration is not possible. Downstream areas at risk and additional volumes of water, even if the runoff rate is controlled, could increase scale or duration of flooding downstream. This development could reduce risk by safeguarding areas for flood storage and enhancement of storage areas to reduce flows downstream. • A drainage strategy would be required to ensure current onsite risk can be managed effectively with no increase in surface water flood risk elsewhere as a result of new development. This will require surface water modelling based on the proposed layout and investigation into appropriate SuDS techniques. Infiltration SuDS may be feasible on parts of the site, subject to ground investigation and contamination testing at the FRA stage.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf