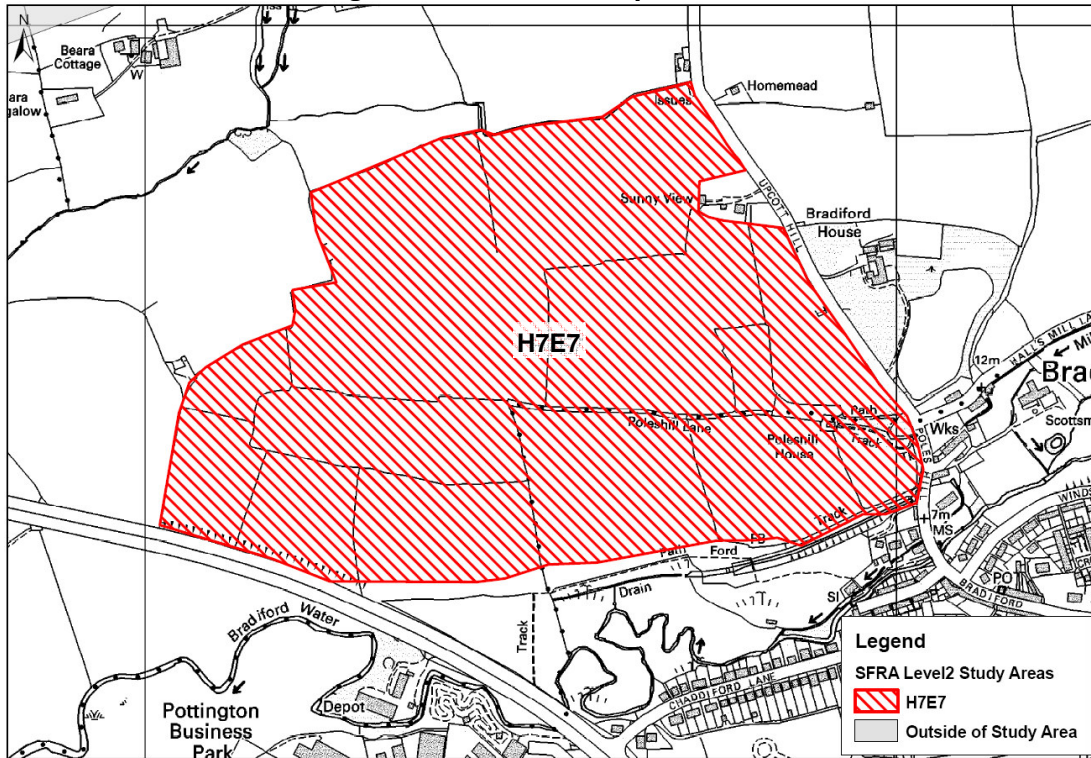


**4.7 Site H7E7**

4.7.1 Site overview

**Figure 4.7.1 – Location plan of site**



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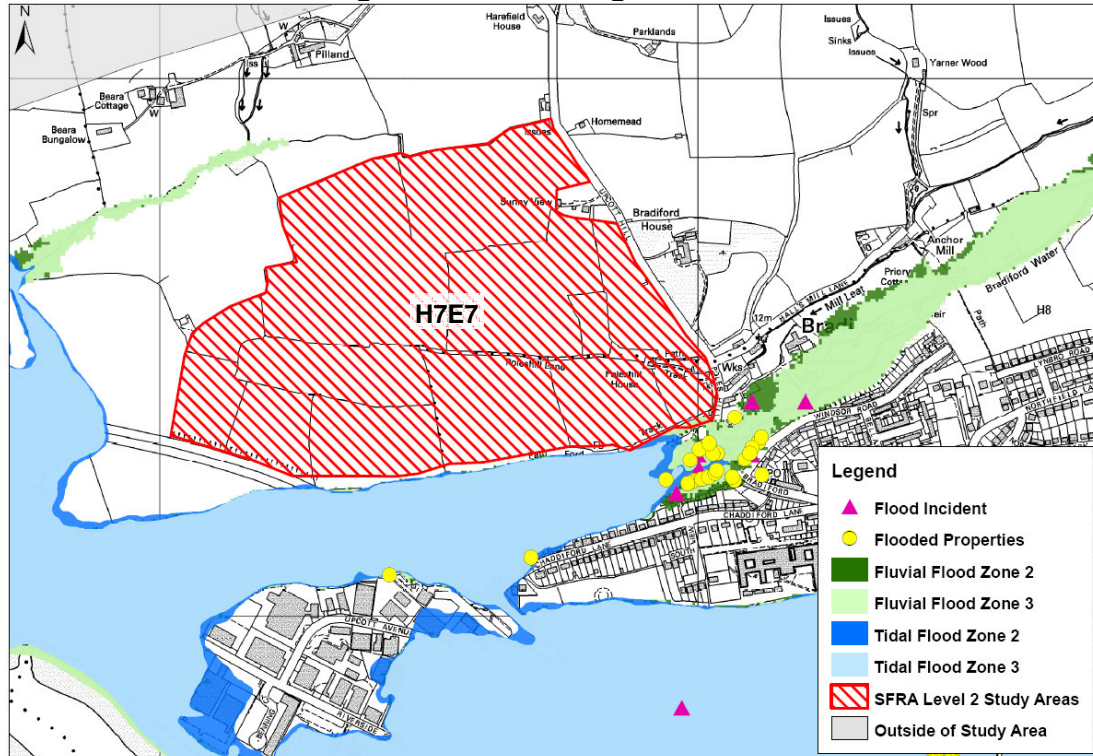
**Table 4.7.1 - Site details**

Site ID	Location	Area (ha)			Proposed use	Capacity		
		Site	Development			40dph	50dph	60dph
			Residen-tial	Employ-ment				
H7E7	Land at Bradford, Pottington	44	20.5	8.5	Mixed	820	1025	1230

Site H7E7 is situated alongside the A361 and Bradford Water at Pottington to the northwest of Barnstaple. It is one of the larger sites being considered for the Barnstaple Urban Extension with a total area of 44 hectares, 29 being available for a mixture of employment and residential development. Table 4.7.1 specifies the development details for the site as provided by North Devon Council.

4.7.2 Overview of existing flood risk and inundation

**Figure 4.7.2 – Existing Flood Risk**

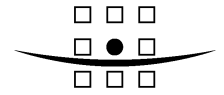


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**Table 4.7.2 – Indicators of existing flood risk**

<b>Entirely within FZ3</b>	N	
<b>Partly within FZ3</b>	Y	~30m lateral extent of fluvial FZ3 in SE corner of site, although there is a flood defence at this location. FZ3 relating to Bradford Water runs along entire southern boundary of the site.
<b>Partly within FZ2</b>	Y	~30m lateral extent of fluvial FZ2 in SE corner of site, although there is a flood defence at this location. FZ2 relating to Bradford Water runs along entire southern boundary of the site.
<b>Entirely within FZ1</b>	N	
<b>Historical flood event</b>	N	None on site, many adjacent to site, mostly fluvial source of flooding, some surface water in 1970, 1974, 1975, 1981. Several properties severely flooded.
<b>Topography</b>		<ul style="list-style-type: none"> <li>• Site slopes steeply from middle to south of site, flatter to the north.</li> <li>• Elevations range from 5mOD (0m above FZ2 / FZ3 extent) in the SE to 52mOD in the centre of the site.</li> <li>• Average elevations of 30-35mOD across northern half of site.</li> </ul>

The topography indicates that the site primarily drains to Bradford Water to the south of the site. The watercourse lies approximately 50m from the site at its nearest point, and a storm overflow channel to Bradford Water flows along the site boundary. Almost all of



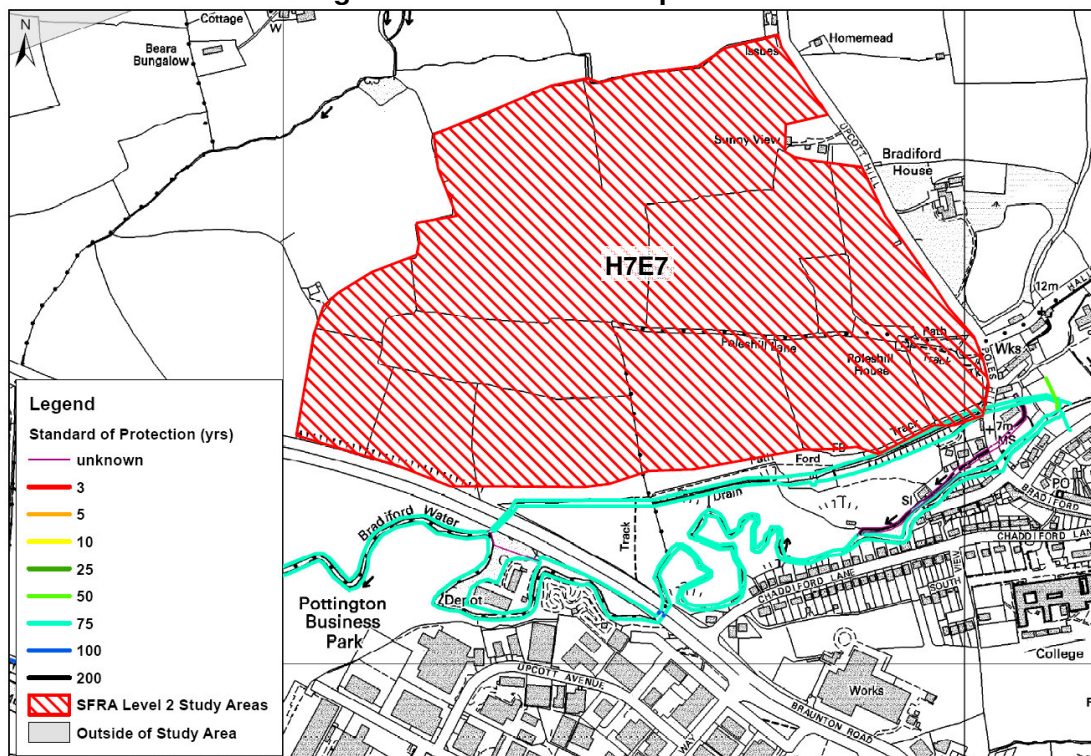
the site lies within Environment Agency Flood Zone 1, fluvial Flood Zones 2 and 3 relating to the Bradford Water and the overflow channel extend along the southern edge of the site and into the south-east corner of the site (in the in the order of 30m laterally). The EA tidal Flood Zones 2 and 3 do not currently extend into the site, however because of their proximity, the impact of development on flood risk must be considered. It should also be noted that tide locking is known to occur along this stretch of Bradford Water, from Windsor Road upstream of the site to the Taw, downstream of the site. There are many recorded incidents of fluvial, tidal and surface water flooding as recently as 2003 to the SE of the site. However, since the construction of the storm bypass channel no incidents have occurred.

There is also a small stream (Ashford stream) flowing along the northern boundary of the site, which discharges into the River Taw. At its nearest point, the LiDAR shows that the site is elevated approximately 2m above the Environment Agency Flood Zones 2 and 3 associated with the stream, the rest of the site being considerably higher. It is therefore suggested that the risk of flooding to the site from the stream is relatively small although the impact of development on the watercourse and its associated risk of flooding should be considered.

#### 4.7.3 Existing defences, Verification of Defences and Areas Benefiting from Defences (ABDs)

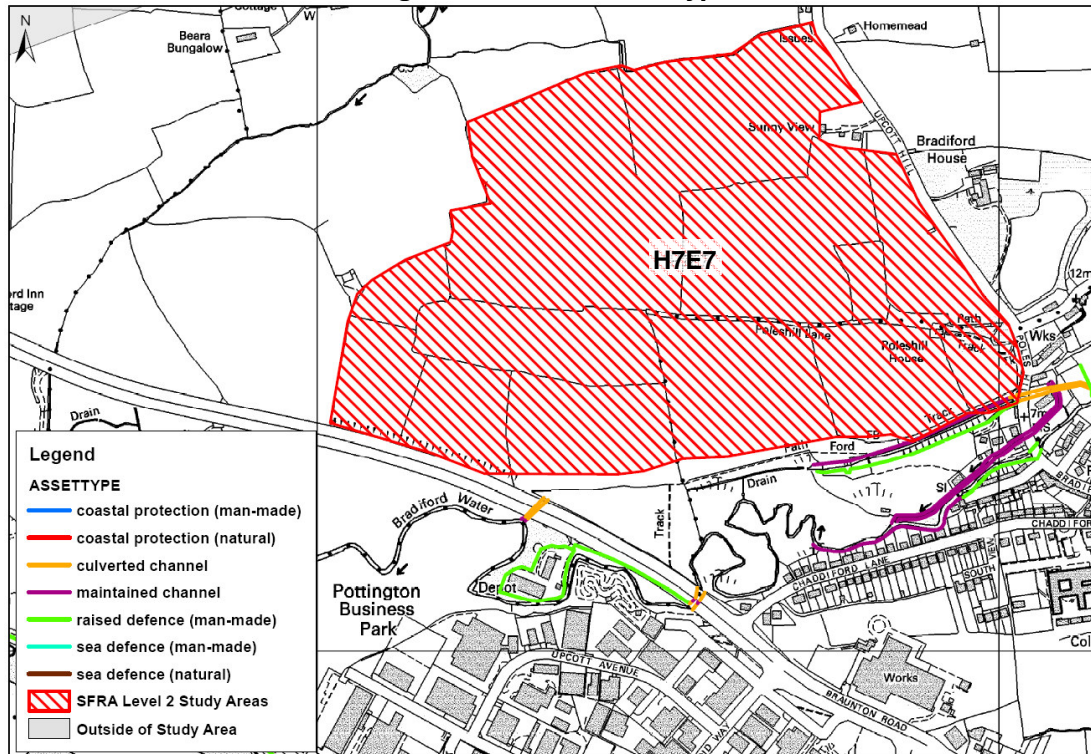
NFCDD shows that there are no defences within the site but there are both raised defences and culverts along Bradford Water to the south and east of the site. The defences are maintained by a combination of the EA and the landowners all with a 1 in 75 year standard of protection. The lowest points on the sections of raised defence are between 4.40 and 4.70mOD.

**Figure 4.7.3 – Standard of protection**



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**Figure 4.7.4 – Defence type**



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#### 4.7.4 Assessment of flood probability and hazard

Although there are no watercourses on the site, there are three watercourses adjacent to it. Of these, Bradiford Water (including the overflow channel along the southern boundary of the site) has been modelled. An existing 1D ISIS model was modified over a reach of 3.5km from Scottsmoor to the confluence with the River Taw. 13 structures have been included. For details see the Barnstaple 2D Modelling and Mapping study. In general structures included in the model comprise features which affect flow, such as culverts, bridges, flood banks and embankments and any flood relief or bypass channels. A lack of data has meant that this model was unable to be calibrated or sensitivity analysis carried out.

Note that the Mill Leat has not been included in the model and the flood risk consequences of this watercourse are therefore unknown. It is recommended that further investigation of the watercourse is undertaken prior to development at either site H7E7 or H8.

##### Flood probability

Model results indicate that no tidal or fluvial flooding occurs on the site under current defended conditions therefore no figures of flood extent, depth or hazard are displayed.

Adjacent to the site, the onset of fluvial flooding occurs along Bradiford Water at QMED showing small increases in extent with increasing return period. The lateral flood extent for the 1 in 100 year undefended scenario is between 2 and 50m greater than the 1 in 100 year defended situation from the River Taw to Poles Hill but upstream of Poles Hill

there is no change in extent.

For land adjacent to the site, the onset of tidal flooding occurs at the lowest modelled event (1 in 10 year). Tidal flood extents were not observed to increase with increasing return period under current defended conditions.

#### Flood depth

Although model results indicate that no fluvial or tidal flooding occurs on site, flooding does occur adjacent to the site as described above. Therefore the impact of development through increasing run-off should be considered, particularly as maximum depths to the south of the site next to Chaddiford Lane and Meadow Road are in excess of 1m for both 1 in 100 year fluvial and 1 in 200 year tidal flood events.

#### Flood hazard

Fluvial and tidal flood hazard is negligible for the site. Downstream of the site, fluvial flood hazard is significant and tidal hazard low to significant, fluvial hazard becoming extreme at the confluence of Bradiford Water with the River Taw.

#### 4.7.5 Impact of climate change

The increase of fluvial flood flows due to the effects of climate change has no impact on flood risk to the site. However along Bradiford Water to the south of the site, fluvial extents are projected to increase up to a maximum of 40m laterally, flood depths and hazard also increases accordingly (this is discussed further in section 5).

Similarly, the projected increase in sea level as a result of climate change is expected to have little or no impact on flood risk to the site, although tidal flood depths along Bradiford Water were modelled to increase by 2070 with significant increases in extent, depth and hazard by 2115.

#### 4.7.6 Access and Egress

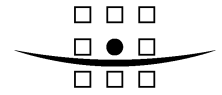
Access and egress remains safe for all modelled fluvial and tidal events if designated routes avoid the south-east of the site where past incidents of flooding have been recorded.

#### 4.7.7 Overview of impact of development on flood risk elsewhere

**Table 4.7.3 - Summary table of impacts of development**

Return Period	% impermeable of net developable residential area	Flow (m <sup>3</sup> /s)		
		Pre-development	Post-development	% increase
1 in 100 year	50	0.26	0.45	76
	70	0.26	0.53	106
	90	0.26	0.61	139

Table 4.7.3 indicates that development will have a considerable impact on the current flow regime of the site. However because flow rates are low (less than 0.5m<sup>3</sup>/s which is



approximately 1.5% of the 1 in 100 year peak flow for Bradford Water) the impact on the surrounding area is likely to be relatively small, nonetheless should development be pursued it is recommended that as far as possible surface water should be stored and managed onsite. This is because the site drains to Bradford Water which incorporates a defended section and culverts south of the site which may have limited capacity to manage additional flow inputs. Several incidents of flooding are known to have occurred to the south and east of the site which is another reason for ensuring excess water is managed onsite should the site be developed.

#### 4.7.8 Surface water drainage

There are no recorded historical surface water flood events on the site therefore it is suggested that there is currently no requirement for a SWMP at the site. This is supported by the ASSWF maps shown in Appendix E. Table 4.7.3 shows that the site is estimated to experience an increase in run-off of at least 76% as a result of increasing the proportion of impermeable surface through site development. Therefore as far as possible it is recommended that excess surface water is managed onsite through the use of techniques such as sustainable drainage systems. This is especially important given the steep nature of the site topography which will encourage run-off to flow rapidly through the site towards the south.

Towards the middle of the site there is a natural basin where land is at a lower elevation than the surrounding fields. Development at this location, particularly residential, is likely to be at risk from surface water flowing from surrounding land. It is recommended that should development of the site go ahead, this area is either designated 'open space' or considered as a possible location for surface water attenuation measures.

No critical drainage areas have been identified, however development should not increase flow to the SE of the site as the area currently experiences a high level of flood risk indicated by the number of recent recorded flood incidents.

#### 4.7.9 Consequences of infilling floodplain

Not applicable at this site.

#### 4.7.10 Potential mitigation and management of residual risk

The site is currently a greenfield site, therefore if development goes ahead it is recommended that the maximum amount of open space is maintained as this will assist in attenuating the flow and allowing surface water to infiltrate. In particular it is suggested that as far as possible, land in the south of the site is designated as open space as this is lowest point of the site, to which surface water will naturally drain.

The site is very steep therefore tide locking is unlikely to affect flood risk to the site, however in developing the site, the additional surface water due to increased impermeable land cover will have to be managed on site so as not to exacerbate flood risk to land surrounding the site, particularly to the area between the River Taw and Windsor Road

Land to the centre of the site has been identified as having a lower elevation than the surrounding fields within the site, therefore should development be pursued, it is

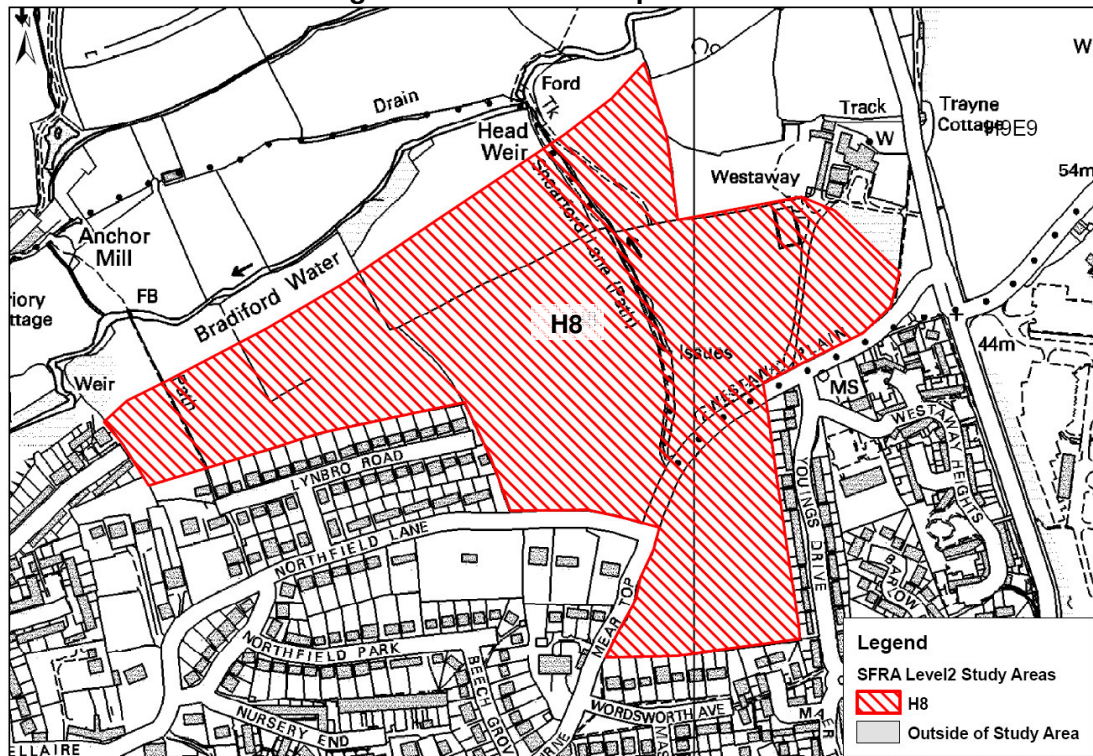
suggested that this could represent a potential location for sustainable surface water attenuation measures such as basins and ponds.

As detailed in section 4.7.8 SuDS would be required for any development in this area. Examples of the different types of SuDS that may be appropriate can be found in Appendix B. SuDS should minimise the impact of development on the surrounding areas, particularly as any excess water is likely to drain rapidly into Bradford Water and subsequently the Taw, which could have implications for flood risk downstream.

## 4.8 Site H8

### 4.8.1 Site overview

**Figure 4.8.1 – Location plan of site**



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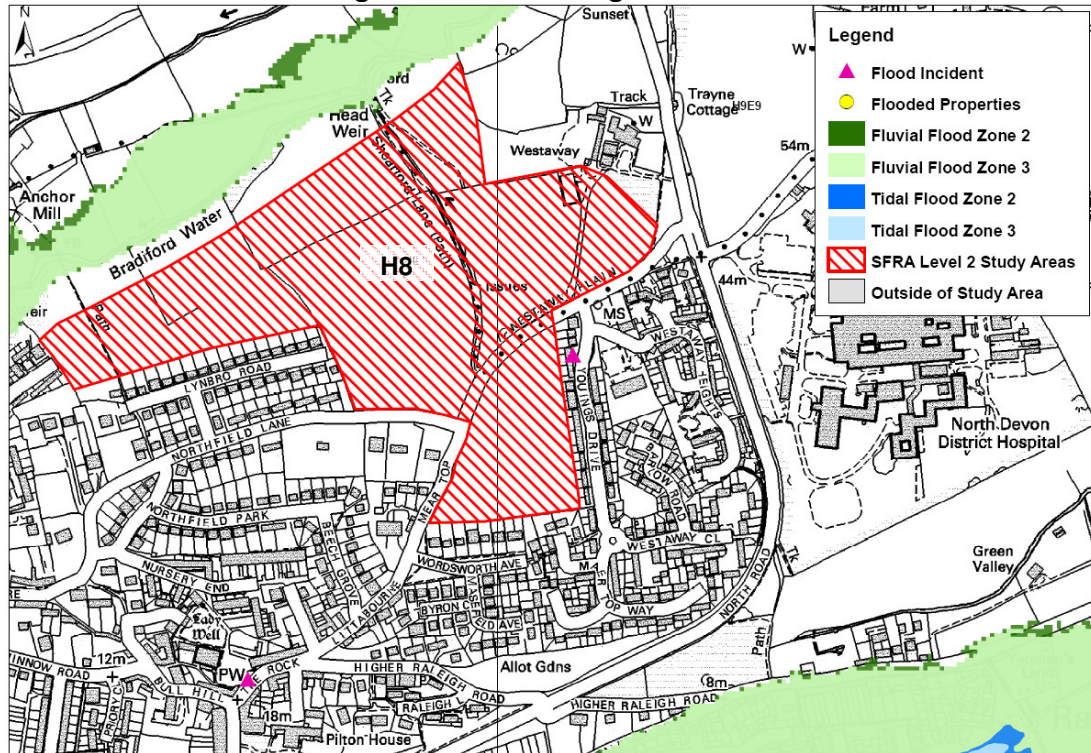
**Table 4.8.1- Site details**

Site ID	Location	Area (ha)			Proposed use	Capacity		
		Site	Development			40dph	50dph	60dph
			Residential	Employment				
H8	Land at Westway Plain, Pilton	16	16	~	Residential	640	800	960

Site H8 is situated alongside Bradford Water at Pilton, to the north of Barnstaple. It is one of the sites being considered for the Barnstaple Urban Extension. Table 4.8.1 specifies the development details for the site as provided by North Devon Council.

4.8.2 Overview of existing flood risk and inundation

**Figure 4.8.2 – Existing Flood Risk**

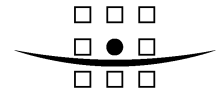


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**Table 4.8.2 – Indicators of existing flood risk**

<b>Entirely within FZ3</b>	N	
<b>Partly within FZ3</b>	N	
<b>Partly within FZ2</b>	N	
<b>Entirely within FZ1</b>	Y	Entire site is 15m from and at least 3m above nearest area of FZ2 / 3.
<b>Other watercourses not considered by Environment Agency Flood Zones</b>	Y	There is a small stream/ditch flowing through the centre of the site.
<b>Historical flood event</b>	N	None on site, one adjacent to site to east, surface water flooding due to heavy rainfall, affecting buildings and transport route in 2007.
<b>Topography</b>		<ul style="list-style-type: none"> <li>Site slopes from 50mOD in the SE to 15mOD in the NW</li> </ul>

The topography suggests that the site primarily drains to Bradford Water to the north of the site. The site is entirely contained within the Environment Agency Flood Zone 1 and although only 15m from Flood Zones 2 and 3 relating to the Bradford Water, it is a minimum of 3m above them at the lowest point, the rest of the site being considerably higher.



Tide locking is known to occur on Bradiford Water up to Windsor Road west of the site, any development must therefore ensure that it does not add to such issues and where possible reduces the risk of flooding to the surrounding area. This especially applies to this site as it is currently surrounded by residential development. Therefore additional run-off generated through increasing the amount of impermeable surface through development of the site must be dealt with onsite.

The site is also approximately 275m from the River Yeo. However it is at least 30m above the Flood Zones relating to this watercourse and therefore the Yeo is considered to be of little risk to the site although the impact of development should be considered.

There is a small stream/ditch flowing through the centre of the site which discharges into Bradiford Water to the north of the site. This stream/ditch is too small for inclusion in the Environment Agency Flood Zones, however it should be noted that there it could still present some level of flood risk to the site which would require further investigation should development be pursued.

#### 4.8.3 Existing defences, Verification of Defences and Areas Benefiting from Defences (ABDs)

NFCDD shows that there are no defences present within or adjacent to the site.

#### 4.8.4 Assessment of flood probability and hazard

Bradiford Water flows along the site's northern boundary. For model details see section 4.7.4. The modelled reach of the watercourse does not extend upstream more than halfway along the site border.

Model results indicate that tidal and fluvial flooding is not expected to occur on the site for both defended and undefended scenarios, (the nearest area of flooding occurring along Bradiford Water approximately 30m from the NW corner of the site) therefore maps of flood extent, depth and hazard are not displayed. The results also confirmed that the River Yeo presents no risk of flooding to the site.

It should be noted that other sources of flooding still present a risk to the site such as surface water and groundwater (which is beyond the scope of this study).

Note that the Mill Leat has not been included in the model and the flood risk consequences of this watercourse are therefore unknown. It is recommended that further investigation of the watercourse is undertaken prior to development at either site H7E7 or H8.

##### Flood probability

Similar to site H7E7, the onset of fluvial flooding downstream of the site occurs at QMED and demonstrates relatively small increases in extent with increasing return period. Extents are recorded to expand at the 1 in 100 year undefended event, however flood risk to site H8 is unaffected.

Tidal flooding occurs downstream of the site along Bradiford Water from the 1 in 10 year event (the lowest modelled tidal event) however extents were not observed to increase beyond this under current defended conditions.

## Flood Depth

Fluvial and tidal flood depths downstream of the site are minimal with an average of less than 0.25m. However it should be noted that flood depths increase significantly as the watercourse nears its confluence with the River Taw, therefore additional inputs to Bradiford Water should be avoided if development is pursued at the site in order to avoid compounding flood risk downstream.

## Flood Hazard

Based on the model results, it is not anticipated that the site experiences any fluvial or tidal flood hazard.

Immediately downstream of the site the area of fluvial flood hazard is small, although within this area it ranges from low to extreme, therefore should site H8 become developed additional inputs to Bradiford Water such as surface water run-off should be minimised through the use of techniques such as SuDS. Tidal flood hazard is mostly limited to the channel and banks of Bradiford Water.

### 4.8.5 Impact of climate change

The projected increase in fluvial flood flows due to the effects of climate change is anticipated to have no impact on flood risk to the site. Similarly the impact of climate change in terms of sea level rise is projected to have no effect on flood risk to the site. However, it is worth noting that immediately downstream of the site, fluvial and tidal flood extents, depths and hazard are projected to increase (although not significantly) as a result of climate change and therefore if the site is developed it should be ensured that where possible excess surface water is managed onsite for the lifetime of the development to minimise the risk of increasing flood risk downstream of the site.

### 4.8.6 Access and Egress

Access and egress remains safe for all modelled fluvial and tidal events.

### 4.8.7 Overview of impact of development on flood risk elsewhere

**Table 4.8.3 - Summary table of impacts of development**

Return Period	% impermeable of net developable residential area	Flow (m <sup>3</sup> /s)		
		Pre-development	Post-development	% increase
1 in 100 year	50	0.09	0.19	102
	70	0.09	0.26	179
	90	0.09	0.34	270

Results show that development at site H8 would create a significantly greater impact than at each of the other sites for all scenarios. Given that the entire site is allocated as net developable area it is recommended that only the lower dwelling density scenarios are considered in order to minimise the impact on the surrounding area. It is also important that where possible surface water is managed on site since the site is adjacent to existing residential areas and the area immediately west of the site is known

to experience tide-locking, although there are few recorded incidents of flooding.

#### 4.8.8 Surface water drainage

There are no recorded historical surface water flood events on the site therefore it is suggested that there is currently no requirement for a SWMP in the vicinity of the site. This is supported by the ASSWF maps shown in Appendix E. However there have been many incidents of flooding including from surface water adjacent to and downstream of the site, the most recent being the flooding of transport routes along the eastern boundary of the site in 2007. In view of this, in addition to the significant increase in run-off projected to occur as a result of development (table 4.8.3), it is recommended that as far as possible excess surface water is managed onsite through the use of techniques such as SuDS.

No critical drainage areas have been identified.

#### 4.8.9 Consequences of infilling floodplain

Not applicable at this site.

#### 4.8.10 Potential mitigation and management of residual risk

The site is mostly in Flood Zone 1 and model results show that development at the site would experience minimal risk from fluvial or tidal flooding. The main risk therefore is to the surrounding area as a result of increased run-off due to the impermeable surfaces created by development of the site. This is especially important given the steep topography of the site which would encourage any surface water to rapidly flow into Bradiford Water in addition to affecting properties downstream and surrounding the site. Since the site is currently a greenfield site, if development goes ahead it is recommended that the maximum amount of open space is maintained as this will assist in attenuating the flow and allowing surface water to infiltrate. In particular it is suggested that as far as possible, land in the north and north west of the site is designated as open space to minimise the risk of increasing flood risk downstream on Bradiford Water.

As detailed in section 4.8.8 SuDS would be required for any development in this area. Examples of the different types of SuDS that may be appropriate can be found in Appendix B.

SuDS will also help to reduce the risk of increasing flow to the stream/ditch running through the centre of the site which discharges into Bradiford Water. The flood risk relating to this should be further investigated prior to any development. Should development be pursued at the site, it is advised that the stream/ditch is not culverted and that a maintenance regime is developed to minimise the risk of flooding from this source. Where possible it is suggested that land surrounding the stream/ditch is designated as 'open space' in order to further reduce the risk of flooding.