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Level 2 Strategic Flood Risk Assessment

Sites CA001uc, CA002uc, CA003uc, and HEA143; EA020uc

Prepared for: Southend-on-Sea City Council

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1 Background

This is a Level 2 Strategic Flood Risk Assessment (SFRA) site screening report for Sites CA001uc, CA002uc, CA003uc, and HEA143; EA020uc. These sites are being jointly promoted as a new neighbourhood in the greenbelt in the northeast of Southend. Descriptions within this site assessment refer to all sites unless specifically stated.

The content of this Level 2 SFRA site screening report assumes the reader has already consulted the Southend-on-Sea City Council Level 1 SFRA and read the Southend-on-Sea City Council Level 2 SFRA Main Report and is therefore familiar with the terminology used in this report.

1.1 Sites details

- Location: the sites are situated in the northeast of Southend.
  - **CA001uc:** Land north of Eastern Avenue (A1159) and Royal Artillery Way (A1159), encompassing the north and west of Garon Park Golf Complex
  - **CA002uc**: Land north of Royal Artillery Way (A1159) and west of Wakering Road, encompassing the southeast of Garon Park Golf Complex
  - **CA003uc:** Land north of Poynters Lane (B1017) and west of Star Lane (B1017)
  - **HEA143; EA020uc:** Land north of Bournes Green Chase (A13) and east of Wakering Road
- Sites area: 296ha
- Existing sites use: Greenbelt
- Proposed sites use: Mixed use new neighbourhood

1.2 Topography

Figure 1-1 shows the topography of the sites represented by the Environment Agency (EA) 1m resolution LiDAR. Across the sites, elevations range from a maximum of 29.4mAOD near the southwestern boundary of CA001uc, to a minimum of 4.0mAOD at the southeastern boundary of CA002uc. Generally, CA001uc slopes downhill towards the north and east towards Mucking Hall Brook. CA002uc predominantly slopes downhill to the southeast, with the northwest part of the site sloping downhill northwards towards Mucking Hall Brook. HEA143; EA020uc slope downhill towards both the southwest and east, resulting in runoff draining in these directions. CA003uc is relatively flat compared to the other sites and has multiple drainage directions.

A more detailed breakdown of the topography and drainage conditions for each of the sites is provided in Section 5.1.

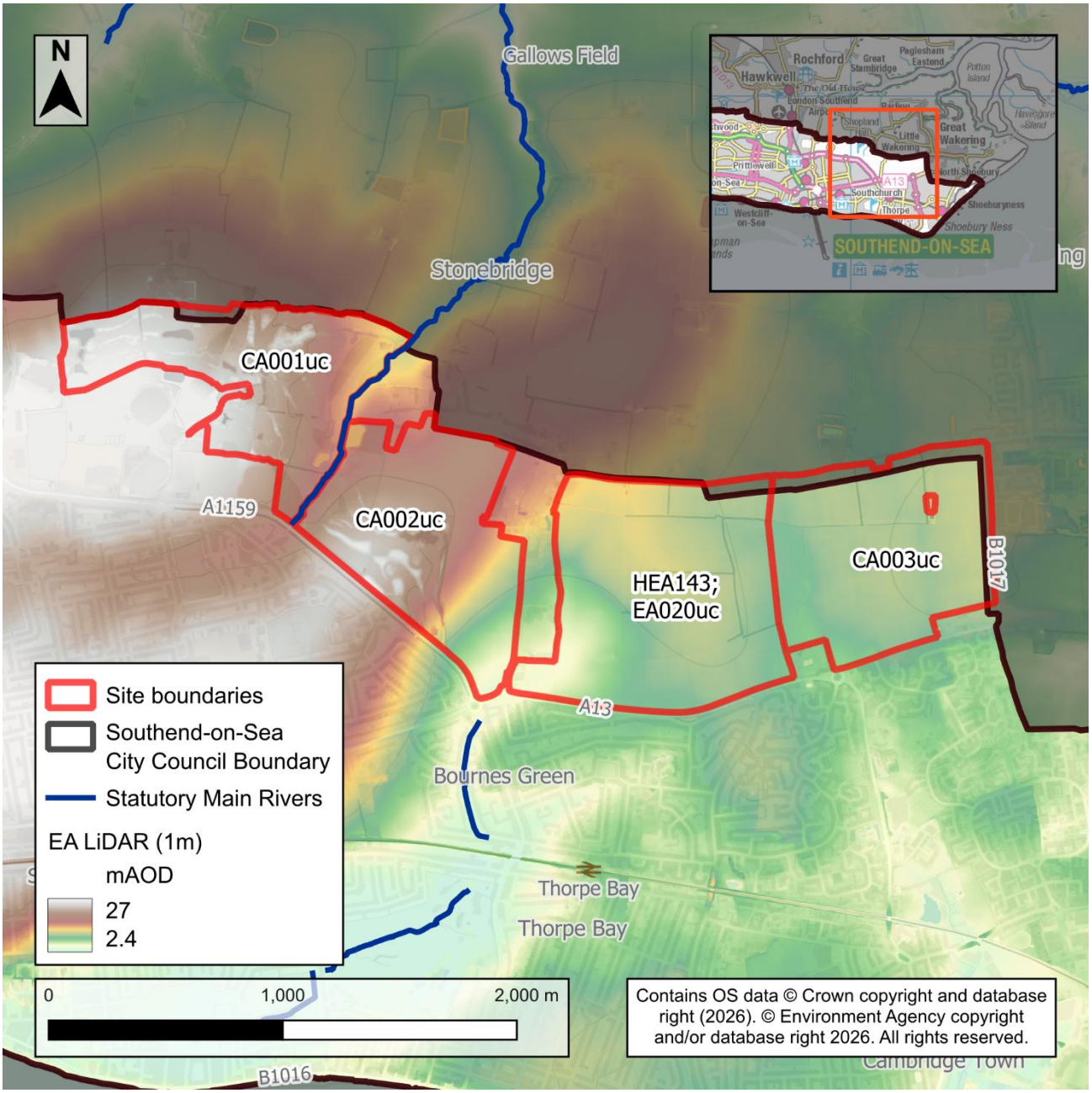


Figure 1-1: Topography of the site.

1.3 Geology and soils

Geology at the sites consists of:

- Bedrock - London Clay Formation comprised of clay, silt, and sand.
- Superficial:
    - **CA001uc:** River terrace deposits, comprised of sand and gravel, are found in the western portion of the site. The east of the site is underlain by head, comprised of clay and silt.
    - **CA002uc:** Predominantly head, comprised of clay and silt. The southwest of the site is underlain by river terrace deposits, comprised of sand and gravel.
    - **CA003uc:** River terrace deposits, comprised of sand and gravel.
    - **HEA143; EA020uc:** Predominantly river terrace deposits, comprised of sand and gravel. Parts of the area along the western boundary are underlain by head, comprised of clay, silt, sand and gravel.

Soils at the sites consist of freely draining slightly acid loamy soils, draining to local groundwater and rivers.

The likely impact of the geology and soils on drainage within the sites is discussed within Section 5.

2 Sources of flood risk

2.1 Location of sites within the catchment

The sites are located in the northeast of the study area. North of the sites the land use is predominantly rural farmland, extending to River Roach. In contrast, the land south of the sites that extends to the Thames Estuary consists of dense urban neighbourhoods, including North Shoebury and Southchurch.

The west of the grouped sites likely drains northwards to River Roach, and the east drains directly to the North Sea. The centre of the sites, including parts of CA002uc and HEA143; EA020uc, drain towards Willingdale Brook and into the Thames Estuary.

2.2 Existing drainage features

Mucking Hall Brook, a statutory main river, flows along the eastern border of CA001uc and the western border of CA002uc, between the two sites.

There are several ponds within Garon park Golf Complex situated in CA001uc and CA002uc.

There are also a number of drainage ditches along the borders of the fields within CA003uc and HEA143; EA020uc.

Willingdale Brook is a statutory main river that flows outside of the site in a southwards direction, discharging into the Thames Estuary. The brook exits a culvert south of Bournes Green Roundabout, around 100m from CA002uc. The path of this culvert is unknown.

2.3 Fluvial and tidal

2.3.1 EA's Flood Map for Planning

Based on the EA's Flood Map for Planning (FMfP) Flood Zones (accessed 21 April 2026) and Flood Zone 3b (functional floodplain), defined in the Southend-on-Sea Level 1 SFRA, the percentage areas of the sites within each Flood Zone are stated in Table 2-1 and can be viewed in Figure 2-1. The FMfP does not consider the benefits from flood defence infrastructure.

The FMfP shows that 'rivers' are the source of flooding to the site, from Mucking Hall Brook and Willingdale Brook. In the climate change scenarios, the FMfP shows that the source of flooding from Willingdale Brook is the 'sea' (Section 2.3.4).

Most of the sites (98%) are not at risk of fluvial flooding. Flood Zones 3b and 3a cover less than 1% of the site, associated with Mucking Hall Brook, impacting CA001uc and CA002uc. Flood Zone 2 also impacts CA002uc and HEA143; EA020uc, from Willingdale Brook. CA003uc is entirely within Flood Zone 1.

Table 2-1: Present day fluvial flood risk based on the EA's FMfP and Rivers and Sea 3.3% AEP defended extent.

Flood Zones	Flood Zone 3b (%)	Flood Zone 3a (%)	Flood Zone 2 (%)	Flood Zone 1 (%)
Percentage of sites at risk* (%)	<1	<1	2	98

**This shows the percentage of the sites at flood risk from a particular flood zone or event, including the percentage of the sites at flood risk at a higher risk zone, e.g. Flood Zone 2 includes the Flood Zone 3a and 3b percentage. Flood Zone 1 + Flood Zone 2 = 100%.*

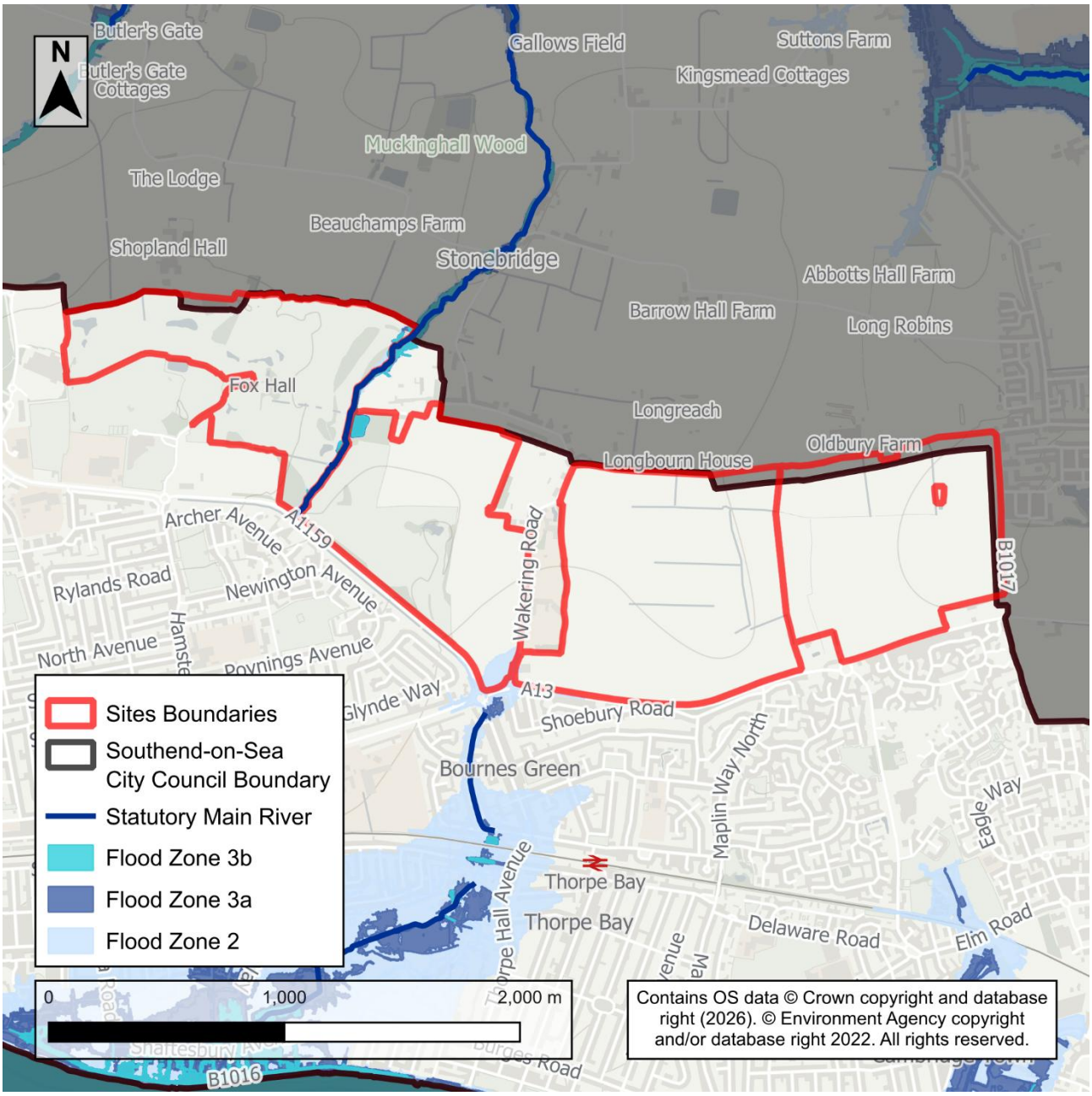


Figure 2-1: Present day fluvial flood risk, based on the EA FMfP and Rivers and Sea 3.3% AEP defended extent.

2.3.2 Fluvial - present day

The EA's FMfP has been used within this assessment to assess fluvial risk as there is no detailed hydraulic modelling currently available for this site. Flood Zone 3b has been defined using the Rivers and Sea 3.3% AEP defended extent. There is currently no available depth, hazard, or velocity information available within the EA FMfP, therefore, detailed hydraulic modelling is likely to be required during a site-specific Flood Risk Assessment.

Most of the sites are not shown to be at fluvial risk.

Mucking Hall Brook flows in a northerly direction between CA001uc and CA002uc. Flood Zones 3b and 3a have similar flood extents and the brook overtops in a number of areas along the watercourse. This includes in the northeast of CA001uc, as well as overtopping and flowing into an existing 90m pond in the northwest of CA002uc. The areas of risk expand slightly along the whole watercourse in Flood Zone 2, particularly within CA001uc.

Willingdale Brook is tidally influenced and flows southwards and discharges to the Thames Estuary. The brook exits a culvert south of Bournes Green Roundabout, around 100m from CA002uc. Willingdale Brook only impacts the sites in Flood Zone 2, flowing around 130m into the southeast of CA002uc and partially encroaching into HEA143; EA020uc from Wakering Road.

2.3.3 Fluvial - climate change

The EA Rivers and Sea 3.3% AEP defended and 1% AEP and 0.1% AEP undefended extents plus climate change have been used to represent future Flood Zones using the Central 2080s allowance. There is currently no available depth, hazard, or velocity information available for these datasets, therefore, detailed hydraulic modelling is likely to be required during a site-specific Flood Risk Assessment including modelling of the latest climate change uplifts.

The climate change extents from Mucking Hall Brook impacting CA001uc and CA002uc show minor increases but largely match those in the present day scenarios.

The largest climate change impacts are to CA002uc and HEA143; EA020uc from the direction of Willingdale Brook. However, Willingdale Brook is tidally influenced and the climate extents encroaching into the sites are from the sea. These are therefore discussed in Section 2.3.5.

2.3.4 Tidal - present day (2026 epoch)

As part of this SFRA, the existing EA detailed hydraulic models of Southend and the Crouch and Roach estuary developed as part of the 2014 Essex, Suffolk and Norfolk Coastal modelling project were combined. The updated model has been used to assess the tidal risk to the site.

None of the sites are shown to be at risk from tidal flooding in the present day, according to the FMfP and local flood modelling.

2.3.5 Tidal - future risk (2126 epoch)

The detailed tidal hydraulic model updated as part of this SFRA (see Section 2.3.4 for further details) was uplifted for the 2126 epoch for the higher central and upper end climate change scenarios.

CA001uc and CA003uc are not at risk from tidal flooding in the future, according to the FMfP and local flood modelling.

Undefended risk

Figure 2-2 and Figure 2-4 show the undefended future tidal risk to CA002uc. Figure 2-3 and Figure 2-5 show the undefended future tidal risk to HEA143; EA020uc. In all the modelled undefended climate change scenarios, the tidal risk is contained to the southeast of CA002uc and southwest of HEA143; EA020uc.

In the undefended 0.5% Higher Central event, the maximum depth is 1.0m in CA002uc and 0.2m in HEA143; EA020uc. The maximum velocity is 1.5m/s in CA002uc and 1.0m/s in HEA143; EA020uc. The maximum hazard classification is 'Danger for Most' in CA002uc and 'Danger for Some' in HEA143; EA020uc.

In the undefended 0.5% Upper End and 0.1% Higher Central events, the maximum depth is 1.5m in CA002uc and 1.1m in HEA143; EA020uc. The maximum velocity is 0.6m/s in CA002uc and 1.2m/s in HEA143; EA020uc. The maximum hazard classification is 'Danger for Most' in CA002uc and 'Danger for All' in a very small area in HEA143; EA020uc.

In the undefended 0.1% Upper End event, the maximum depth is 2.0m in CA002uc and 1.5m in HEA143; EA020uc. The maximum velocity is 1.0m/s in CA002uc and 1.1m/s in HEA143; EA020uc. The maximum hazard classification is 'Danger for All' for both sites.

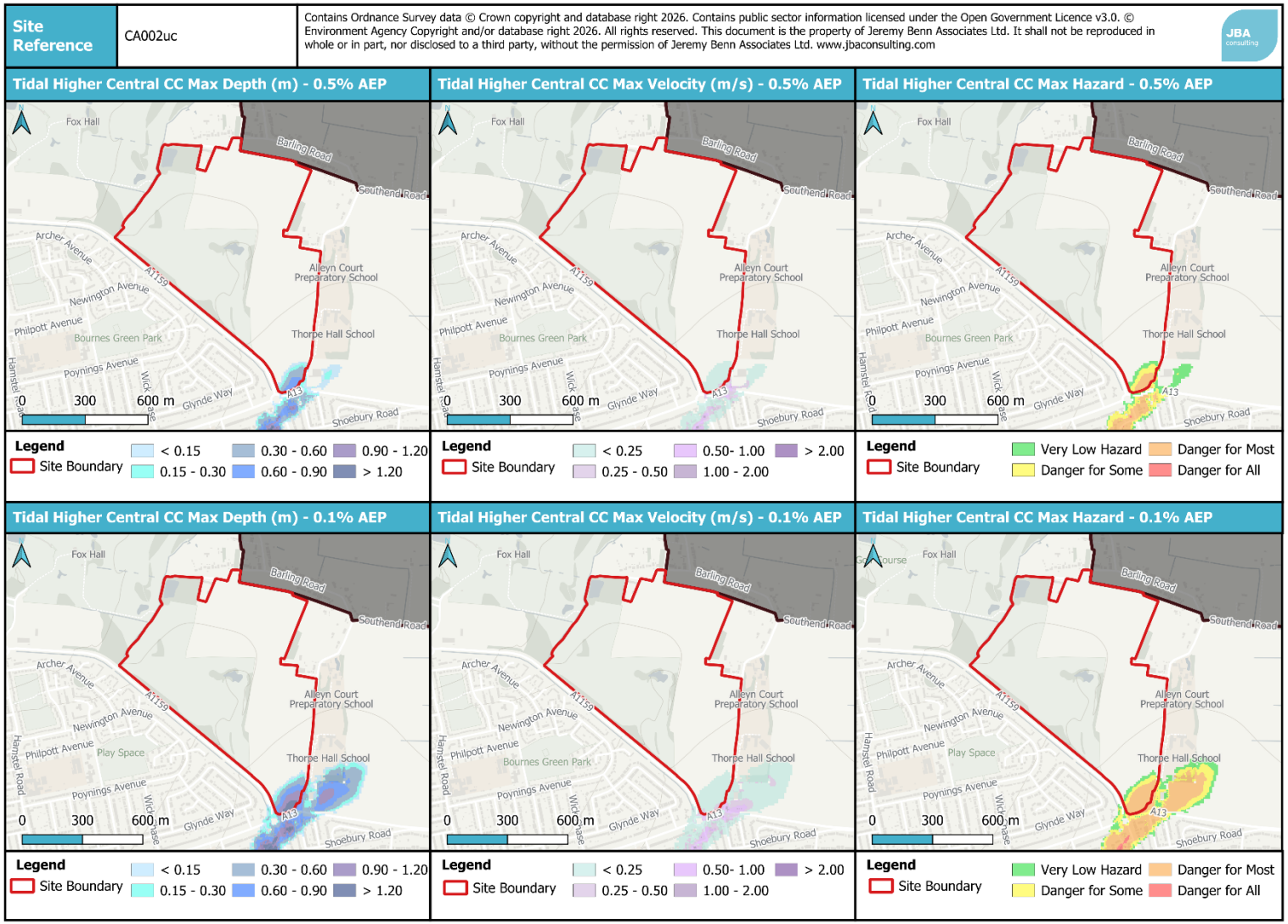


Figure 2-2: Tidal risk to CA002uc for the 0.5% AEP and 0.1% AEP higher central climate change undefended scenarios.

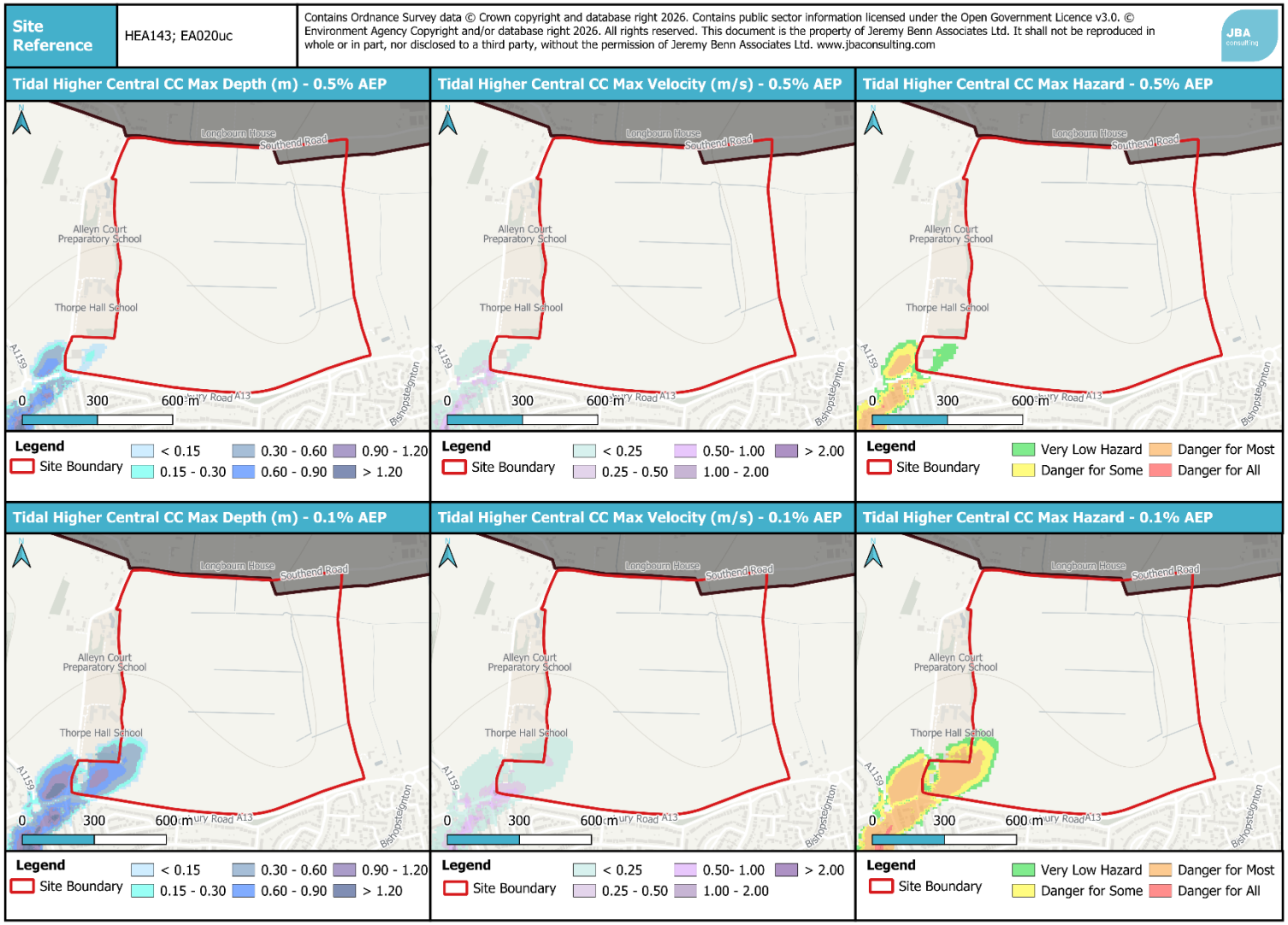


Figure 2-3: Tidal risk to HEA143; EA020uc for the 0.5% AEP and 0.1% AEP higher central climate change undefended scenarios.

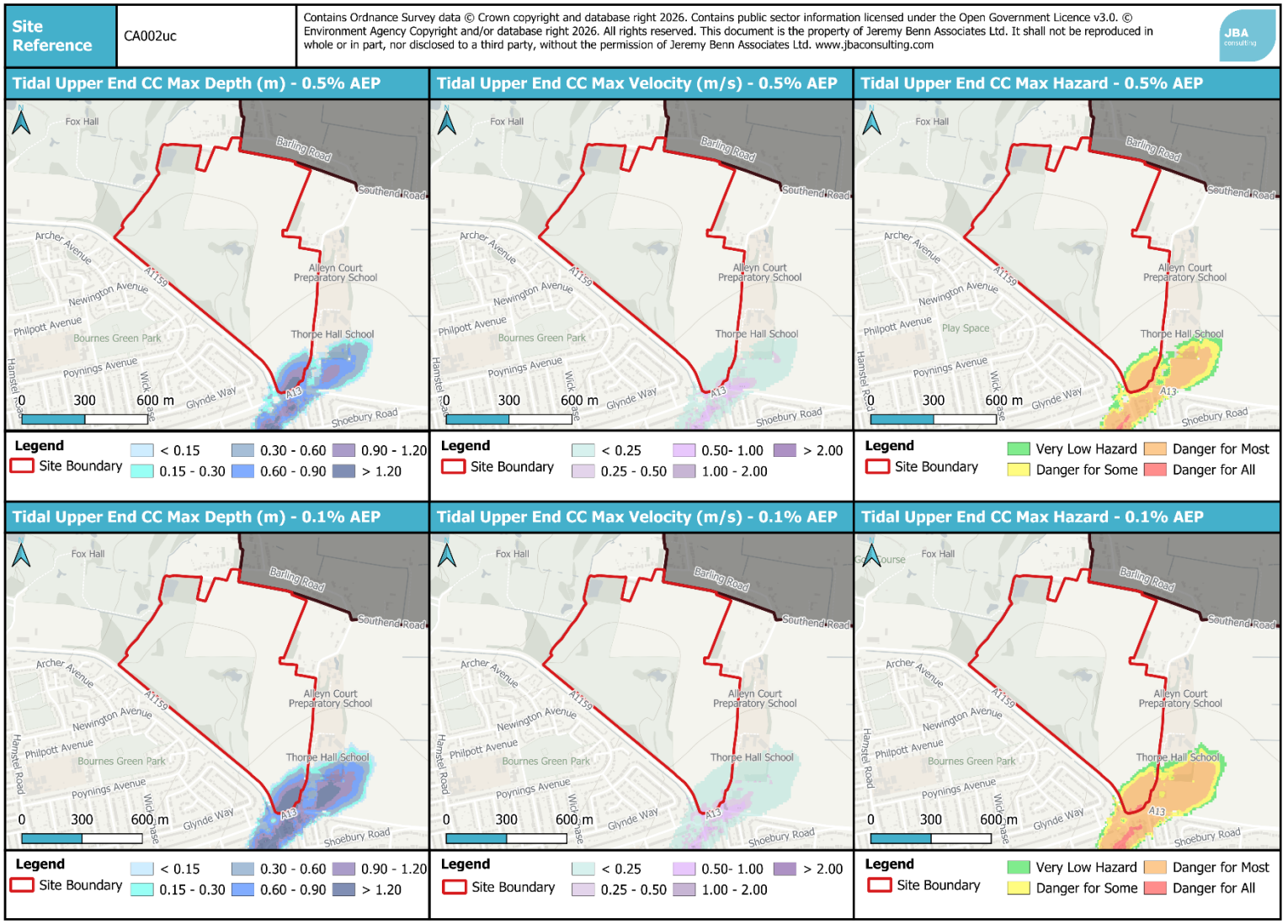


Figure 2-4: Tidal risk to CA002uc for the 0.5% AEP and 0.1% AEP upper end climate change undefended scenarios.

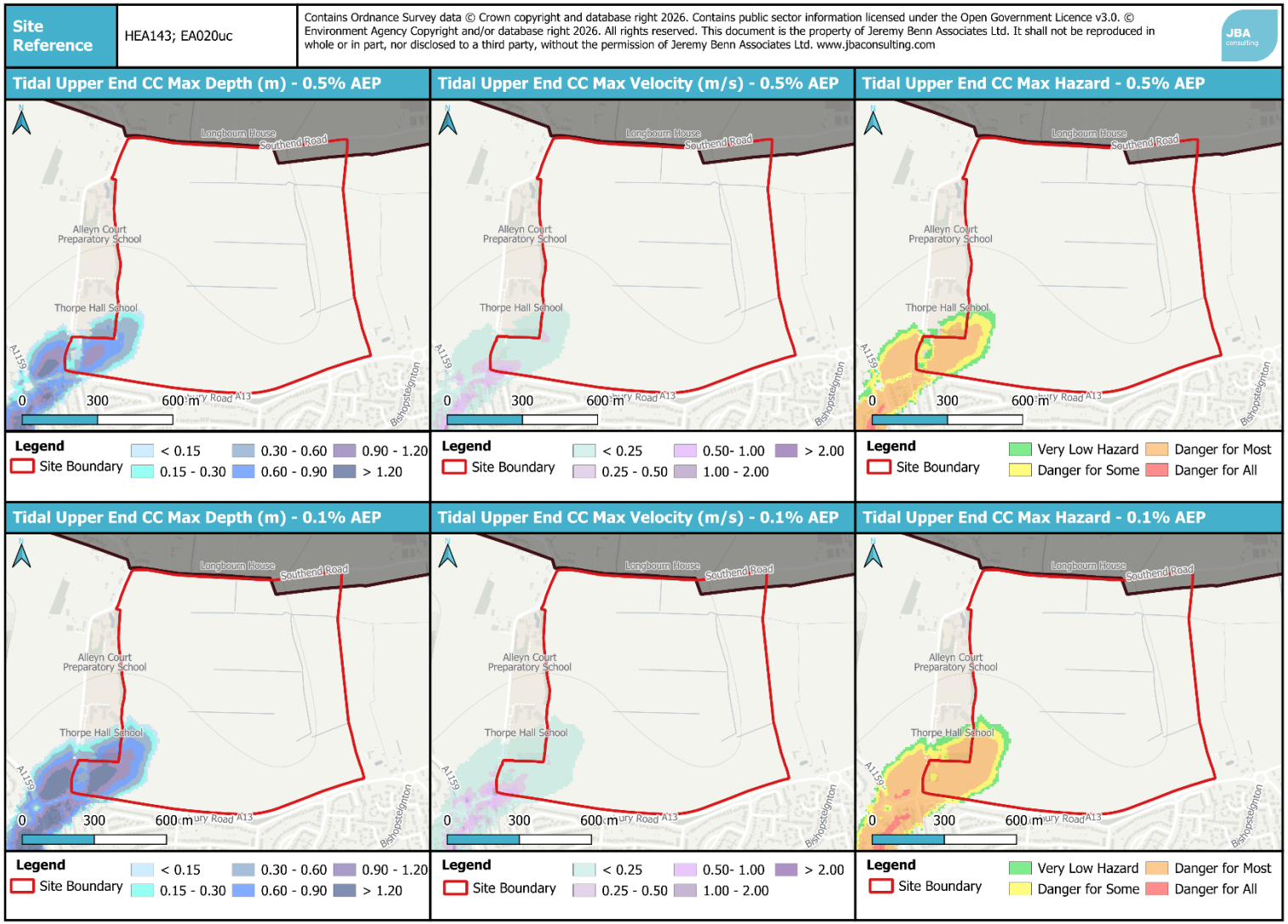


Figure 2-5: Tidal risk to HEA143; EA020uc for the 0.5% AEP and 0.1% AEP upper end climate change undefended scenarios.

Defended risk

Figure 2-6 and Figure 2-8 show the defended future tidal risk to CA002uc. Figure 2-7 and Figure 2-9 show the defended future tidal risk to HEA143; EA020uc.

None of the sites are at risk in the defended 3.3% AEP Higher Central and Upper End scenarios, or the 0.5% AEP Higher Central event. In the other modelled defended climate change events, the tidal risk is contained to the southeast of CA002uc and southwest of HEA143; EA020uc.

In the defended 0.5% Upper End event, the maximum depth is 1.2m in CA002uc and 0.5m in HEA143; EA020uc. The maximum velocity is 0.8m/s in CA002uc and 1.0m/s in HEA143; EA020uc. The maximum hazard classification is 'Danger for Most' for both sites.

In the defended 0.1% Higher Central event, the maximum depth is 1.4m in CA002uc and 0.9m in HEA143; EA020uc. The maximum velocity is 1.3m/s in CA002uc and 1.1m/s in HEA143; EA020uc. The maximum hazard classification is 'Danger for Most' for both sites.

In the defended 0.1% Upper End event, the maximum depth is 2.0m in CA002uc and 1.5m in HEA143; EA020uc. The maximum velocity is 0.7m/s in CA002uc and 1.3m/s in HEA143; EA020uc. The maximum hazard classification is 'Danger for All' for both sites.

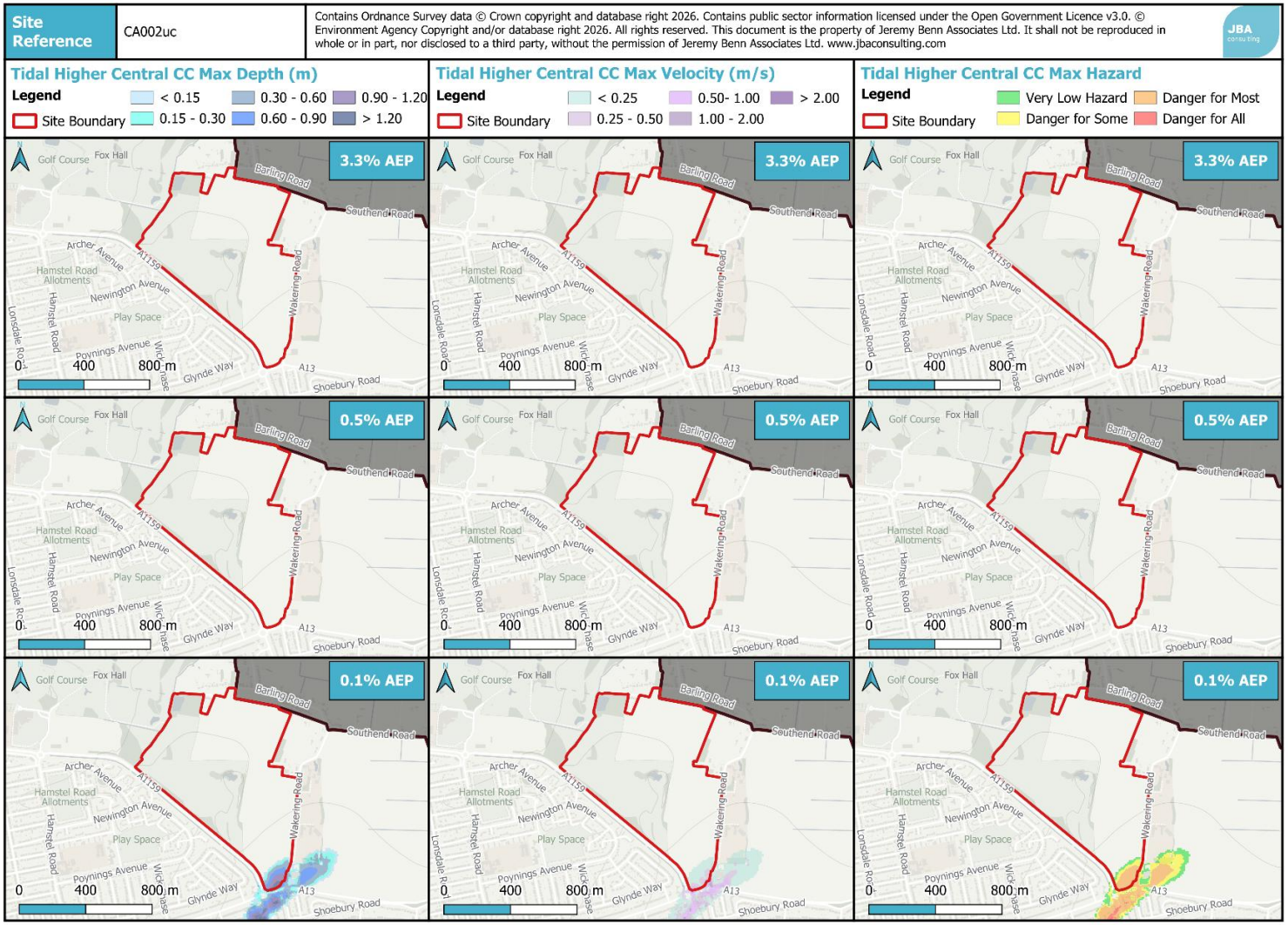


Figure 2-6: Tidal risk to CA002uc for the 3.3% AEP, 0.5% AEP and 0.1% AEP higher central climate change defended scenarios.

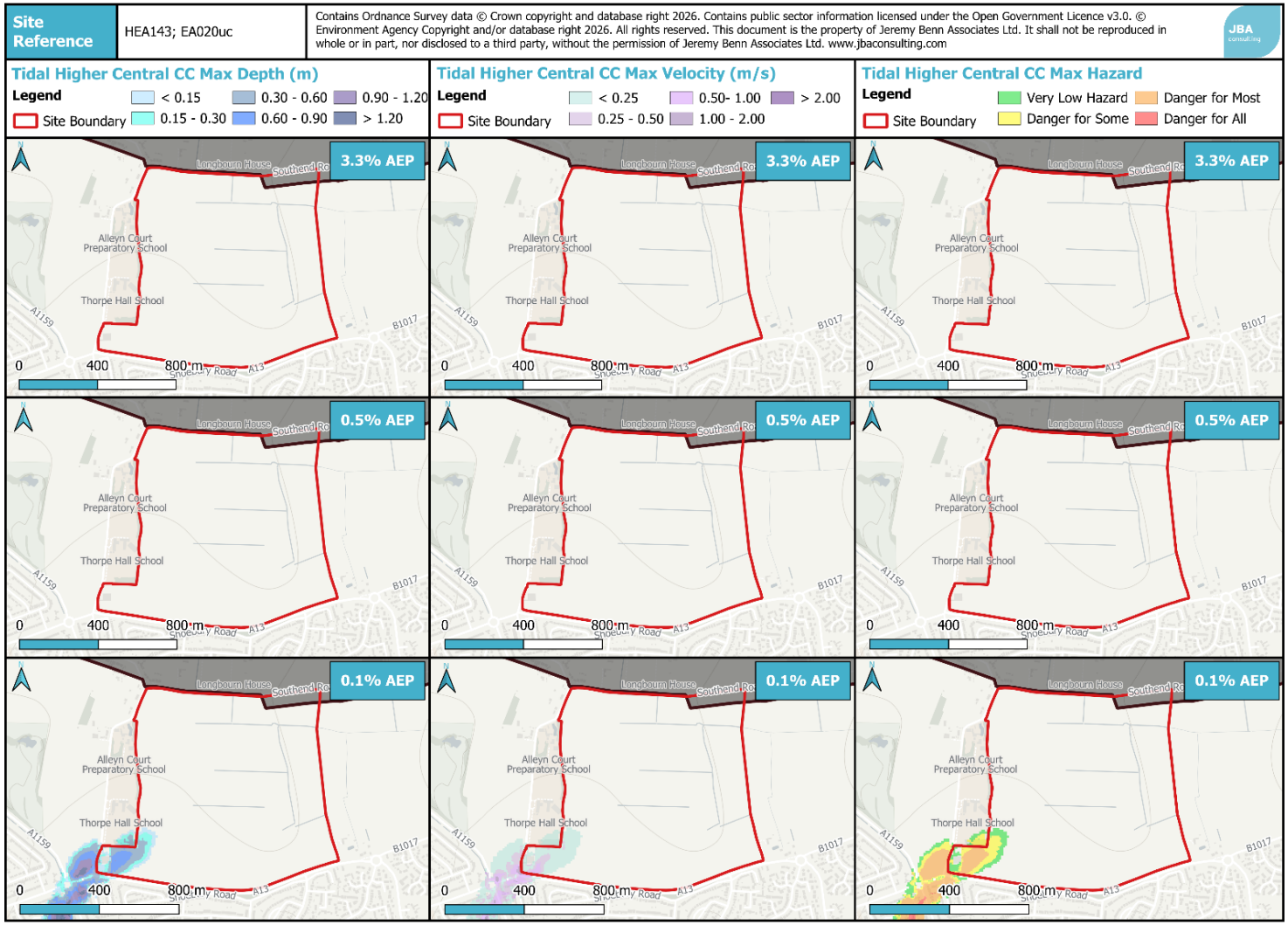


Figure 2-7: Tidal risk to HEA143; EA020uc for the 3.3% AEP, 0.5% AEP and 0.1% AEP higher central climate change defended scenarios.

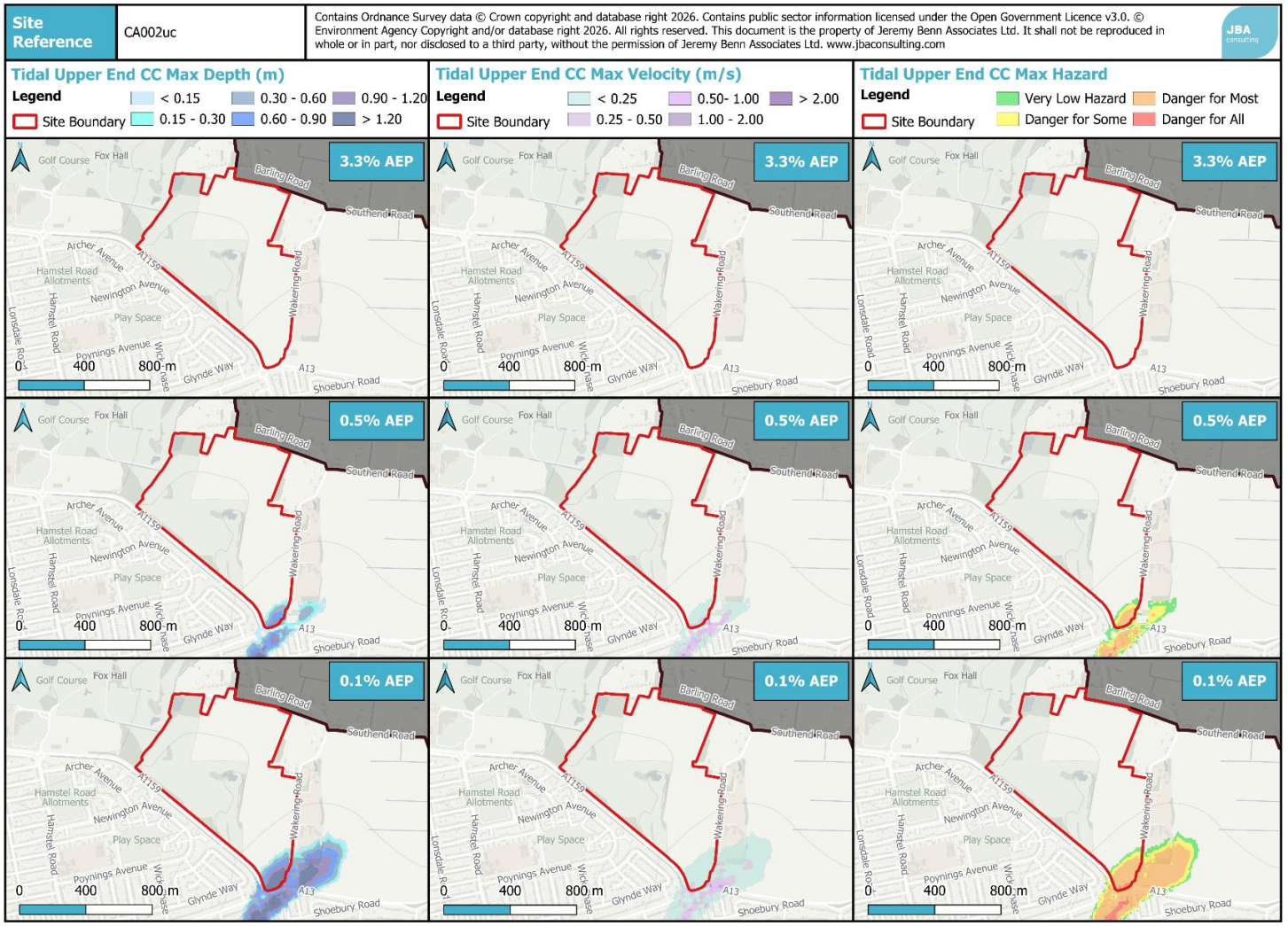


Figure 2-8: Tidal risk to CA002uc for the 3.3% AEP, 0.5% AEP and 0.1% AEP upper end climate change defended scenarios.

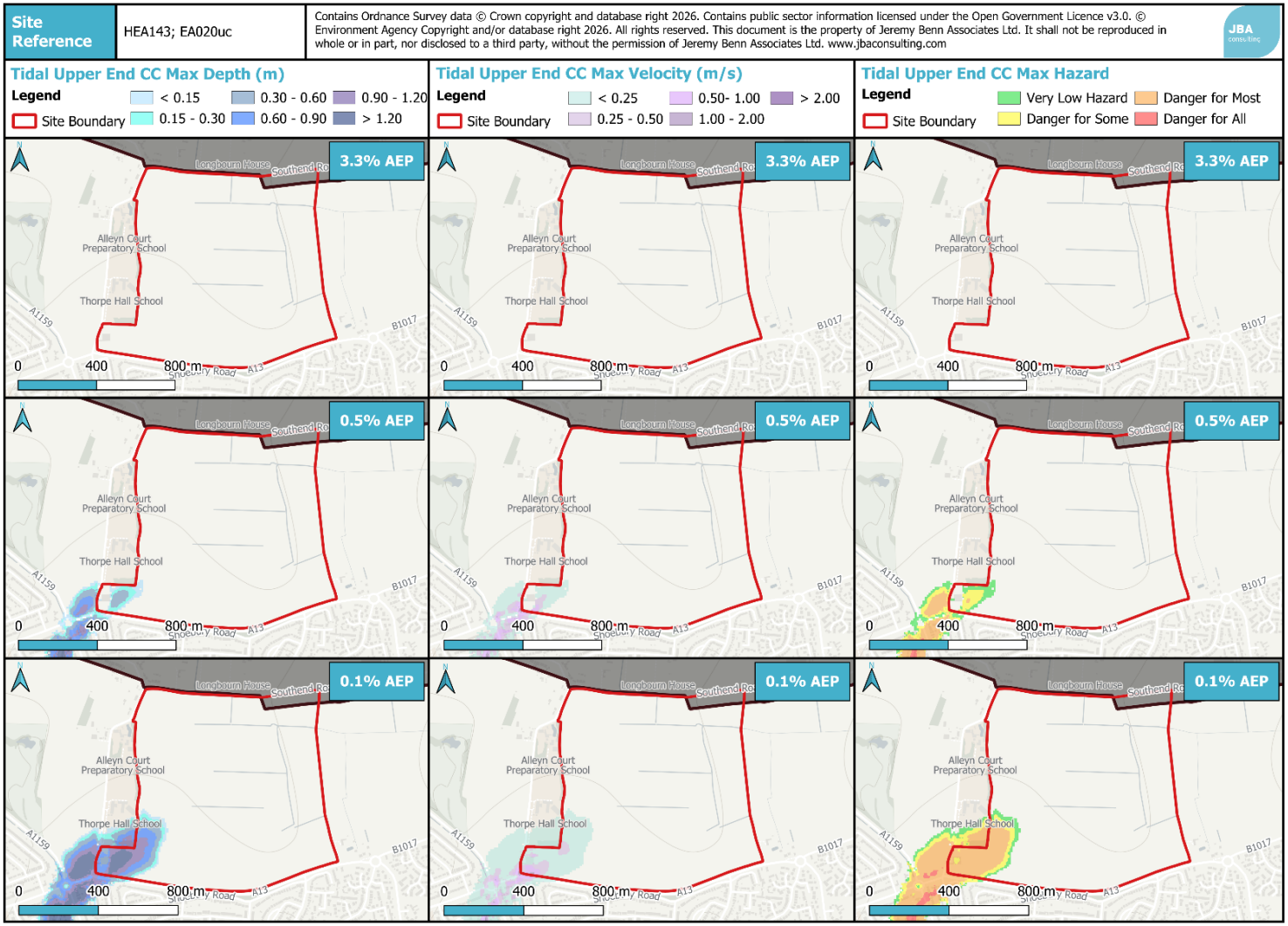


Figure 2-9: Tidal risk to HEA143; EA020uc for the 3.3% AEP, 0.5% AEP and 0.1% AEP upper end climate change defended scenarios.

2.4 Surface water

2.4.1 Available data

The EA's FMfP Surface Water Spatial Planning Dataset, released in May 2026, has been used within this assessment to inform the extent and depth of the present day and future surface water risk. Climate change outputs are available for the 3.3%, 1%, and 0.1% AEP events with the Upper End climate change allowance for the 2070s epoch.

The Risk of Flooding from Surface Water (RoFSW) map has been used within this assessment to inform the velocity and hazard of the present day surface water risk. There is currently no available velocity or hazard information to use to assess future surface water risk.

Descriptions refer to the maximum depth, velocity, and hazard values experienced in each area of the sites within a given event.

2.4.2 Present day

Figure 2-10 shows the surface water flood risk across all the sites. Figure 2-11, Figure 2-12, Figure 2-13, and Figure 2-14 show the depth, velocity, and hazard across the sites in each event.

In the 3.3% AEP event, there are several areas of isolated surface water ponding across all of the sites. Water collects in the several existing ponds within CA001uc and CA002uc, as well as in the drainage ditches located in CA003uc and HEA143; EA020uc. In the 3.3% AEP event, the largest areas of ponding are found northeast of Bournes Green Roundabout, as well as in the southeast of CA002uc and the southwest of HEA143; EA020uc.

In the 1% and 0.1% AEP events, the existing areas of risk increase in size and there are a few new areas of ponding, particularly in CA001uc. A large flow path travelling south also forms in the west of CA003uc, crossing the northeast of HEA143; EA020uc in the 0.1% AEP event. Parallel to this, in the east of CA003uc, is an area of risk stretching over 300m in the 0.1% AEP event.

As shown in Table 2-2, the maximum depths are between 0.6m and 0.9m in the 3.3% AEP event. These depths are found across the sites, particularly along the drainage ditches and near to Bournes Green Roundabout. However, the majority of the depths are below 0.6m, with many areas also being less than 0.15m in depth. In the southeast of CA002uc, depths reach between 0.9m and 1.2m in the 1% AEP event, rising to between 1.2m and 2.3m in the 0.1% AEP event. These depths are also found in small areas of ponding in CA001uc. However, depths between 0.15m and 0.3m are more prevalent in the 1% and 0.1% AEP events.

In the 3.3% AEP event, the maximum velocity exceeds 0.5m/s but does not exceed 1.0m/s in a small area by the southeastern boundary of CA002uc and in the northwest of CA003uc. In both the 1% and 0.1% AEP events, the maximum velocities exceed 1.0m/s but does not

exceed 2.0m/s. However, this is only in a small number of areas across the flood extents, including along the largest flow path in CA003uc. In all the events, velocities do not exceed 0.25m/s for most areas at surface water risk.

All events have the same maximum hazard classification of 'Danger for Most'. This hazard classification is found across all of the sites, particularly in the large area of ponding near to Bournes Green Roundabout and along the drainage ditches.

Table 2-2: Present day surface water flood risk based on the EA's FMfP Surface Water Spatial Planning dataset (extent, depth) and RoFSW dataset (velocity, hazard).

Event	3.3% AEP	1% AEP	0.1% AEP
Percentage of sites at risk* (%)	2	3	7
Maximum depth (m)	0.6 - 0.9	0.9 - 1.2	1.2 - 2.3
Maximum velocity (m/s)	0.5 - 1.0	1.0 - 2.0	1.0 - 2.0
Maximum hazard classification	Danger for Most	Danger for Most	Danger for Most

** The percentage surface water extents quoted show the percentage of the sites at surface water risk from that particular event, including the percentage of the sites at flood risk at a higher risk zone (e.g. the 1% AEP includes the 3.3% AEP percentage).*

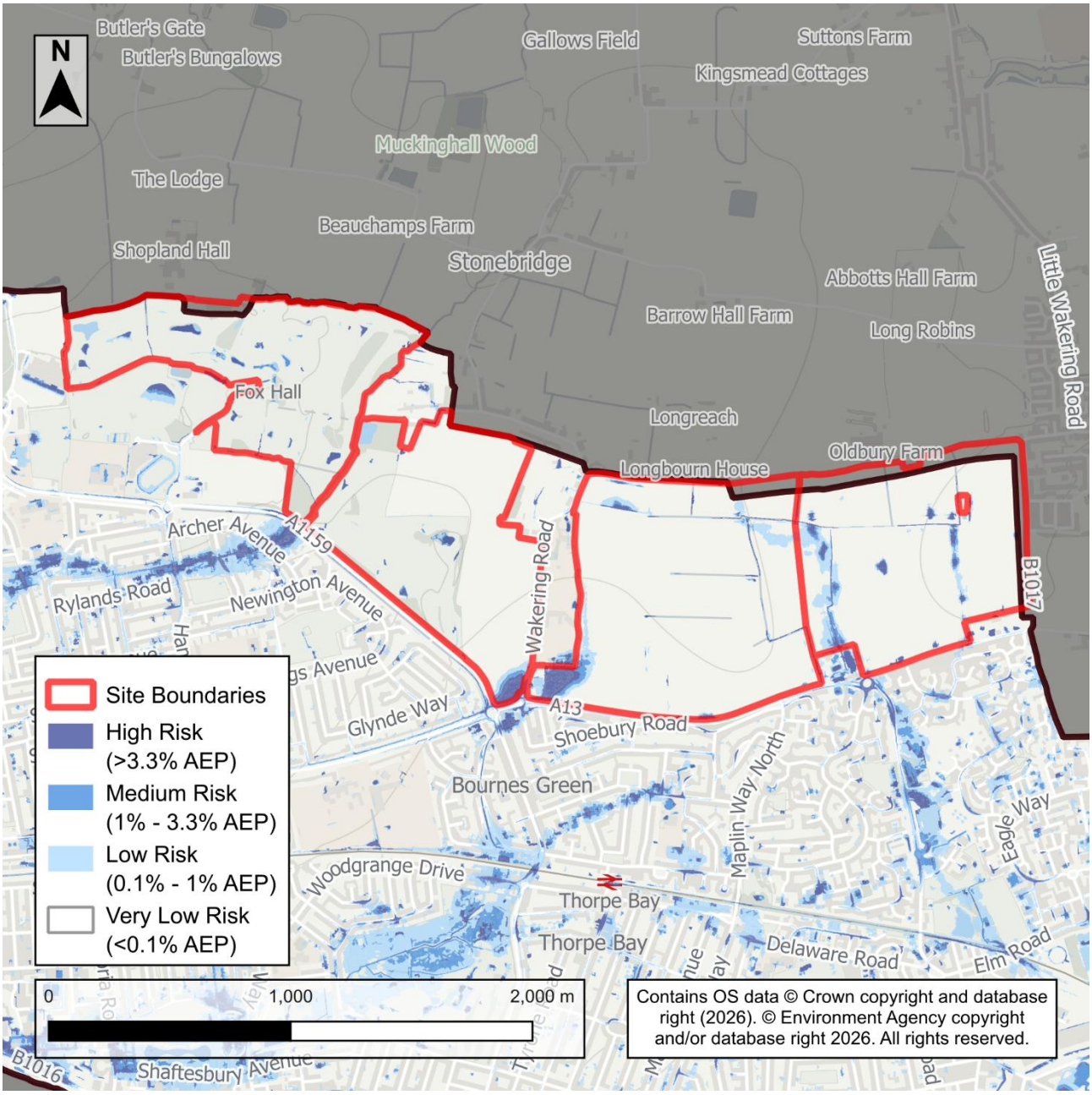


Figure 2-10: Present day surface water extents from the FMfP Surface Water Spatial Planning Dataset.

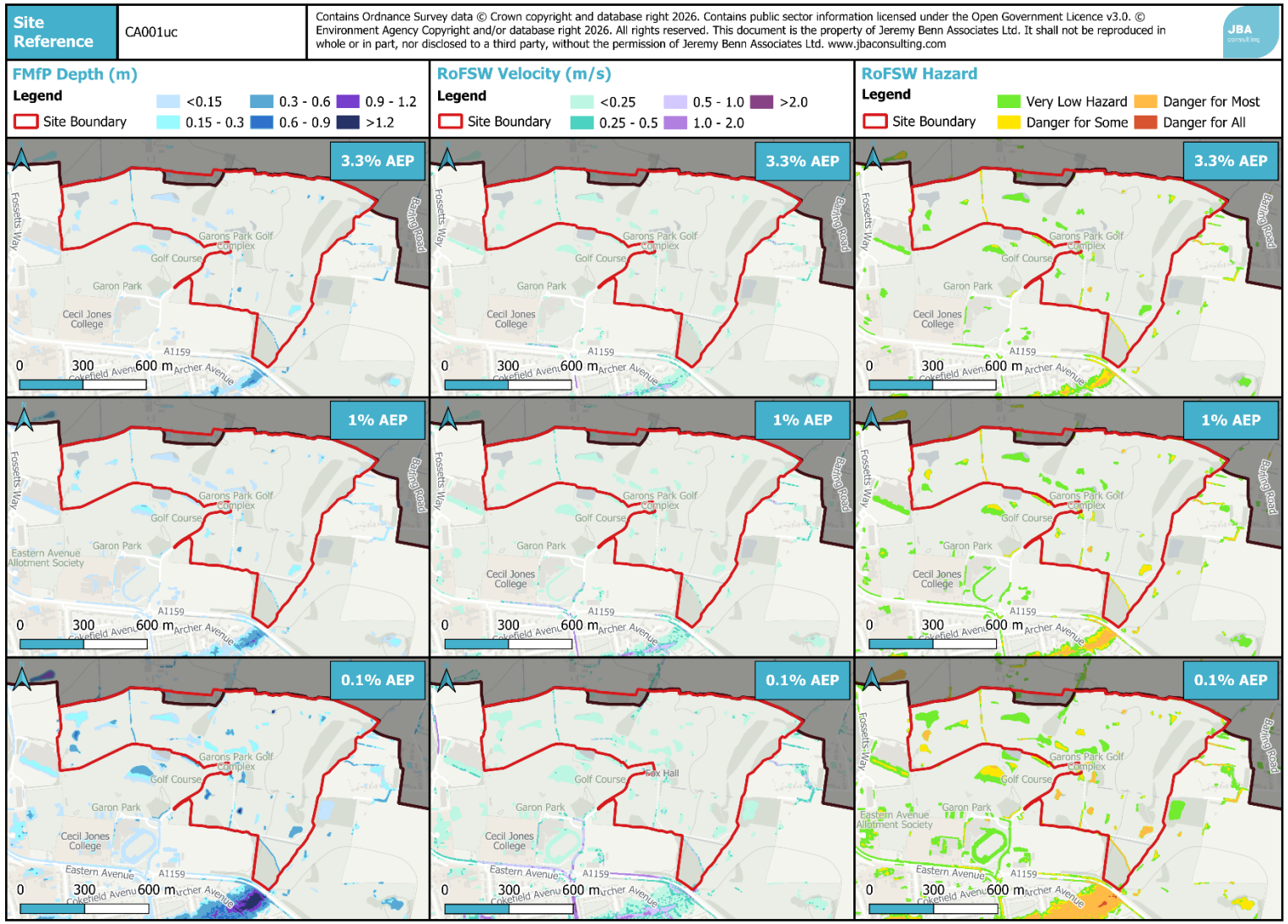


Figure 2-11: Present day surface water risk to CA001uc in the 3.3%, 1%, and 0.1% AEP events.

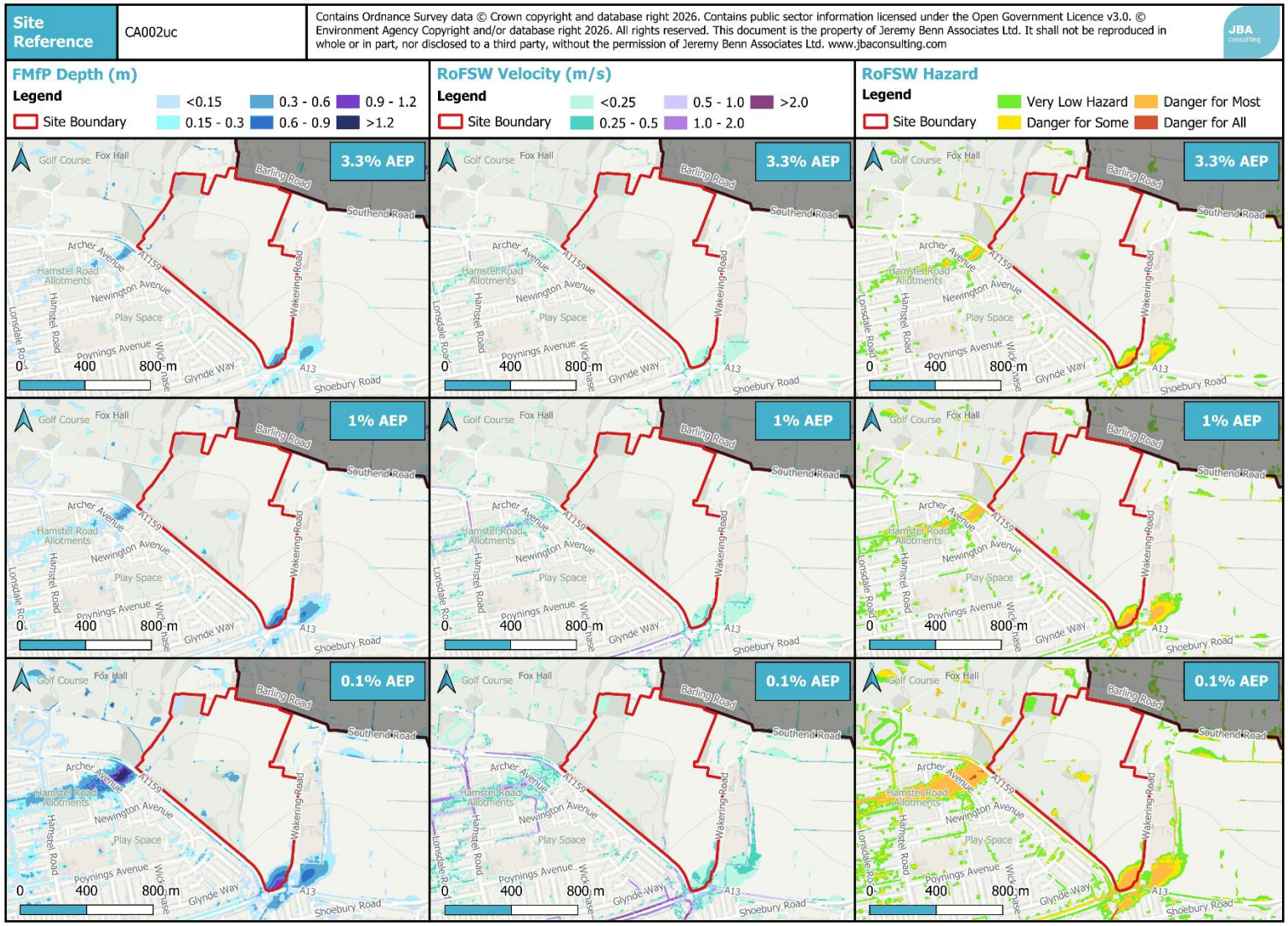


Figure 2-12: Present day surface water risk to CA002uc in the 3.3%, 1%, and 0.1% AEP events.

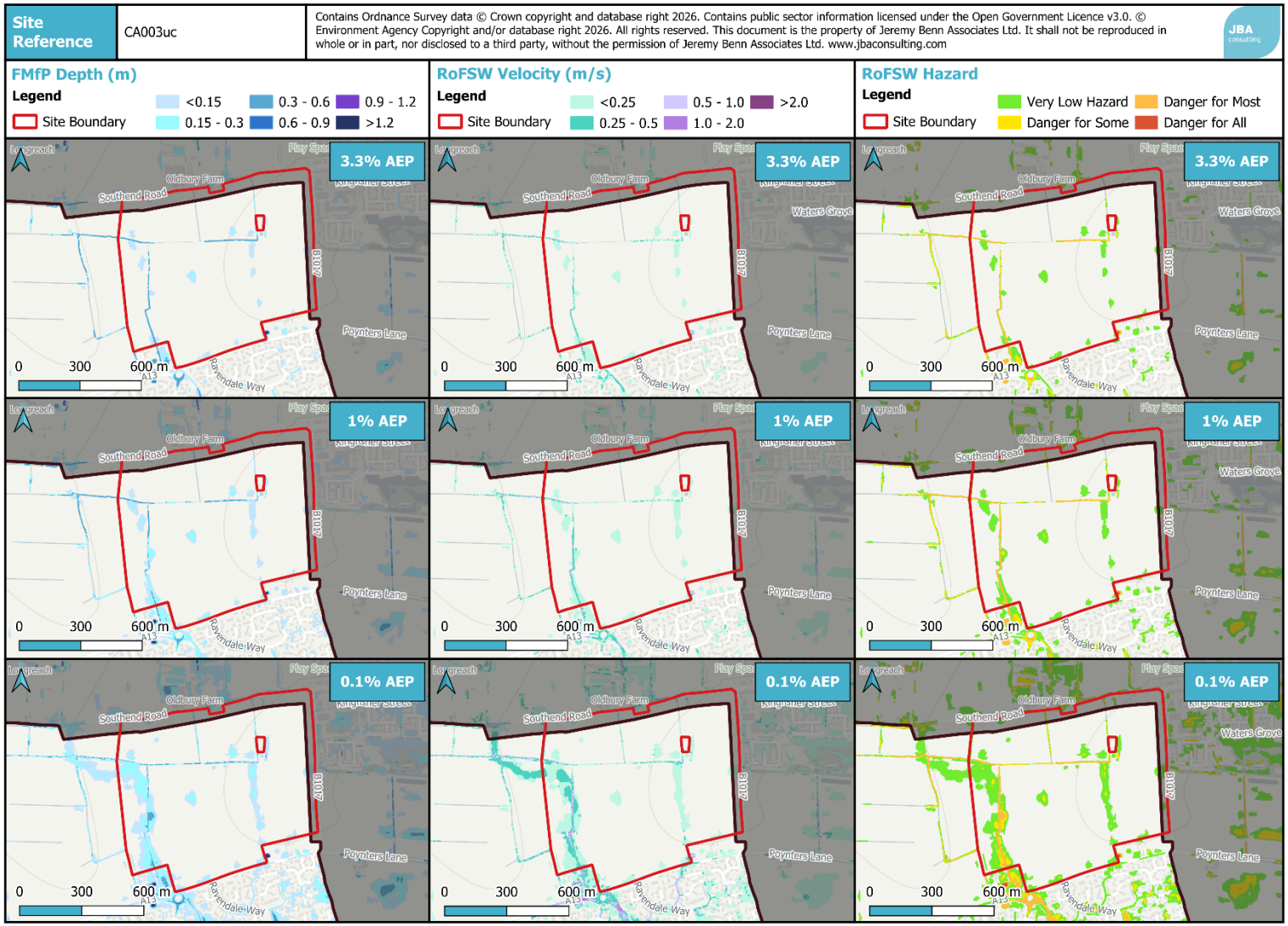


Figure 2-13: Present day surface water risk to CA003uc in the 3.3%, 1%, and 0.1% AEP events.

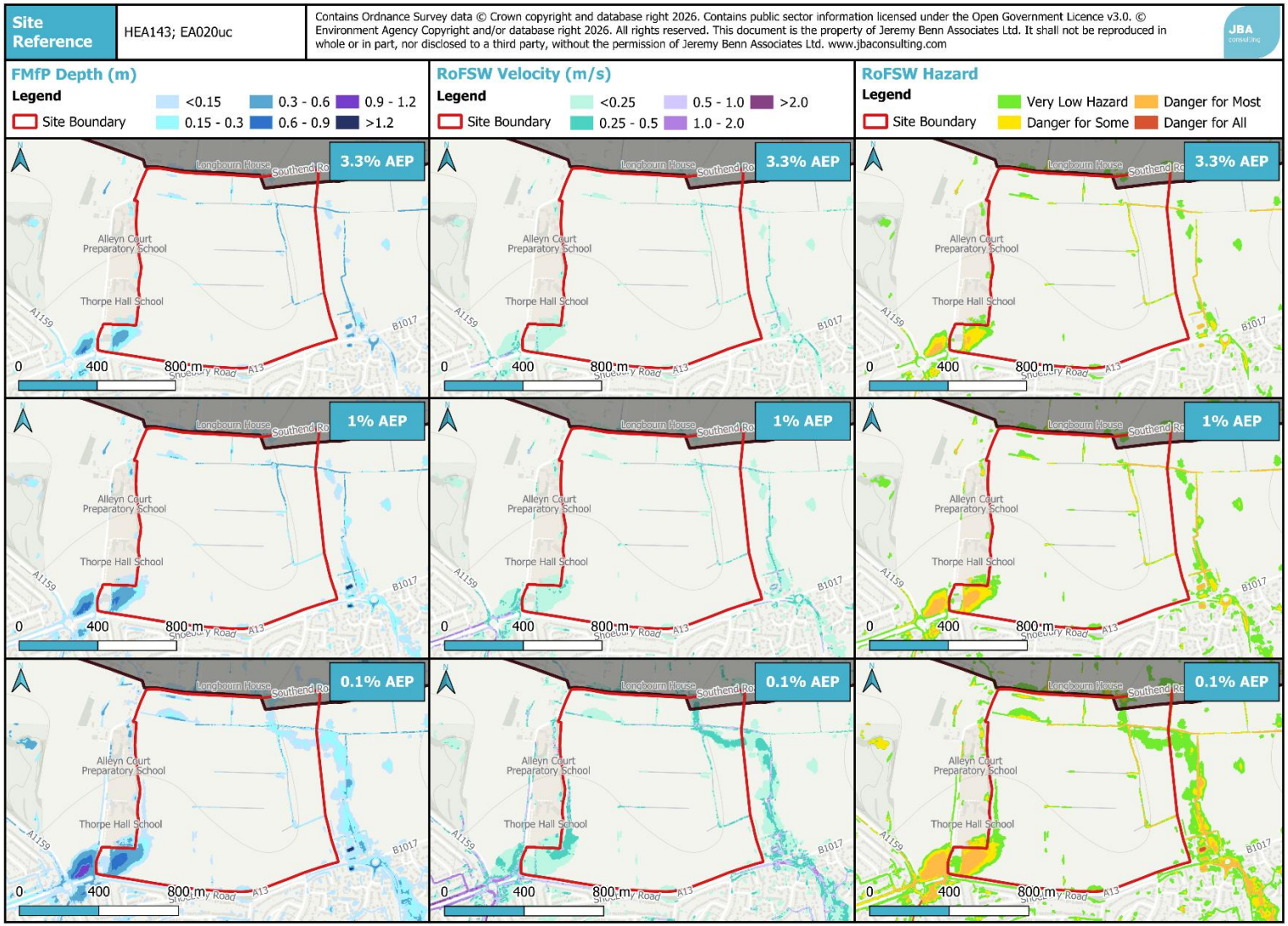


Figure 2-14: Present day surface water risk to HEA143; EA020uc in the 3.3%, 1%, and 0.1% AEP events.

2.4.3 Climate change - 2070s Upper End

All sites are shown to be at increased risk of surface water flooding with climate change. The extents and depths for each site are shown in Figure 2-15, Figure 2-16, Figure 2-17, and Figure 2-18.

Between the 3.3% AEP present day and climate change events, the existing extents increase slightly and there are a few new areas ponding, particularly in CA001uc. Maximum depths increase to between 0.9m and 1.2m in the southeast of CA002uc and southwest of HEA143; EA020uc. There are several areas where depths are between 0.3m and 0.6m, such as in the drainage ditches in CA003uc and isolated ponding in CA001uc.

As shown in Table 2-3, between the 1% AEP present day and climate change events, the percentage of the sites at risk doubles from 3% to 6%. This increase in risk is seen particularly around the flow path in the west of CA003uc, and around the areas of ponding in CA001uc. The maximum depths increase from between 0.9m and 1.2m, to between 1.2m to 2.3m. These depths are found in an area of isolated ponding in the south of CA001uc.

In the 0.1% AEP climate change scenario, maximum depths remain between 1.2m and 2.3m as in the present day. Most of the extents increase slightly in size, with the largest increases found around the two flow paths in CA003uc and the ponding CA002uc and southwest of HEA143; EA020uc.

Table 2-3: Comparison of surface water flood risk between the present day and climate change scenarios based on the EA's FMfP Surface Water Spatial Planning.

Event	1% AEP	1% AEP plus 2070s Upper End Climate Change
Percentage of sites at risk* (%)	3	6
Maximum depth (m)	0.9 - 1.2	1.2 - 2.3

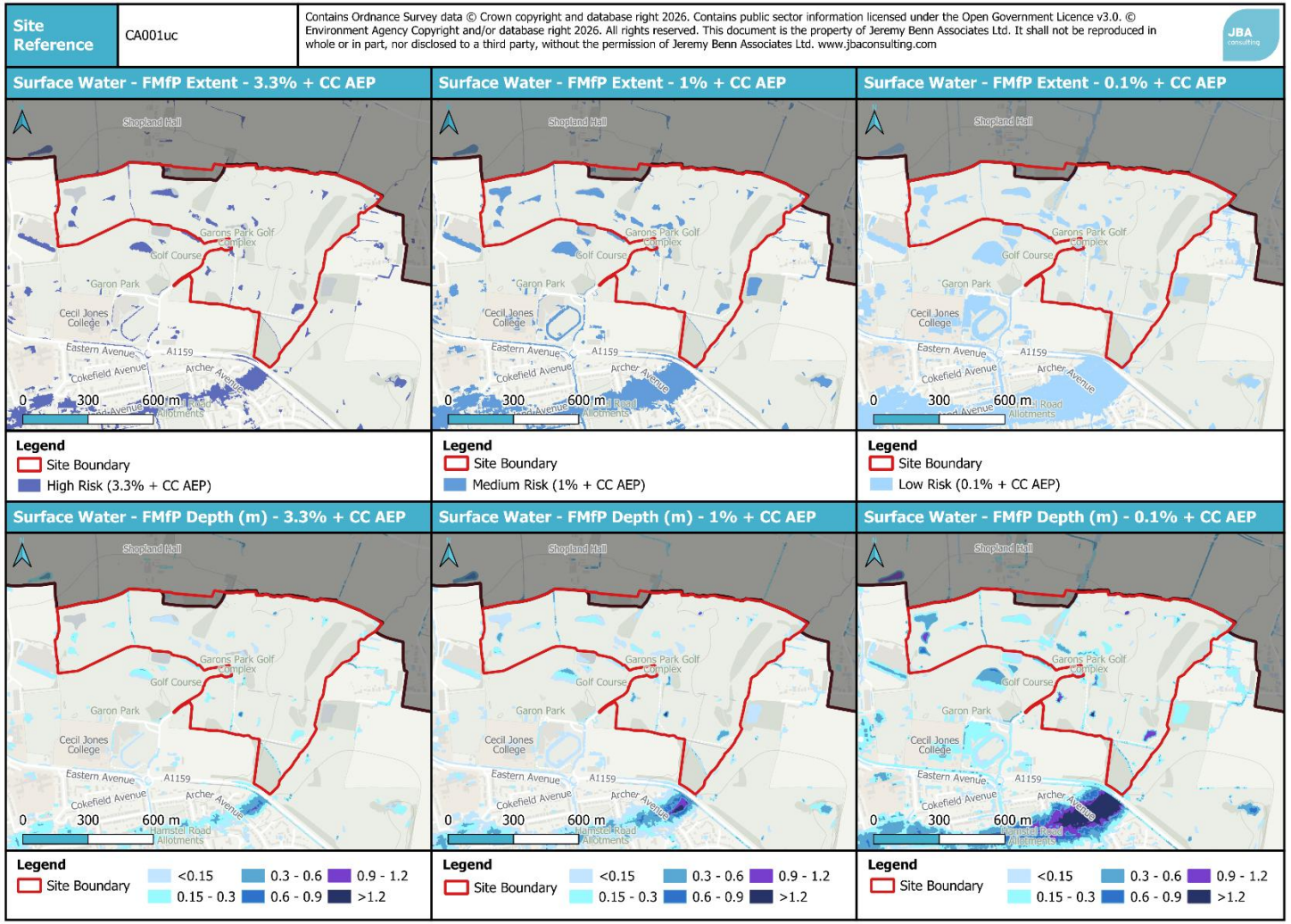


Figure 2-15: Extents and depths of surface water risk to CA001uc in the 3.3%, 1%, and 0.1% AEP Upper End climate change scenarios.

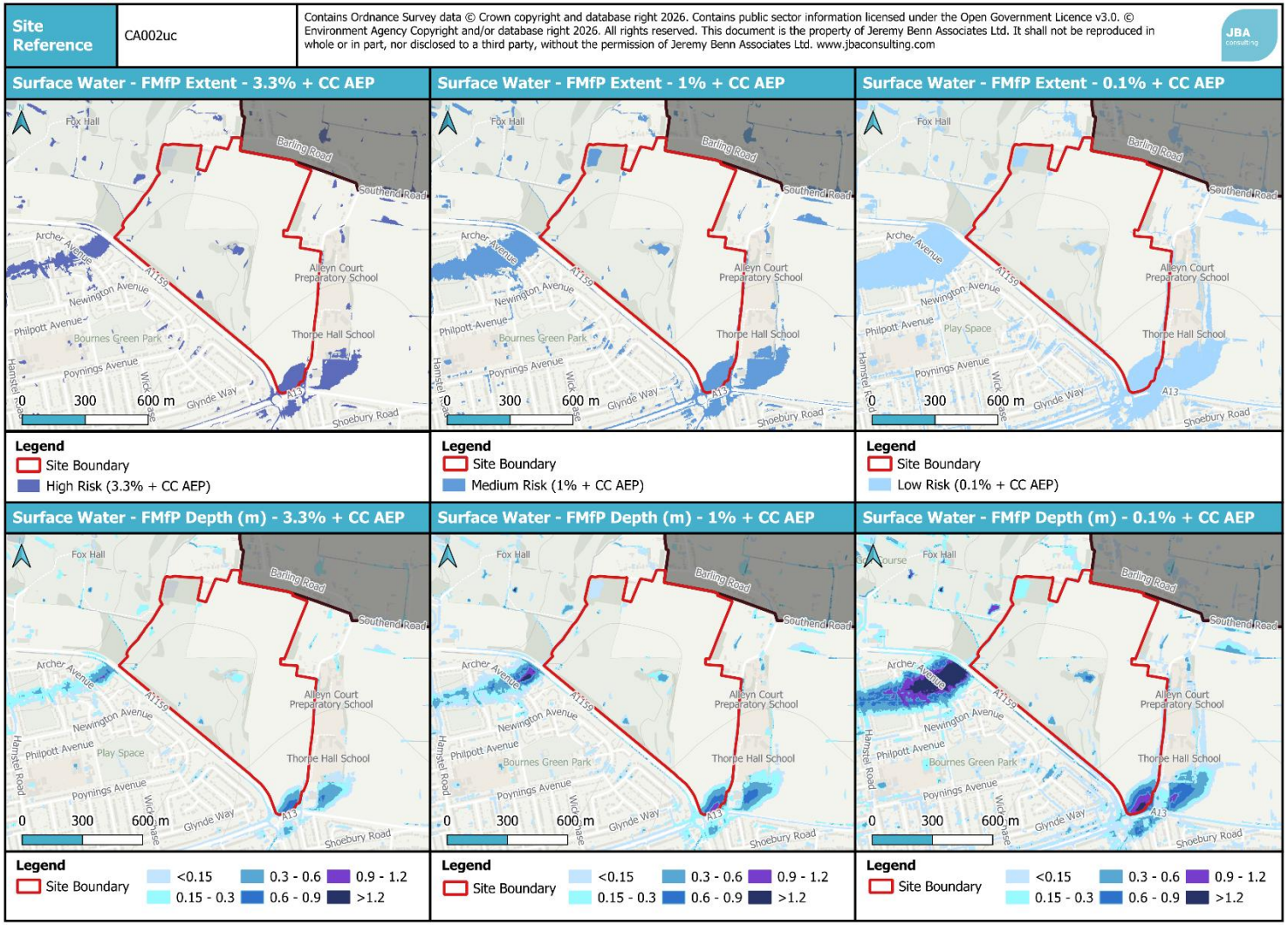


Figure 2-16: Extents and depths of surface water risk to CA002uc in the 3.3%, 1%, and 0.1% AEP Upper End climate change scenarios.

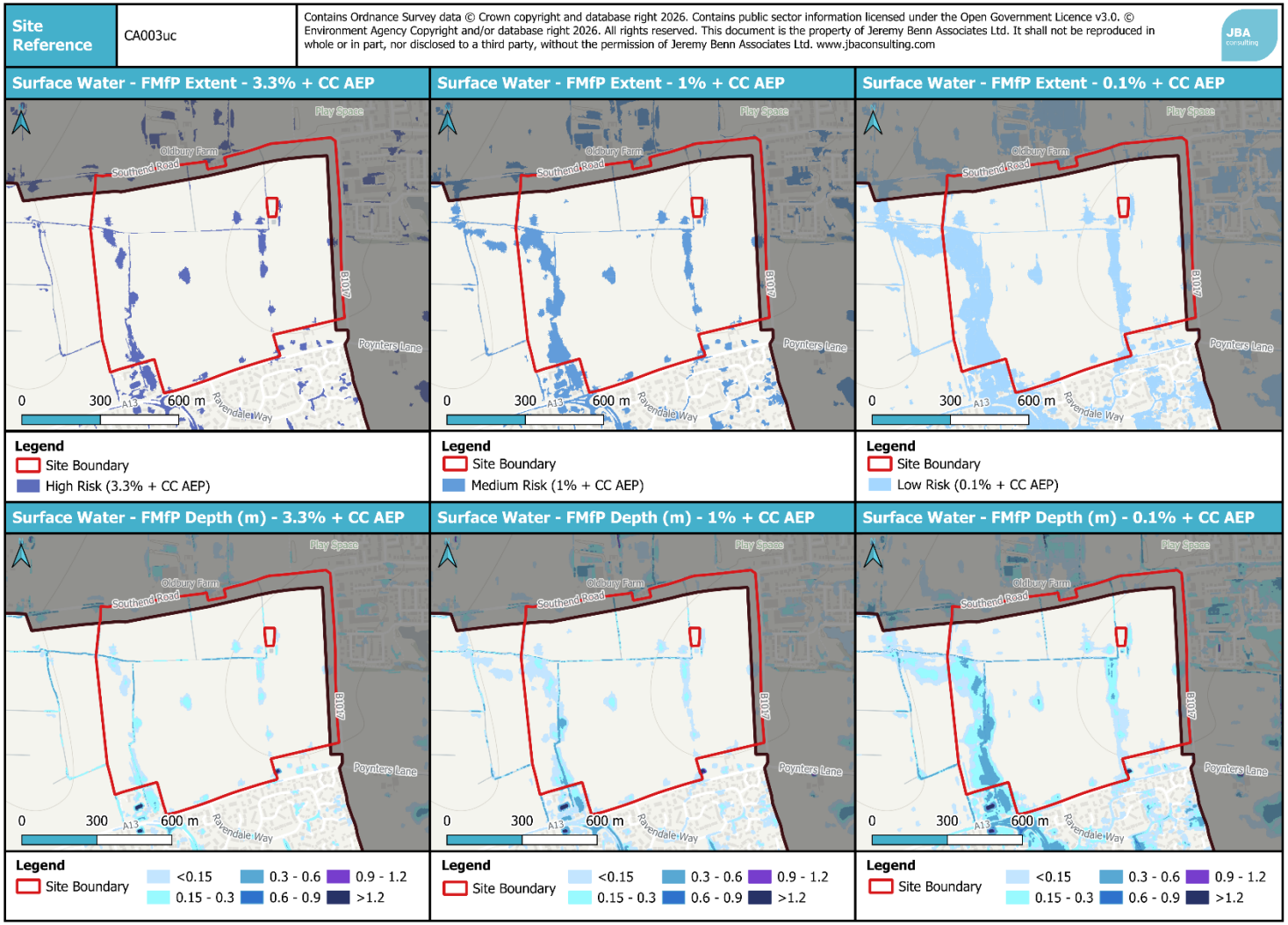


Figure 2-17: Extents and depths of surface water risk to CA003uc in the 3.3%, 1%, and 0.1% AEP Upper End climate change scenarios.

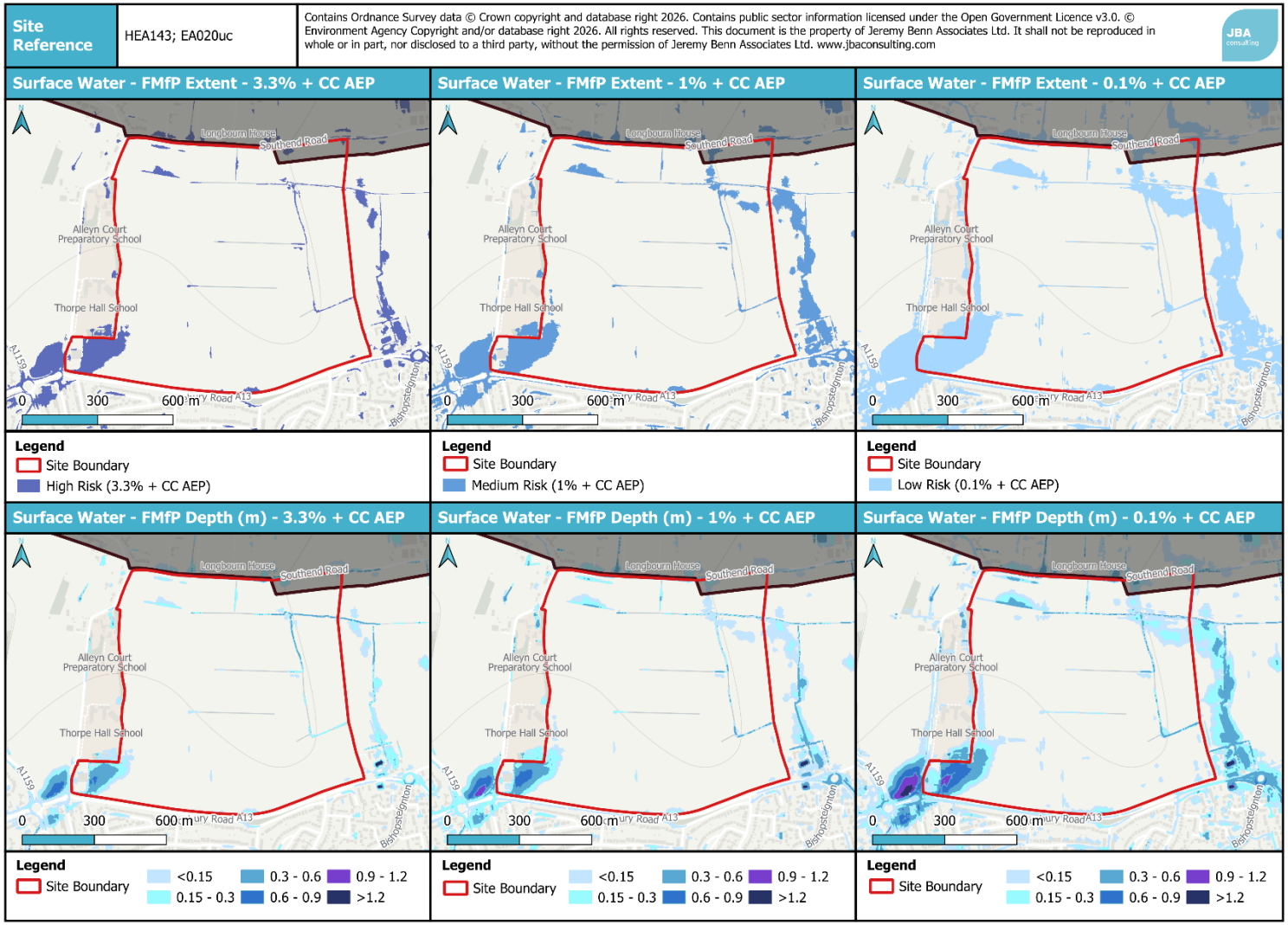


Figure 2-18: Extents and depths of surface water risk to HEA143; EA020uc in the 3.3%, 1%, and 0.1% AEP Upper End climate change scenarios.

2.5 Groundwater

The JBA Groundwater Emergence Map, mapped in Figure 2-19, shows that groundwater levels are between 0.025m and 0.5m below the ground surface in the western half of CA001uc, and the southwest of CA002uc. In these areas there is a risk of groundwater flooding to both surface and subsurface assets. There is also the possibility of groundwater emerging at the surface locally. In the westernmost area of CA001uc, groundwater levels are between 0.5m and 5m below the ground surface. Here there is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.

Based on the surface water mapping and topography of the site, it is likely that any groundwater that emerges will flow towards the north or collect within the existing ponds located across CA001uc and CA002uc.

The JBA Groundwater Emergence Map shows that CA003uc and HEA143; EA020uc have a negligible risk from groundwater flooding due to the nature of the local geological deposits.

This assessment does not negate the requirement that an appropriate assessment of the groundwater regime should be carried out at the site-specific Flood Risk Assessment (FRA) stage.

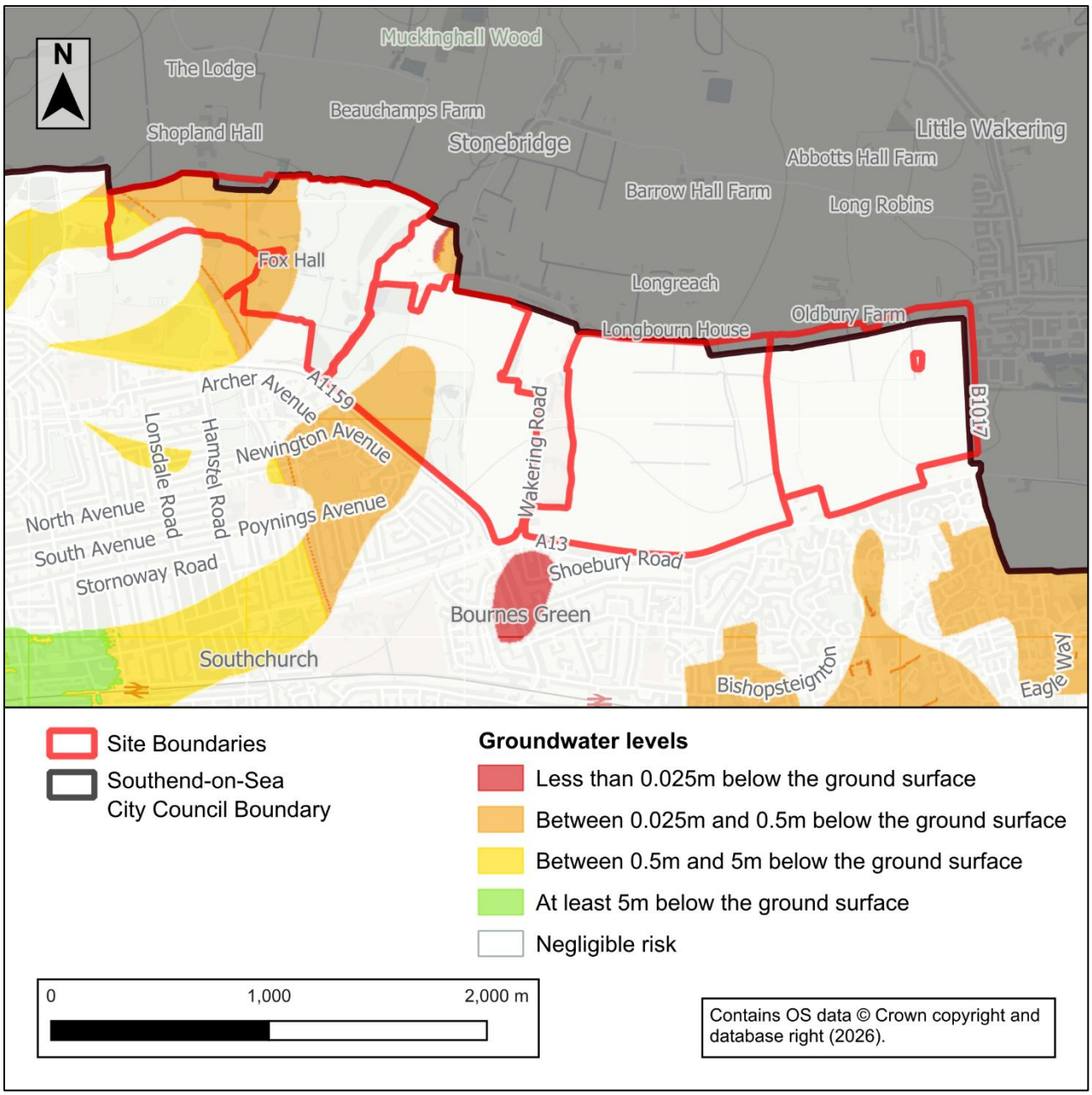


Figure 2-19: Groundwater levels across the sites.

2.6 Sewers

Anglian Water provided a redacted GDPR compliant version of their DG5 dataset for the study area, which identifies internal and external historic sewer flooding records between 2022 and 2026.

There are no records within any of the sites. However, the following incidents were reported in close proximity of the sites:

- Four incidents of external sewer flooding in the residential area south of Poynters Lane around Churchfields, south of CA003uc.
- Two incidents of external sewer flooding by Barling Road, north of CA002uc, in Rochford District.
- Four incidents of external sewer flooding south of CA002uc, one on Locksley Close and three along Newington Avenue.

The available data should always be supplemented by direct consultation with Anglian Water to ascertain if there is any site-specific risk from a public sewer. This is because sewer flood risk information is not publicly available and would need to be considered on a site-specific basis.

2.7 Flood history

The EA's Historic Flood Map shows no records of flooding at the sites.

Data provided by Essex County Fire and Rescue Service shows no records of flooding at the sites.

3 Flood risk management infrastructure

3.1 Defences

The EA AIMS dataset shows that CA002c and HEA143; EA020uc are protected by a coastal flood wall along Eastern Esplanade, approximately 2km to the south. The flood wall is privately owned and is designed to provide protection against a 0.1% AEP tidal event.

As discussed in Sections 2.3.3 and 2.3.4, detailed hydraulic modelling shows the sites are not at risk in the present day defended and undefended scenarios. The sites are protected from flood risk in the defended 3.3% and 0.5% AEP Higher Central events, and the 3.3% AEP Upper End scenario.

3.2 Residual risk

Breach modelling has been carried out for the 3.3%, 1%, and 0.1% AEP events for present day and climate change scenarios for the higher central and upper end scenarios for the 2126 epoch. Three breach scenarios were considered. Details of the breaches are provided in Appendix D.

CA001uc and CA003uc are not at residual risk from tidal flooding. CA002uc and HEA143; EA020uc are shown to be impacted in all three breaches, during most modelled scenarios except for: 3.3%, 1%, and 0.1% present day events, any 3.3% AEP climate change scenarios, or the 0.5% AEP Higher Central event.

Table 3-1 and Table 3-2 provide the approximate rate of onset (time between the breach and the first flooding experienced at the site) and the maximum duration of the flooding at CA002uc and HEA143; EA020uc respectively.

Breach one

For CA002uc and HEA143; EA020uc, in the 0.5% AEP upper end and 0.1% AEP higher central climate change scenarios, there is a lead time between 15 and 16 hours. This provides a reasonable warning time, and the sites have a maximum flooding duration between 30 and 31 hours. The 0.1% AEP event has a slightly shorter lead time of approximately 14 hours and has a slightly longer maximum duration of up to between 32 and 33 hours.

Breach two

For CA002uc and HEA143; EA020uc, in the 0.5% AEP upper end and 0.1% AEP higher central climate change scenarios, there is a lead time between 13 and 14 hours. This is similar to breach one and provides a reasonable warning time. For these two scenarios, the sites have a maximum flooding duration of up to around 30 to 31 hours. The 0.1% AEP event has a slightly shorter lead time of approximately 12 hours and has a slightly longer maximum duration of up to between 32 and 33 hours.

Breach three

For CA002uc and HEA143; EA020uc, in the 0.5% AEP upper end and 0.1% AEP higher central climate change scenarios, there is a lead time between 13 and 14 hours. This is similar to breach one and two, providing a reasonable warning time. For these two scenarios, the sites have a maximum flooding duration of up to 31 hours. The 0.1% AEP event has a much shorter lead time of 2 hours and has a slightly longer maximum duration of up to 42 hours

Table 3-1: Maximum depth, velocity, hazard, and rate of onset and duration of flooding for each breach scenario where CA002uc is shown to be at risk of tidal flooding.

Breach	Event	Maximum depth (m) (2dp)	Maximum velocity (m/s) (2dp)	Maximum hazard (2dp)	Rate of onset (hours) (1dp)	Maximum flooding duration (hours) (1dp)
1	0.5% AEP Upper End CC	1.16	0.80	1.62	15.6	30.4
1	0.1% AEP Higher Central CC	1.43	1.26	1.89	15.1	30.9
1	0.1% AEP Upper End CC	1.98	0.73	2.13	13.5	32.7
2	0.5% AEP Upper End CC	1.16	0.80	1.62	13.8	30.4
2	0.1% AEP Higher Central CC	1.43	1.26	1.89	13.1	30.9
2	0.1% AEP Upper End CC	1.98	0.73	2.13	11.8	32.7
3	0.5% AEP Upper End CC	1.35	1.21	1.85	13.8	30.7
3	0.1% AEP Higher Central CC	1.48	1.25	1.92	13.1	31.1
3	0.1% AEP Upper End CC	1.98	0.79	2.14	2.6	42.1

Table 3-2: Maximum depth, velocity, hazard, and rate of onset and duration of flooding for each breach scenario where HEA143; EA020uc is shown to be at risk of tidal flooding.

Breach	Event	Maximum depth (m) (2dp)	Maximum velocity (m/s) (2dp)	Maximum hazard (2dp)	Rate of onset (hours) (1dp)	Maximum flooding duration (hours) (1dp)
1	0.5% AEP Upper End CC	0.54	0.87	1.60	15.6	30.4
1	0.1% AEP Higher Central CC	0.90	1.09	1.86	15.2	30.8
1	0.1% AEP Upper End CC	1.54	1.26	2.23	13.9	32.3
2	0.5% AEP Upper End CC	0.54	0.87	1.60	13.9	30.4
2	0.1% AEP Higher Central CC	0.90	1.09	1.86	13.2	30.8
2	0.1% AEP Upper End CC	1.54	1.26	2.23	12.1	32.3
3	0.5% AEP Upper End CC	0.73	1.05	1.83	13.8	30.7
3	0.1% AEP Higher Central CC	0.98	1.19	1.96	13.2	31.0
3	0.1% AEP Upper End CC	1.54	1.33	2.26	2.8	41.9

4 Emergency planning

4.1 Flood warnings and alerts

The sites are not located in an EA Flood Warning or Flood Alert Area.

4.2 Access and escape

Safe access and escape will need to be demonstrated in the 1% AEP plus climate change fluvial and surface water events and the 0.5% AEP plus climate change tidal event. Site drainage proposals should address the requirements for access routes, avoid impeding surface water flows and preserve the storage of surface water to avoid exacerbation of flood risk elsewhere on the site and in the wider catchment.

4.2.1 Potential access

- **CA001uc:** The site is accessible via a road that travels northwards to the central southern boundary from the Eastern Avenue/Royal Artillery Way roundabout (A1159). Royal Artillery Way (A1159) also runs parallel to the southeastern most part of the site boundary.
- **CA002uc:** Royal Artillery Way (A1159) runs along the southwestern boundary for just over 1km before reaching Bournes Green roundabout, where it transitions into Wakering Road and continues north along the eastern boundary. Access to the northern section of the site is possible via Rebels Lane.
- **CA003uc:** The site is bordered by three roads, Poynters Lane (B1017) to the south, Star Lane (B1017) to the east, and Southend Road to the north.
- **HEA143; EA020uc:** Bournes Green Chase borders the south of the site, and Southend Road borders the north. The northwest of the site can also be accessed via Wakering Road.

4.2.2 Fluvial

Access and escape are likely possible for all sites in all modelled fluvial events.

Flood Zones 2 and 3a cover parts of the Bournes Green Roundabout and some of the joining roads. This should be considered, particularly for CA001uc and CA002uc, as Royal Artillery Way is a dual carriageway and the lanes closest to the sites travel southeast towards the Bournes Green Roundabout. The 1% AEP plus climate change extents by the roundabout are from the sea and are considered in Section 4.2.3.

Additionally, if travelling north, all modelled events cover part of the road in Stonebridge by the Shopland Road and Barling Road junction.

Aside from these areas of risk, the access routes to and from the sites remain clear.

4.2.3 Tidal

Access and escape are likely possible for all sites in all modelled fluvial events.

The tidal flood risk closest to the sites impacts parts of the Bournes Green Roundabout and some of the joining roads. In the 1% AEP plus climate change tidal event, depths here exceed 1.0m. Similar to the fluvial events, this should be considered, particularly for CA001uc and CA002uc, because Royal Artillery Way is a dual carriageway and the lanes closest to the sites travel southeast towards the Bournes Green Roundabout. The other access and escape routes to the sites remain clear.

4.2.4 Surface water

Access and escape are likely possible for all sites in all modelled surface events.

In all modelled events, there are several areas of ponding on the access roads. However, depths only exceed 0.3m in in a few areas and it is still possible to access and escape the sites. There is small area of ponding on Royal Artillery Way with depths above 0.3m, directly south of CA001uc, as well as by Bournes Green Chase and Poynters Lane roundabout. South of this roundabout, while not an essential access route, there is a large flow path covering much of North Shoebury Roady (A13).

In the 1% AEP event, depths are above 0.3m in a small area on the south of Wakering Road. This area of risk extends to cover part of the Bournes Green Roundabout in the 1% AEP plus climate change and 0.1% AEP events.

Aside from these areas of risk, the access routes to and from the sites should be possible. Star Lane (B1017) in the east and most of the access roads north of the sites are clear. Depths are mostly below 0.3m on the southern roads closest to the sites.

4.3 Dry islands

The sites are not located on a dry island.

5 Requirements for drainage control and impact mitigation

5.1 Topography and drainage conditions

As part of this New Neighbourhood Assessment a drainage assessment has been undertaken. This looks at how each of the sites drains currently and makes recommendations for drainage of the new neighbourhood.

5.1.1 CA001uc

Numerous ponds associated with the current use of the site as a golf course are present within the site.

The western part of the site slopes in a northerly direction from approximately 28.7mAOD along the southern boundary to approximately 19.4mAOD along the northern boundary. It drains via a combination of infiltration to the ground and overland flow, via a network of field drains, towards an unnamed tributary of Paglesham Reach.

The eastern part of the site slopes in a north-easterly direction from approximately 25.8mAOD in the south to approximately 11.5mAOD in the north-eastern corner. It drains via a combination of infiltration to the ground and overland flow towards Mucking Hall Brook bounding the site to the east, a tributary of Paglesham Reach.

The current flow paths are shown indicatively in Figure 5-1.

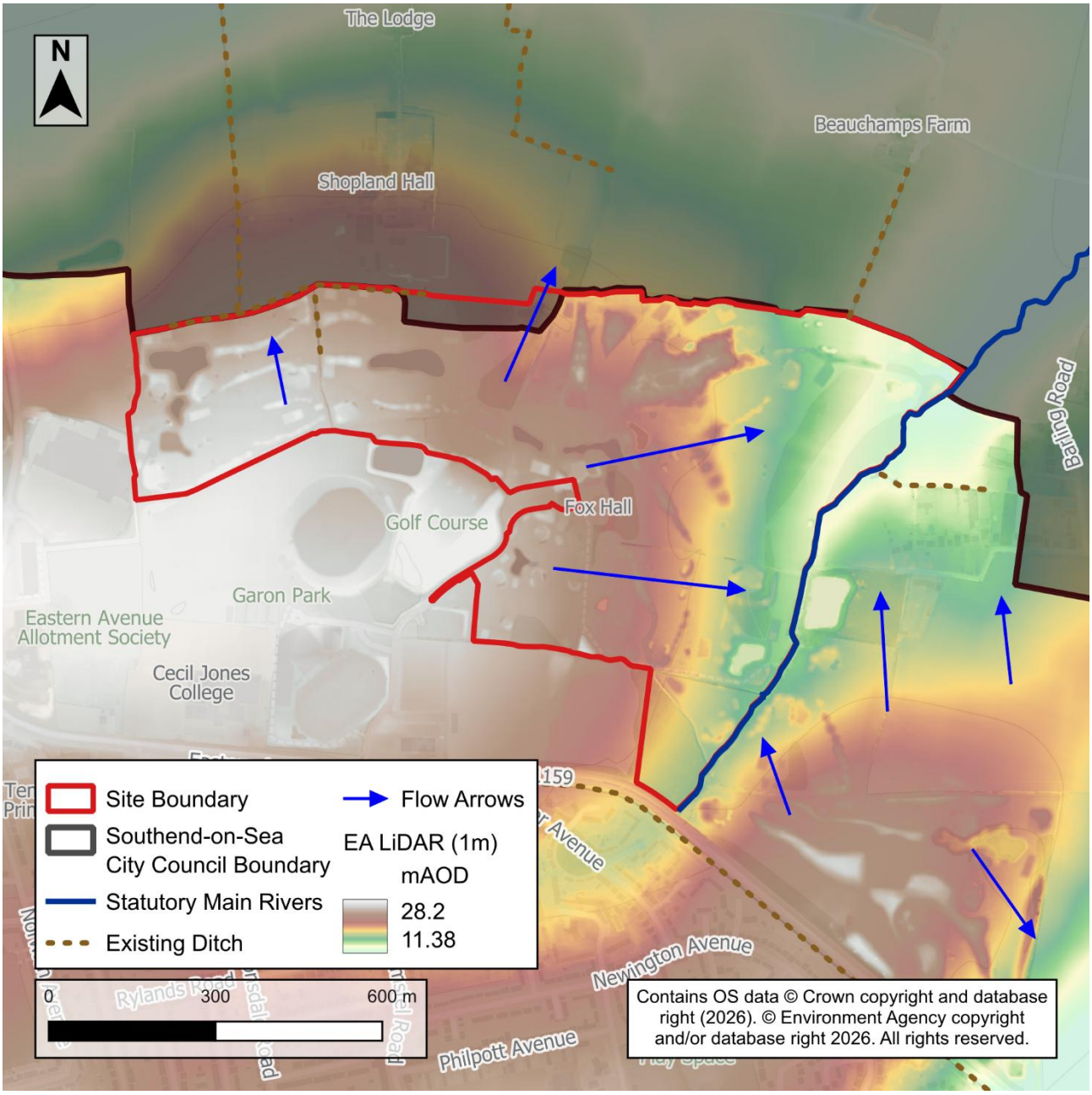


Figure 5-1: CA001uc drainage flow paths.

5.1.2 CA002uc

The site is partially used as a golf course and partially in agricultural use.

The north-western part of the site slopes in a north-westerly direction from approximately 24.00mAOD along the southern boundary to approximately 15.0mAOD in the north-western corner. It drains via a combination of infiltration to the ground and overland flow towards Mucking Hall Brook.

The south-eastern part of the site slopes in a south-easterly direction from approximately 26.0mAOD in the south to approximately 4.9mAOD in the south-eastern corner. It drains via a combination of infiltration to the ground and overland flow towards an unnamed

watercourse discharging to Southend Flat. The recorded start of the watercourse is immediately south of A1159/Bournes Green Chase. It is uncertain however how far upstream it is culverted and if any of the culvert extents are within the site boundary. A CCTV survey confirming connectivity of existing land drains with the watercourse would need to be undertaken prior to making any post-development runoff discharges.

The current flow paths are shown indicatively on Figure 5-2.

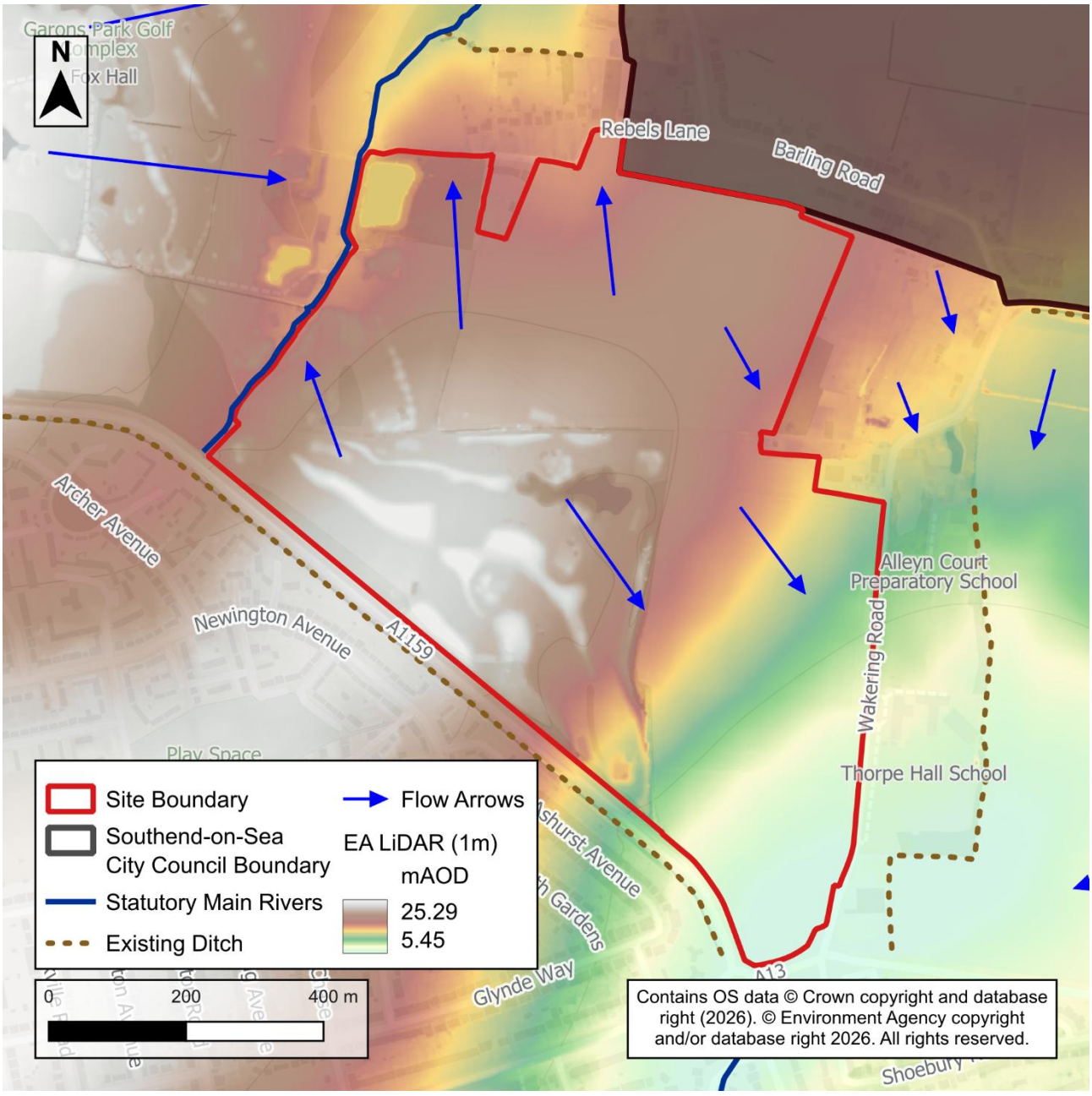


Figure 5-2: CA002uc drainage flow paths.

5.1.3 CA003uc

The site is currently in agricultural use.

A small portion of the northern part of the site (at levels between approximately 10.5mAOD and 9.7mAOD) drains in a northerly direction towards ditches present along Southend Road. The runoff is then conveyed towards Little Wakering Creek.

A narrow strip of the eastern part of the site drains to a ditch along Star Lane.

The western part of the site then slopes in a westerly direction from approximately 10.6mAOD in the centre of the site to approximately 8.0mAOD in the south-west. It drains via a combination of infiltration to the ground and an overland flow towards a land drain culminating within lower lying area immediately to the north of Bournes Green Chase/ Poynters Lane (B1017). This area lies within the catchment of unnamed watercourse discharging at Shoebury Common Beach. However, the connectivity between the land drains and the watercourse is currently uncertain.

The eastern part of the site slopes towards a depression in the centre of that area. It drains via a combination of infiltration to the ground and an overland flow towards the said depression running from north to south. There is no indication on the LiDAR dataset of any field drains at that location; it is therefore uncertain if there are any formal outfalls from that area, and where would those be located and discharged.

CCTV surveys to confirm the physical connectivity of the land drains and watercourses would need to be undertaken prior to any post-development runoff discharges taking place. If no formal outfalls are available these will not be suitable discharge environments for the post-development runoff.

The current flow paths are shown indicatively on Figure 5-3.

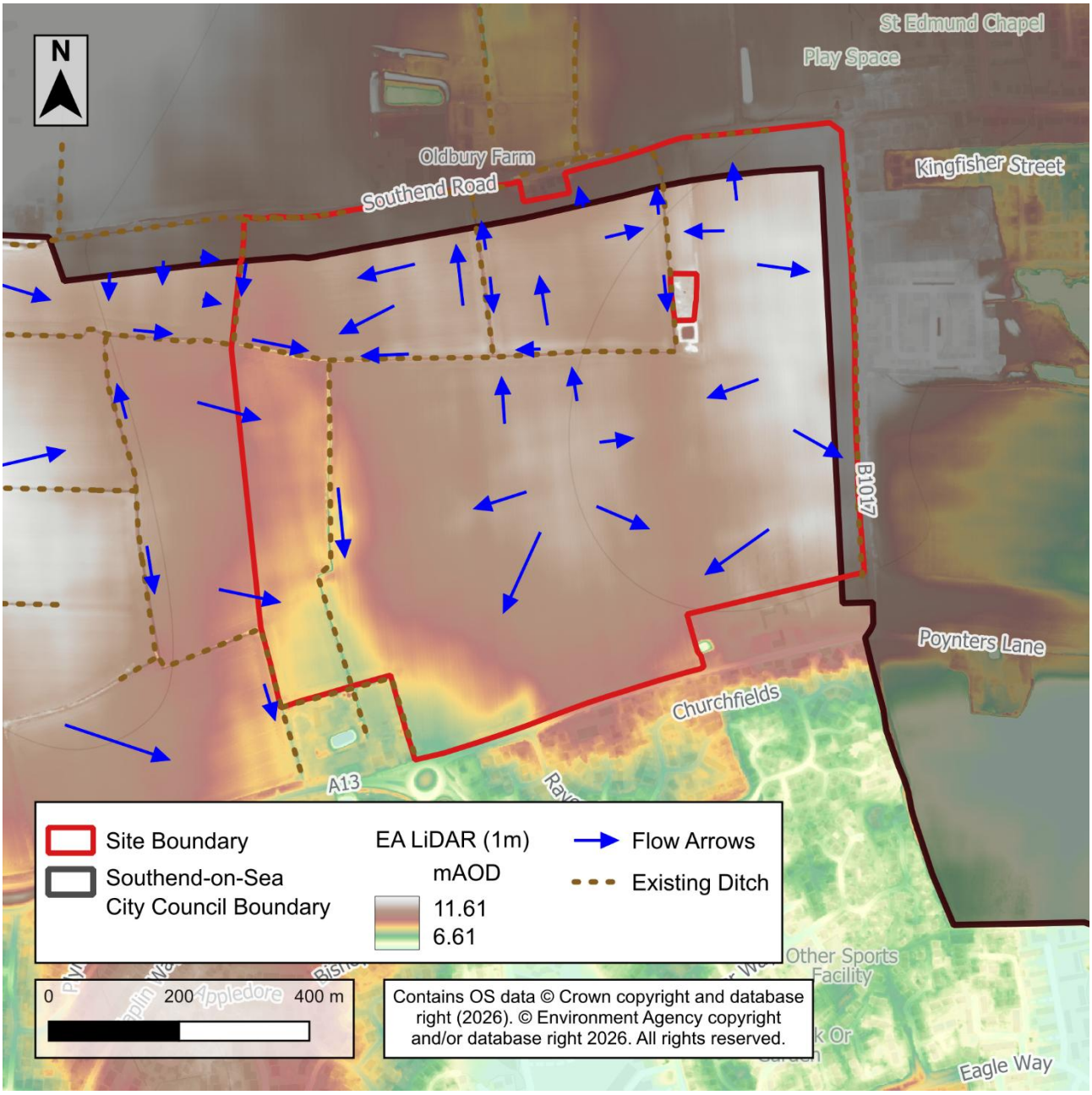


Figure 5-3: CA003uc drainage flow paths.

5.1.4 HEA143; EA020uc

The site is currently in agricultural use.

The western part of the site slopes in a south-westerly direction from approximately 12.4mAOD in the north to approximately 5.0mAOD in the south-west. It drains via a combination of infiltration to the ground and overland flow towards land drain seemingly leading to an unnamed watercourse discharging to Southend Flat, although physical connectivity is not evident from the publicly available information.

The recorded start of the watercourse is immediately south of A1159/Bournes Green Chase. It is uncertain however how far upstream it is culverted.

The eastern part the site slopes in an easterly direction from approximately 12.4mAOD in the north to approximately 8.8mAOD in the south-east. It drains via a combination of infiltration to the ground and overland flow towards a network of land drains culminating within lower lying area immediately to the north of Bournes Green Chase/Poynters Lane (B1017). This area lies within the catchment of unnamed watercourse discharging at Shoebury Common Beach. However, the connectivity between the land drains and the watercourse is currently uncertain. CCTV surveys to confirm the physical connectivity between land drains and watercourses would need to be undertaken prior to any post-development runoff discharges to the existing land drains.

The current flow paths are shown indicatively on Figure 5-4.

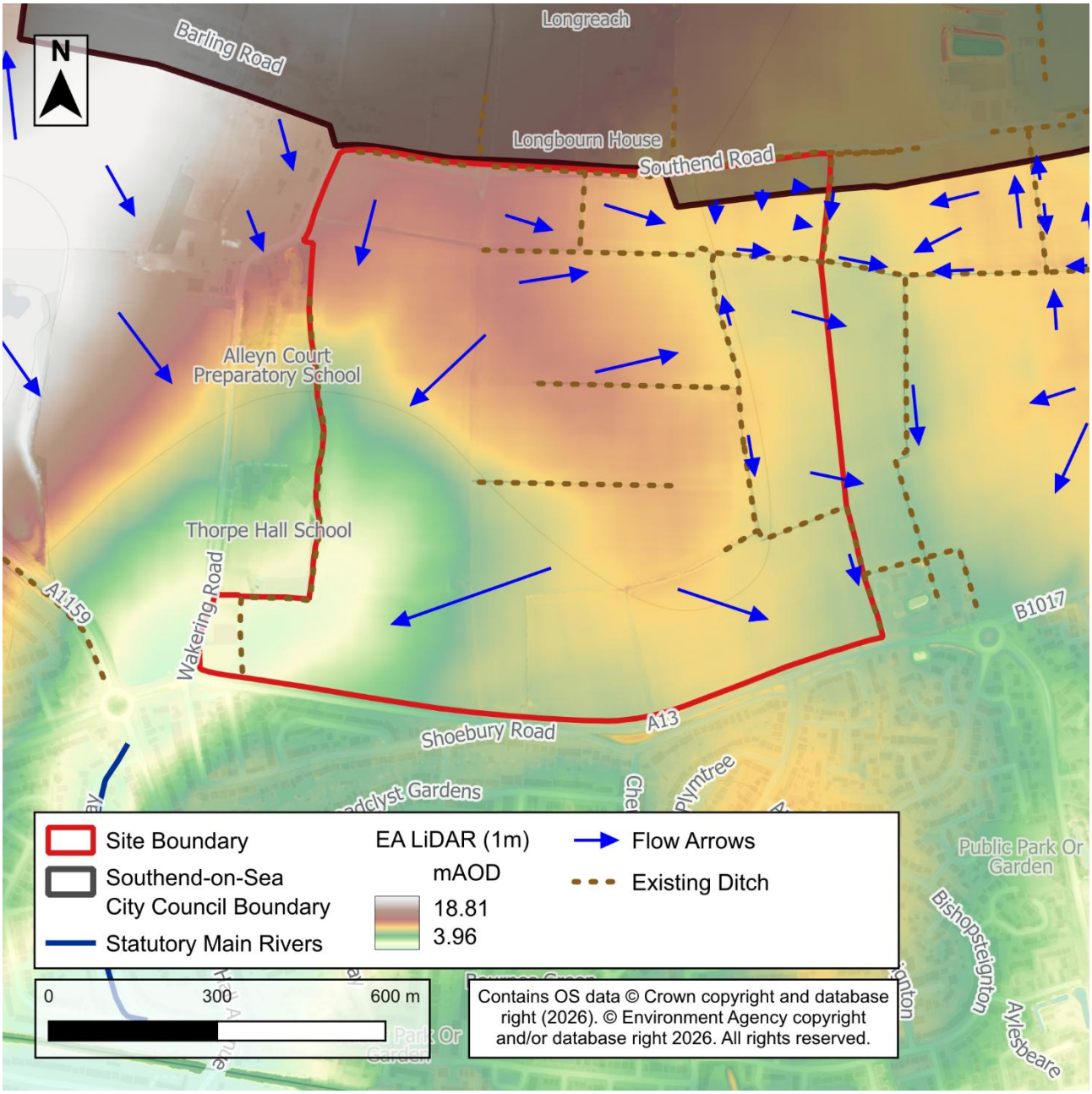


Figure 5-4: HEA143; EA020uc drainage flow paths.

5.2 Broadscale assessment of possible SuDS

Surface water at the sites should be discharged in accordance with the drainage hierarchy as set out in the National standards for SuDS (gov.uk). SuDS that provide opportunities to deliver multiple benefits including volume control, water quality, amenity, and biodiversity should be prioritised. SuDS proposals should be discussed with relevant stakeholders (Local Planning Authority (LPA), Lead Local Flood Authority (LLFA), and the EA) at an early stage to understand possible constraints.

Surface water discharge rates should not exceed the existing greenfield runoff rates for the site. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA.

CA001uc is located within the Temple Sutton Critical Drainage Area (CDA). CA002uc is located in both the Temple Sutton and Southchurch CDAs. HEA143; EA020uc is situated within the Southchurch and Shoebury CDAs, and CA003uc in the Shoebury CDA. The CDAs currently designated were identified in the Southend-on-Sea SWMP 2015 (southend.gov.uk). Any development within these CDAs will need to demonstrate an adequate surface water drainage system which is maintainable for the lifetime of the development within a site-specific FRA. Developers will need to provide details of the long term maintenance of the surface water drainage system. Developers should collaborate with the LLFA to identify all sources of flood risk, help reduce risk to existing communities, and explore grant funding opportunities for these wider improvements. Furthermore, growth allocations should take CDAs into account when assessing site suitability for development, ensuring that flood risk is properly managed and mitigated during planning.

Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting must be considered in the design of the sites.

The potential to utilise conveyance features such as swales to intercept and convey surface water runoff should be considered. Conveyance features should be located on common land or public open space to facilitate ease of access. Where slopes are >5%, features should follow contours or utilise check dams to slow flows.

The following factors should be considered when assessing whether infiltration is suitable at the sites:

- In CA001uc and CA002uc, groundwater levels are indicated to be less than 0.5m below ground level during a 1% AEP event. Detention and attenuation features should be designed to prevent groundwater ingress from impacting hydraulic capacity and structural integrity. Additional site investigation work may be required to support the detailed design of the drainage system. This may include groundwater monitoring to demonstrate that a sufficient unsaturated zone has been provided above the highest occurring groundwater level. Below ground development such as basements are not appropriate in these areas of the sites.
- CA003uc and HEA143; EA020uc are not considered to be susceptible to groundwater flooding, due to the nature of the local geological conditions. This should be confirmed through additional site investigation work.

- BGS data indicates that the underlying geology is clay, silt, and sand, which is likely to have highly variable permeability. This should be confirmed through infiltration testing. Off-site discharge in accordance with the SuDS hierarchy may be required to discharge surface water runoff from the site.
- The sites are not located within a Groundwater Source Protection Zone and there are no restrictions over the use of infiltration techniques with regard to groundwater quality.
- The sites are not located within a historic landfill site.

If it is proposed to discharge runoff to a watercourse or sewer system, the condition and capacity or the receiving watercourse or asset should be confirmed through surveys and the discharge rate agreed with the asset owner.

The flow path in CA003uc, as well as existing ponds and Mucking Hall Brook, should be integrated into the site drainage strategy as blue-green infrastructure and public open space.

5.3 Post-development surface water runoff management recommendations

The following points should be considered within the site design to manage surface water and drainage within the new neighbourhood:

- Future surface water drainage strategies / designs should account for the requirements of the National Standards (England) for SuDS, 2025 (or any updated versions available) and any local guidance, if stricter.
- CCTV surveys should be undertaken to confirm the physical connectivity of existing culverts, land drains, and receiving watercourses.
- Priority should be given to rainwater re-use and groundwater recharge via infiltration, where possible.
- The runoff interception should be provided through source controls and creation of blue-green corridors across the development sites. The ‘end of pipe’ pond solution will not be considered compliant with the National Standards.
- Existing topographic flow paths and depressions should be considered, and if practicable, retained within design to closely mimic the natural drainage patterns. Any impact on existing drainage patterns due to land regrading and introduction of hardstanding will need to be assessed and appropriate measures provided to mitigate the risk of increased flood risk elsewhere.
- Drainage designs should respect natural catchments, as far as practicable, to avoid transporting additional water between catchments. If this is unavoidable, appropriate assessment and mitigation measures will be required to demonstrate there is no adverse impact on flood risk elsewhere.
- Site specific drainage strategies will need to be prepared for the development sites, accounting for existing topography, geology and hydrogeology and environmental and technical constraints to ensure there is no increase in surface water flood risk elsewhere because of new developments, and to provide fully

integrated drainage system into the site setting providing water quantity, quality, amenity and biodiversity benefits.

- Any overland flow entering the sites from higher ground would need to be accounted for within the site design without adversely impacting the runoff conveyance and storage to mitigate against increased flood risk elsewhere.

5.4 Opportunities for wider sustainability benefits and integrated flood risk management

The following are opportunities for wider sustainability benefits and integrated flood risk management at the sites:

- It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques.
- Opportunities to incorporate filtration techniques such as filter strips, filter drains and bioretention areas must be considered.
- The use of multistage SuDS treatment will improve water quality of surface water runoff discharged from the site and reduce the impact on receiving water bodies and can also contribute towards requirements for Biodiversity Net Gain.

6 NPPF and planning implications

6.1 Exception Test requirements

The Local Planning Authority will need to confirm that the Sequential Test has been carried out in line with national guidelines. The Sequential Test will need to be passed before the Exception Test is applied.

The NPPF classifies mixed development as 'More Vulnerable'.

The Exception Test will be required for this site if 'More Vulnerable' development is proposed within Flood Zone 3a. 'More Vulnerable' development is not permitted in Flood Zone 3b.

6.2 Requirements and guidance for site-specific Flood Risk Assessment

At the planning application stage, a site-specific FRA will be required as the proposed development sites are:

- greater than one hectare
- in Flood Zones 2 and 3a
- at increased risk of flooding from rivers or sea in future
- in an area identified as having critical drainage problems
- at risk of flooding from surface water

All sources of flooding should be considered as part of a site-specific FRA.

Consultation with the LPA, LLFA, Anglian Water, and the EA should be undertaken at an early stage.

Any FRA should be carried out in line with latest guidance including the National Planning Policy Framework (NPPF), Flood Risk and Coastal Change Planning Practice Guidance (PPG), and Southend-on-Sea City Council Local Plan Policies.

The development should be designed with mitigation measures in place where required.

6.3 Guidance for site design and making development safe

The site layout must adopt a sequential approach by steering more vulnerable aspects of the development outside of the surface water flow path in CA003uc, the fluvial risk from Mucking Hall Brook between CA001uc and CA002uc, and the tidal and surface water risk in southeast of CA002uc and southwest of HEA143; EA020uc. Developers should consider utilising these areas as a green corridor or as a location for SuDS.

A CCTV survey should confirm the route of Willingdale Brook and the associated culvert, and to establish whether the watercourse is located within the site. If the watercourse is confirmed to be within the site boundary, a buffer of at least 8m should be maintained between the culverted watercourse and any built development.

The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, so runoff magnitudes from the development are not increased by development across any surface water flow routes. A drainage strategy should help inform site layout and design to ensure runoff rates are as close as possible to pre-development greenfield rates, with areas of surface water ponding used as open space and SuDS or water compatible/essential infrastructure uses only.

Arrangements for safe access and escape will need to be provided for the 1% AEP fluvial and surface events and the 0.5% AEP tidal event with an appropriate allowance for climate change, considering depth, velocity, and hazard. Design and access arrangements will need to incorporate measures, so development and occupants are safe.

Provisions for safe access and escape should not impact on surface water flow routes or contribute to loss of floodplain storage. Consideration should be given to the siting of access points with respect to areas of surface water flood risk.

7 Conclusions

Fluvial: The majority of the sites (98%) are not at risk of fluvial flooding. Flood Zones 3b and 3a cover less than 1% of the site, associated with Mucking Hall Brook, impacting CA001uc and CA002u. Flood Zone 2 also impacts CA002uc and HEA143; EA020uc, from Willingdale Brook.

Tidal: None of the sites are shown to be at risk from tidal flooding in the present day. However, the southeast of CA002uc and southwest of HEA143; EA020uc are at risk in several of the climate change scenarios, with depths in places exceeding 1.0m.

Residual: CA002uc and HEA143; EA020uc are at residual risk of tidal flooding due to breach or overtopping of the tidal defences. Breach modelling has shown that breaches typically give a long lead time, between 12 and 16 hours, aside from one 0.1% AEP event breach scenario that gives a much shorter lead time of 2 hours.

Surface water: In all events there are several areas of isolated surface water ponding across the sites. Water collects in the several ponds that exist within CA001uc and CA002uc, as well as in the drainage ditches. The largest areas of ponding are in the southeast of CA002uc and the southwest of HEA143; EA020uc. In the 1% and 0.1% AEP events, there is also a large flow path travelling south in the west of CA003uc.

Groundwater: Groundwater levels are between 0.025m and 0.5m below the ground surface in the western half of CA001uc, and the southwest of CA002uc. In these areas there is a risk of groundwater flooding to both surface and subsurface assets. There is also the possibility of groundwater emerging at the surface locally.

The following points should be considered in development of this site:

- The Exception Test will be required if 'More Vulnerable' development is proposed within areas of Flood Zone 3a.
- A site-specific FRA should be undertaken, which assesses all sources of flood risk.
- A buffer of at least 8 metres should be maintained between Mucking Hall Brook and any built development.
- Safe access and escape routes should be demonstrated in the 1% AEP plus climate change surface water, fluvial, and events. This initial assessment has shown that access and escape will likely be possible.
- The tidal defence owner should be consulted at an early stage to determine defence ownership and understand future plans for the defences, including plans for ongoing maintenance or defence improvements.
- A carefully considered and integrated flood resilient and sustainable drainage design should be put forward, including a site-specific Surface Water Drainage Strategy considering the recommendations set out in Section 5.3, and SuDS maintenance and management plan supported by detailed modelling.

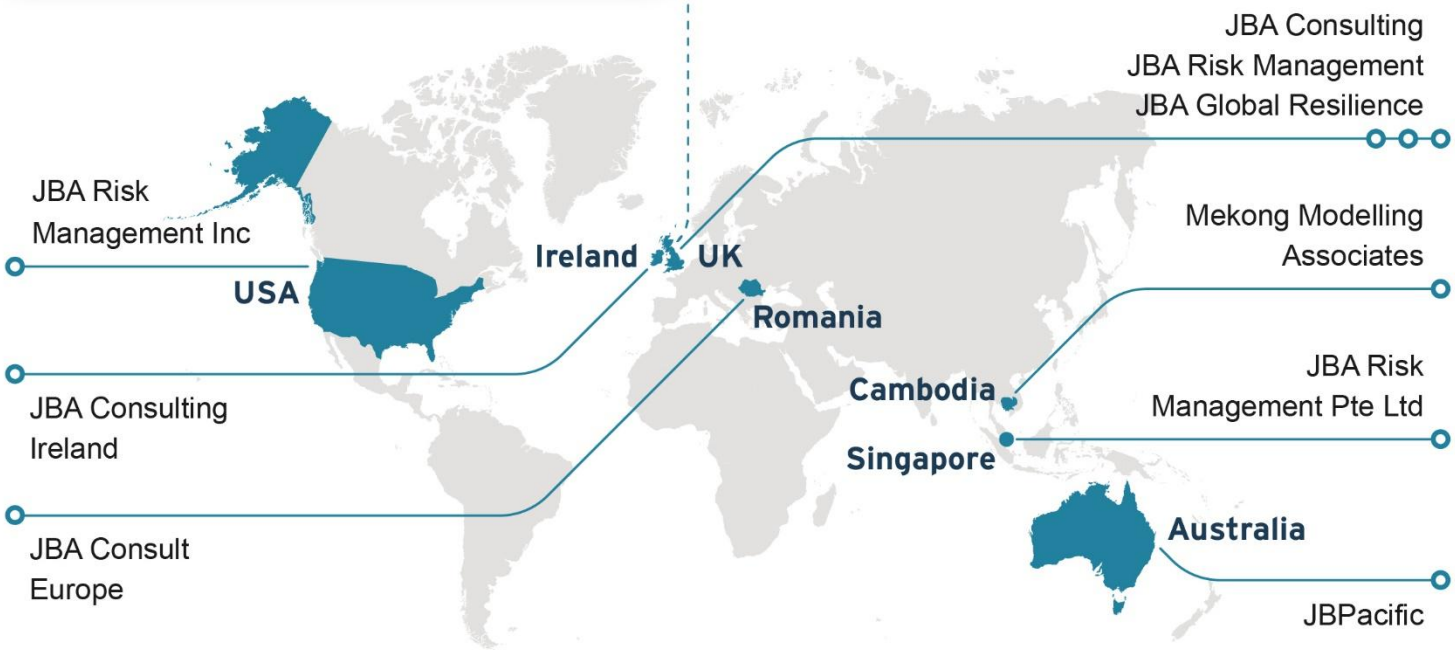
- Anglian Water should be consulted at an early stage on drainage proposals for the sites to identify any potential constraints or existing sewer flooding issues that may not have been identified through this high level assessment.

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