



BATTLEFIELDS LANE SOUTH, HOLBEACH

FLOOD RISK ASSESSMENT &
DRAINAGE STRATEGY

January 2021

Cicero Estates

**RESIDENTIAL DEVELOPMENT
BATTLEFIELDS LANE SOUTH, HOLBEACH**

FLOOD RISK ASSESSMENT & DRAINAGE STRATEGY

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1. INTRODUCTION

- 1.1 Paul Basham Associates have prepared this Flood Risk Assessment (FRA) and Drainage Strategy on behalf of Cicero Estates to support an outline planning application for a residential development of up to 185 dwellings, on a 6.2ha site. The land is to the South of Battlefields Lane South, Holbeach; the nearest postcode is PE12 7PQ.

2. SITE DETAILS

- 2.1 The proposed development is in Holbeach, in the South Holland District of South East Lincolnshire. The site is in a low-lying area, west of The Wash estuary. The area is protected from flooding by an extensive network of raised engineered defences.
- 2.2 The plot size is approximately 6.2ha, and the land is currently open field and used for agricultural purposes. The topographical survey shows the site to be mostly flat with levels varying gradually between 2.7m and 3.3m across the 6.2ha site. See **Figure 1** for the site location; the topographic survey is in **Appendix A**.
- 2.3 The development proposals are for a 185-dwelling residential development on a 6.2ha site.



Figure 1: Site Location Plan

- 2.4 The site is within Flood Zone 3a. According to the South East Lincolnshire strategic FRA, the site is predominantly at risk from a 1-in-200-year tidal flooding event. The site is defended from tidal flooding by raised engineered defences along The Wash estuary. However, this FRA will look to mitigate the risks should those defences be breached or overtopped, as per the guidance in the South East Lincolnshire Strategic Flood Risk Assessment (SFRA).
- 2.5 The SFRA predicts flooding of the site could occur in the future due to; *Climate change, particularly associated with the predicted effects on sea level rise, brings an increased likelihood of flooding that could be a danger to life affecting whole settlements. Such an extreme consequence would come about as a result of the highest tides (predicted to be common in 100 years time) coupled with storm surge conditions causing major breaches in coastal/tidal defences.* (SE Lincs, JSPC, 2017)
- 2.6 The site is allocated for residential development in the South East Lincolnshire Local Plan, adopted March 2019. The site's reference within the local plan is **Hob032**. See **Appendix B** for the local plan policies map, **Figure 2** below shows an excerpt from the map.

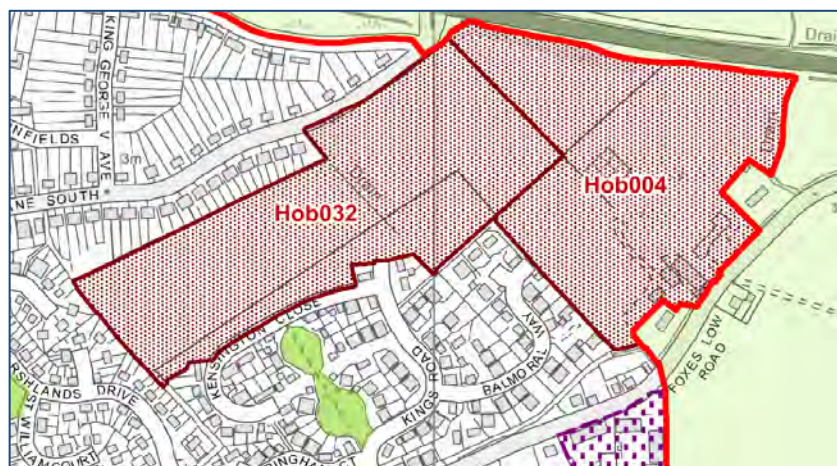


Figure 2 - Excerpt from Local Plan Policies Map showing the development site.

- 2.7 The South East Lincolnshire Local Plan, adopted March 2019, notes that;
"The site is within Flood Zone 3a, and the SFRA identifies flood hazard in 2115 as a combination of 'danger for most' and 'danger for some' and flood depth in 2115 as up to 1.0m. Development will be required to include appropriate mitigation." (SE Lincs, 2019)
- 2.8 Therefore, any development on the site will require the existing site levels to be raised by a minimum of 1m to mitigate future flood risk.
- 2.9 As the site is allocated in the adopted local plan and is assessed as "developable" in the supporting Strategic Housing Land Availability Assessment (SHLAA) (SE Lincs, 2018) a further sequential test is not required.

3. SITE GEOLOGY

- 3.1 A review of the British Geological Survey (BGS) mapping indicates that the bedrock geology beneath the site is "Amphill Clay Formation - Mudstone. Sedimentary bedrock formed between 163.5 and 157.3 million years ago during the Jurassic period"; overlain by superficial deposits of "Tidal Flat Deposits - Clay and silt. Sedimentary superficial deposit formed between 11.8 thousand years ago and the present during the Quaternary period". See **Figure 3** for the BGS map extract.

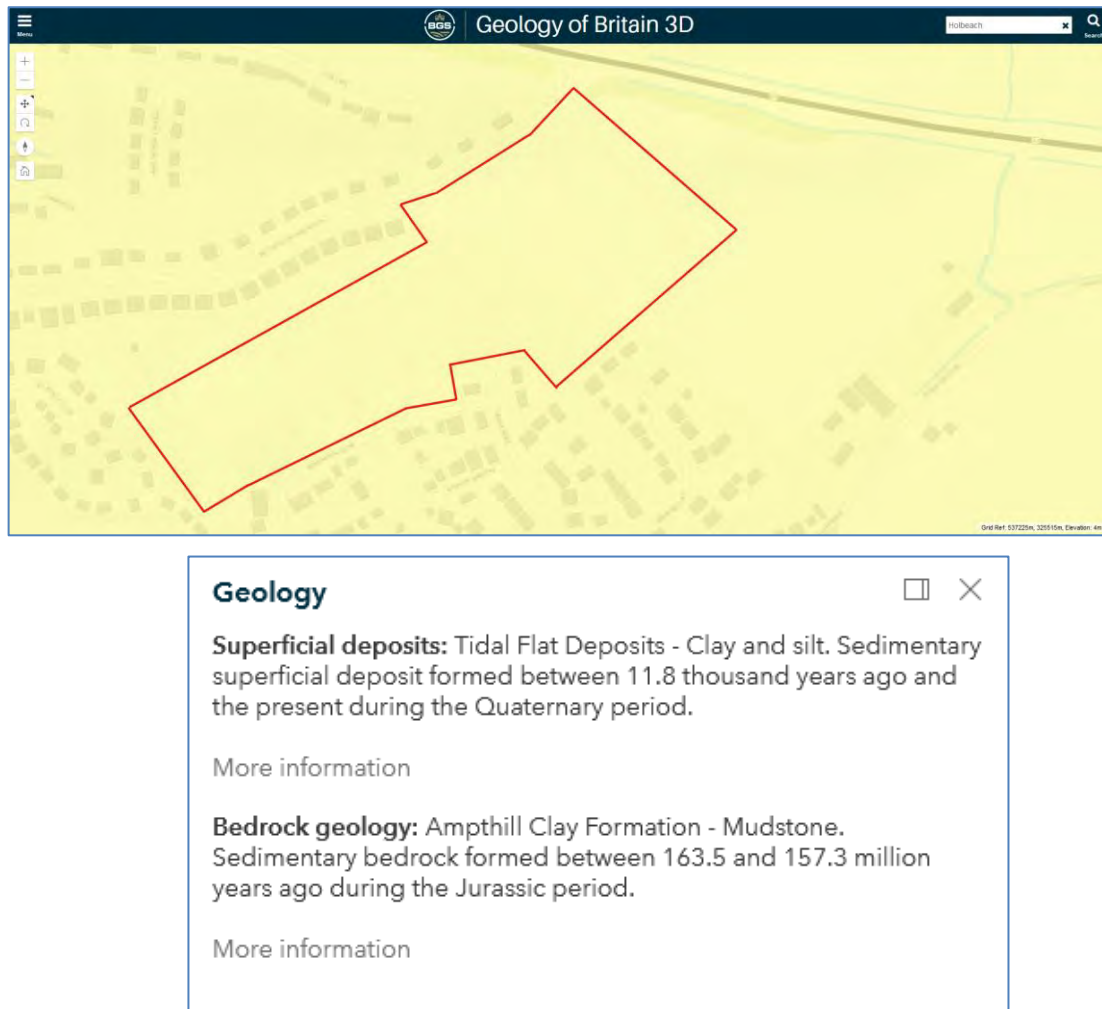


Figure 3: BGS bedrock mapping

- 3.2 Local boreholes from the BGS website show clay soils to the south of the site (TF32SE17 & TF32SE24) with fine silt encountered further to the north (TF32NE1 adjacent to the A17/Penny Hill Junction). Sitting groundwater was recorded at depths of between 0.6m 3.0m bgl. See **Appendix C** for the borehole records.

- 3.3 The borehole records and BGS mapping suggest an infiltration drainage system will not be suitable due to high groundwater and impermeable soils.
- 3.4 Ground investigations comprising five windowless sample boreholes were completed on the 20th January 2021, see **Appendix D** for the report.
- 3.5 The investigation confirms the data shown on the BGS mapping in **Figure 3**, very clayey soil was encountered in each of the 5 boreholes from 0.1m to depths of up to 5m. See **Figure 4** for an excerpt from the ground investigation report in **Appendix D**.

<u>WS101:</u>	
0.0-0.1m	Soft brown silty CLAY (Topsoil)
0.1-2.9m	Brown very clayey SILT
2.9-5.0m	Grey very clayey SILT
Well: 0.72m unslotted, 2.0m slotted	

Figure 4: Excerpt from Report J21-001-R01

- 3.6 Shallow standing groundwater as high as 0.75mbgl was encountered during the ground investigation works. See **Figure 5**.

Groundwater		
Borehole ID	Standing Water Level (mbgl)	Installation Base Dip (mbgl)
WS101	0.79	2.72
WS102	0.93	1.56
WS103	0.75	2.47
WS104	1.08	3.02
WS105	1.24	3.10

Figure 5: Excerpt from Report J21-001-R01, Groundwater levels

- 3.7 The site is not suitable for an infiltration drainage system, as indicated by the heavy clay soils and high groundwater encountered during the ground investigation. Surface water shall therefore be discharged to either a watercourse or adopted surface water sewer.

4. EXISTING DRAINAGE

Existing Surface Water Drainage

- 4.1 The site is currently open agricultural land. There does not appear to be any existing positive drainage.
- 4.2 The P14 Foxes Low drain (Reach ID - DRN206G1405) runs parallel to the site's western boundary; South Holland Internal Drainage Board (IDB) maintain the drain and identify it as a high priority pipeline. The maximum water level is maintained at 2.1mAOD by the IDB.
- 4.3 There is also a drainage ditch running across the centre of the site. The ditch flows south and connects into the Foxes Low drain which runs along Foxes Low Road (Reach ID - DRN206G1404).
- 4.4 The site has a total area of 6.2ha. The site masterplan has not been finalised; however, the proposed impermeable area will be 62.5% of the site's total area, equal to 3.875ha.
- 4.5 The developed impermeable area of 3.875ha, gives the QBAR greenfield rate of 5.7l/s, as shown in **Figure 6** and **Appendix E**. The developed area is all the impermeable areas added together (roofs, driveways, internal road, footway and a nominal patio allowance of 3.0x3.0m).

Paul Basham Associates		Page 1
Lancaster Court Fareham Hampshire, PO15 5TU		
Date 06/01/2021 14:17	Designed by MicroDrainage	
File 087.5011 - SOURCE CONTR...	Checked by	
Innovyze	Source Control 2019.1	
<u>ICP SUDS Mean Annual Flood</u>		
Input		
Return Period (years)	100	Soil 0.300
Area (ha)	3.875	Urban 0.000
SAAR (mm)	581	Region Number Region 5
Results 1/s		
QBAR Rural 5.7		

Figure 6: Total developed area greenfield rate

- 4.6 Due to the topography of the site, the proposed development will be split into two catchments, east and west.
- 4.7 The eastern catchment is 2.9ha, it has a developed impermeable area of 1.813ha and a developed area QBAR greenfield rate of 2.7 l/s. See **Figure 7** and **Appendix E**.

Paul Basham Associates		Page 1
Lancaster Court Fareham Hampshire, PO15 5TU		
Date 06/01/2021 14:22 File 087.5011 - SOURCE CONTR...	Designed by MicroDrainage Checked by	
Innovyze	Source Control 2019.1	
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 Soil 0.300 Area (ha) 1.813 Urban 0.000 SAAR (mm) 581 Region Number Region 5 Results 1/s QBAR Rural 2.7		

Figure 7 East Catchment, developed area greenfield rate.

- 4.8 The western catchment is 3.3ha, it has a developed impermeable area of 2.063ha, and a developed area QBAR greenfield rate of 3.0 l/s. See **Figure 8** and **Appendix E**.

Paul Basham Associates		Page 1
Lancaster Court Fareham Hampshire, PO15 5TU		
Date 06/01/2021 14:24 File 087.5011 - SOURCE CONTR...	Designed by MicroDrainage Checked by	
Innovyze	Source Control 2019.1	
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 Soil 0.300 Area (ha) 2.063 Urban 0.000 SAAR (mm) 581 Region Number Region 5 Results 1/s QBAR Rural 3.0		

Figure 8 West Catchment, developed area greenfield rate.

- 4.9 **Table 1** summarises the catchment areas and greenfield run off rates to which discharge from the development shall be limited.

Catchment	Area (ha)	Greenfield QBAR (l/s) Maximum allowable discharge rate from the proposed development
Total	3.875	5.7
East	1.813	2.7
West	2.063	3.0

Table 1 Developed area greenfield rate summary table

Existing Foul Water Drainage

- 4.10 The site is currently undeveloped and does not generate foul discharge. Anglian Water provides sewer services in the area. There are adopted foul sewers to the north of the site on Battlefields Lane South. And south of the site on Kensington Close and Kings Road. The sewer on Kings Road has a stub (MH Ref 9300, C.L - 3.102m I.L - 0.390m) which could serve as a connection point for the development's foul drainage, See **Figure 9**. The sewer in Kings Road is shown to be 225mm in diameter and of Vitrified Clay. See **Appendix F** for a copy of the Anglian Water asset map (up to date as of January 2021).



Figure 9: Excerpt from Anglian Water asset map

5. FLOOD RISKS

Fluvial/tidal flooding

- 5.1 Flood mapping obtained from the Environment Agencies 'flood map for planning' website has identified that the site falls within Flood Zone 3, see **Figure 10**. Indicating that the site is at 1 in 100 or greater annual probability of fluvial flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
- 5.2 On the 13th of January 2021, the Environment Agency provided a Product 4 Flood Risk Data Report for the site, ref CCN/2020/198662. The EA data confirms that the site is considered to be at risk from tidal flooding in the 2115 scenario if The Wash estuary flood defences are breached. The EA does not consider the site to be at risk from fluvial flooding. See **Figure 11** and **Appendix G**.

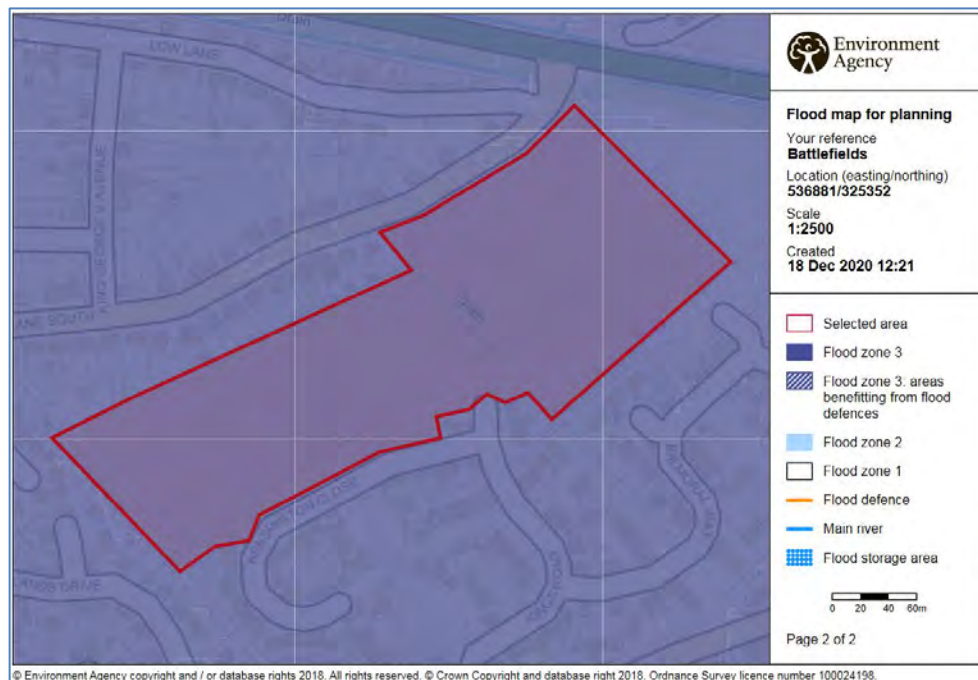


Figure 10: Flood Map for Rivers and Seas

4. Fluvial Flood Risk Information

This site is not considered to be at risk of flooding from main rivers.

The site may be at risk from local ordinary watercourses for which other risk management authorities, such as the Lead Local Flood Authority (ie top tier council) or Internal Drainage Board (where they exist) have responsibility.

5. Tidal Flood Risk Information

5.1 Tidal Defence Information

The existing tidal defences protecting this site consist of earth embankments. They are in fair condition and reduce the risk of flooding (at the defence) to a 0.67% (1 in 150) chance of occurring in any year. We inspect these defences routinely to ensure potential defects are identified.

Figure 11: Excerpt from EA report ref CCN/2020/198662

- 5.3 Tidal breach hazard mapping from the EA Product 4 Flood Risk report is shown below in **Figure 13**, **Figure 15** and **Figure 16**. The full report is available in **Appendix G**.
- 5.4 The EA max depth mapping, shown in **Figure 13**, confirms that the western part of the site is at risk of flooding up to 1m in depth, as per the comments in the adopted local plan (See **Para 2.7**).
- 5.5 **Figure 14** identifies that during a 1-in-1000-year event the maximum depth is still 1m; however, it is spread over a large area of the site.
- 5.6 During a 1-in-200-year flooding event in 2115, the EA mapping shows that conditions across the majority of the site will pose a "Danger to most", with remaining areas posing a "danger to some", see **Figure 15**. This assessment is a combination of the predicted max depths and max velocities.
- 5.7 The EA product 4 report shows that the site is at risk of tidal flooding from a breach of The Wash estuary flood defences resulting during a 1-in-200-year (0.5%) storm event. The EA product 4 report also confirms that the flood defences have a 1-in-150 (0.67%) chance of failing in any given year. The EA product 4 report and the SFRA have both identified that a breach of The Wash estuary flood defences during a 1-in-200-year storm event poses the main flood risk to the site.

★ Modelled Breach Locations - see also the accompanying plan "Location of Modelled Breaches"						
Max Hazard (Flood Risk to People : FD2320) Less than 0.75 (Low Hazard) Between 0.75 and 1.25 (Danger for Some) Between 1.25 and 2.0 (Danger for Most) Greater than 2.0 (Danger for All)		Max Depth (m) 0 - 0.25 0.25 - 0.50 0.50 - 1.0 1.0 - 1.6 1.6 +		Max Velocity (m/s) 0 - 0.3 0.3 - 1.0 1.0 - 1.5 1.5 - 2.5 2.5 +		
Date Printed	January 2021	Scenario year	2115	Scenario Annual Chance	0.5% (1 in 200)	CCN Number CCN-2020-198573

Figure 12: EA Mapping Legend

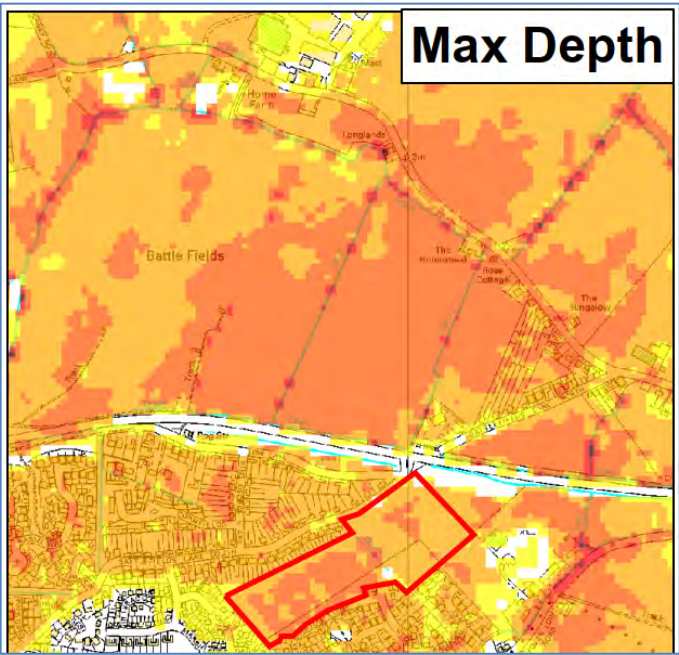


Figure 13: EA PRODUCT 4, YEAR 2115, 0.5% ANNUAL EVENT, MAX DEPTH, TIDAL BREACH

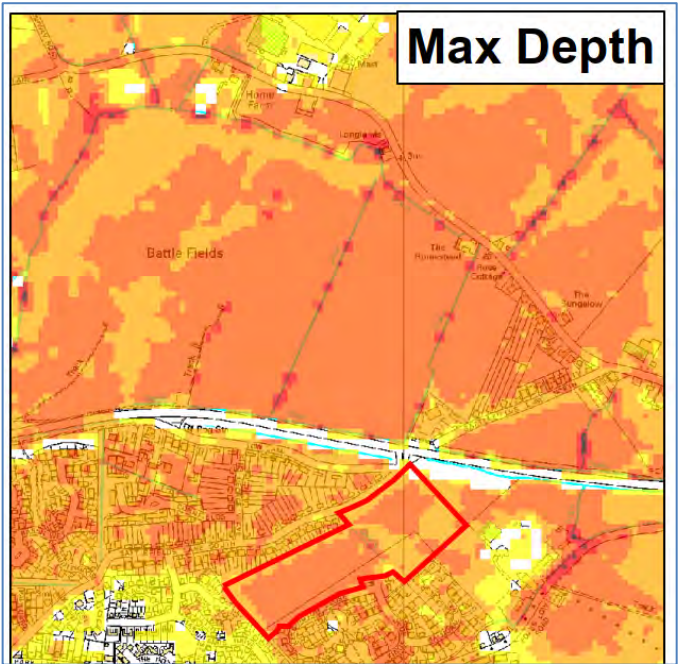


Figure 14: EA PRODUCT 4, YEAR 2115, 0.1% ANNUAL EVENT, MAX DEPTH, TIDAL BREACH

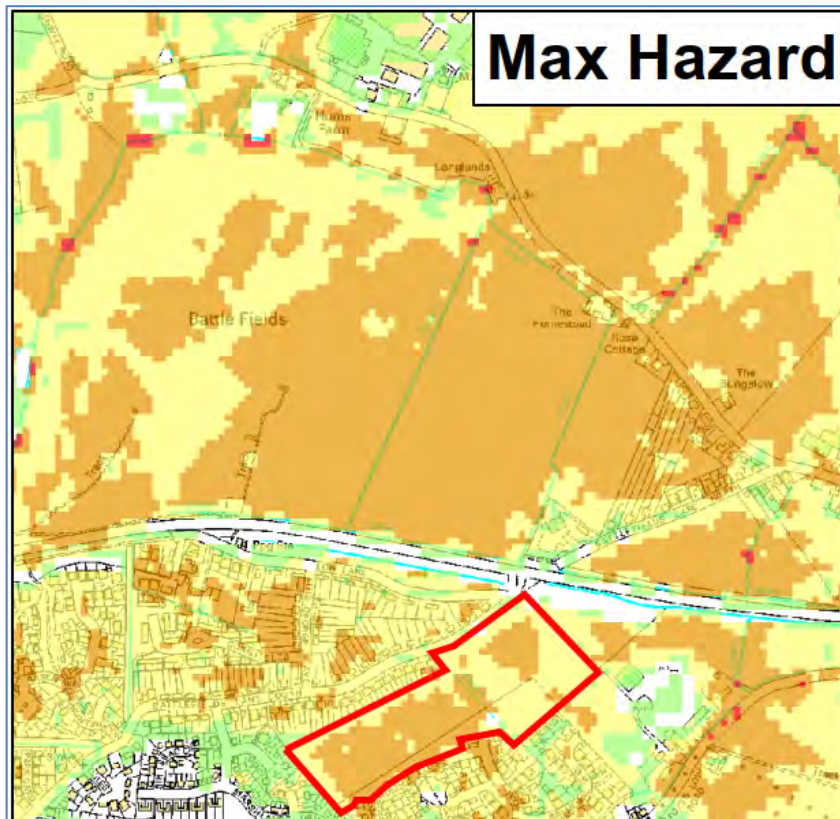


Figure 15: EA PRODUCT 4, YEAR 2115, 0.5% ANNUAL EVENT, MAX HAZARD, TIDAL BREACH

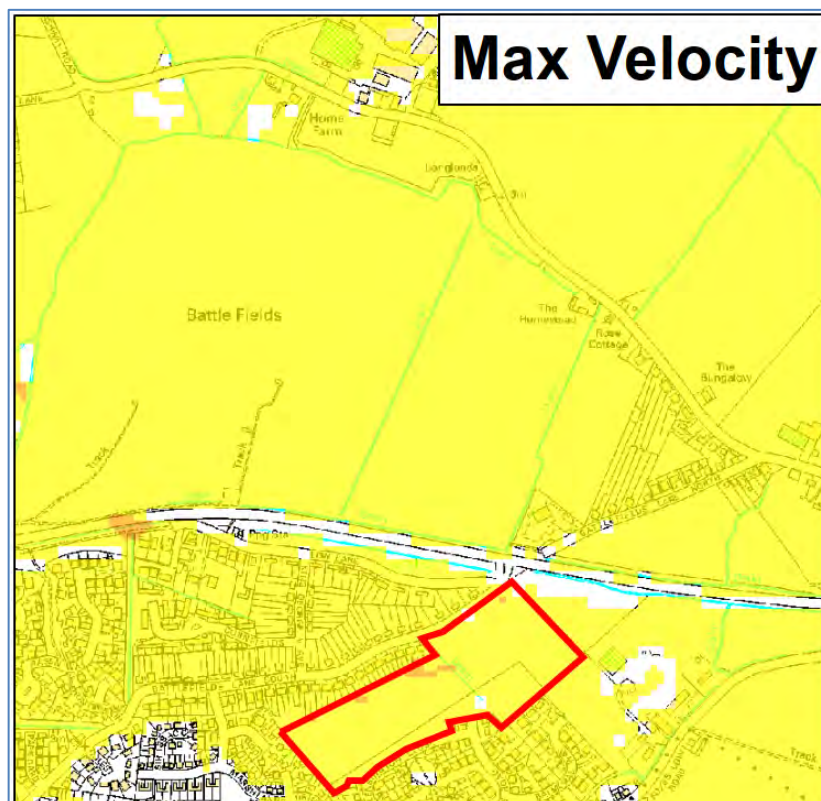


Figure 16: EA PRODUCT 4, YEAR 2115, 0.5% ANNUAL EVENT, MAX VELOCITY, TIDAL BREACH

Long term flood risk from rivers and seas

- 5.8 The long-term flood risk from rivers and seas mapping shows that the majority of the site is at very low risk, with a small area at low risk, see **Figure 17**. As stated in the SFRA and EA Product 4 Report (See **Figure 11**), the site is predominantly at risk from tidal flooding, not fluvial flooding.
- 5.9 Although most of the site is shown to be at very low risk of long term flooding from rivers or the sea, the key flooding risk to the site is a breach of the coastal flood defences along the Wash Estuary, as identified in the SFRA and EA Product 4 report.

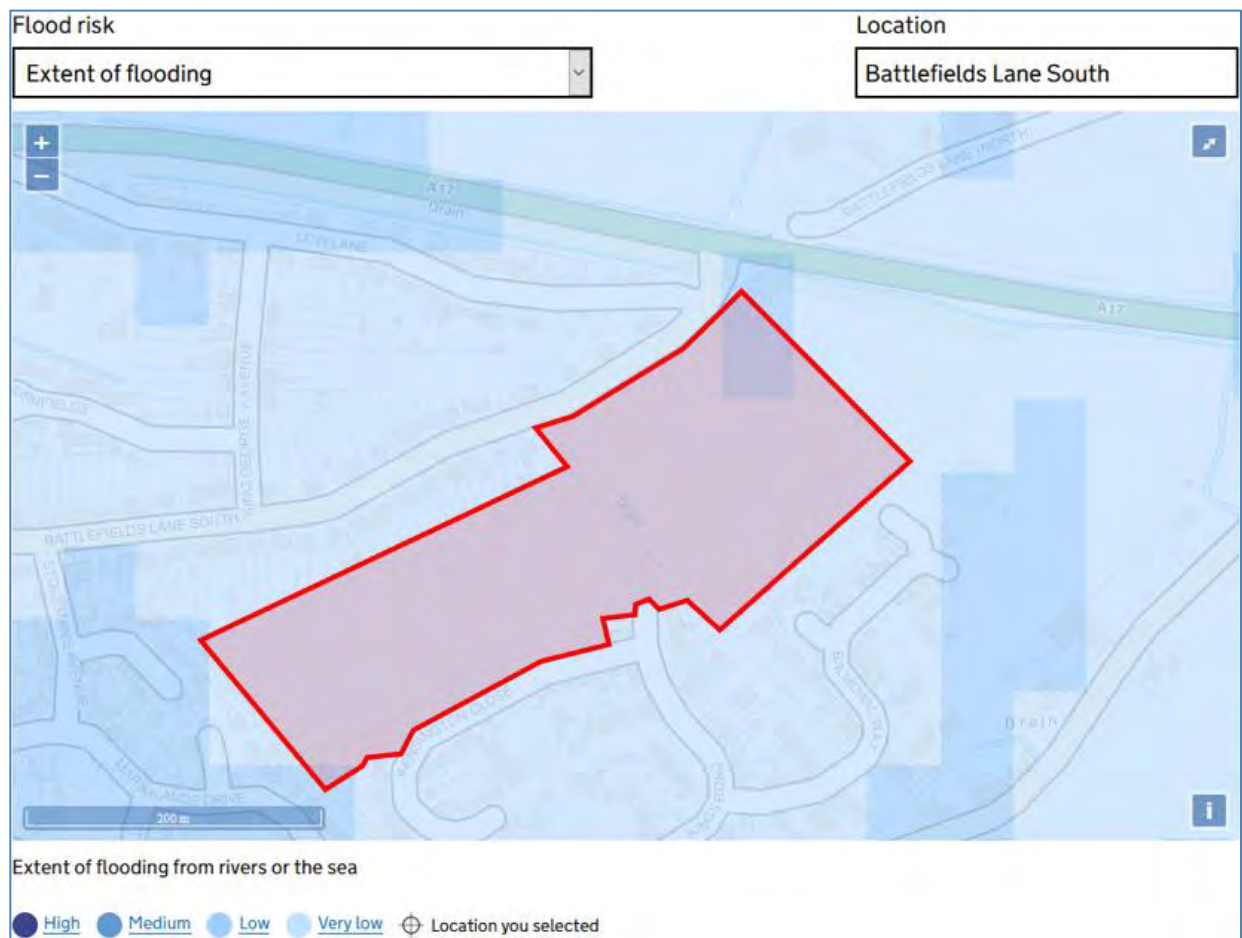


Figure 17: Long-term flood risk from rivers and seas map

Long-term flood risk from reservoirs

5.10 The site is entirely outside of the maximum extent of flooding from reservoirs. See **Figure 18**.

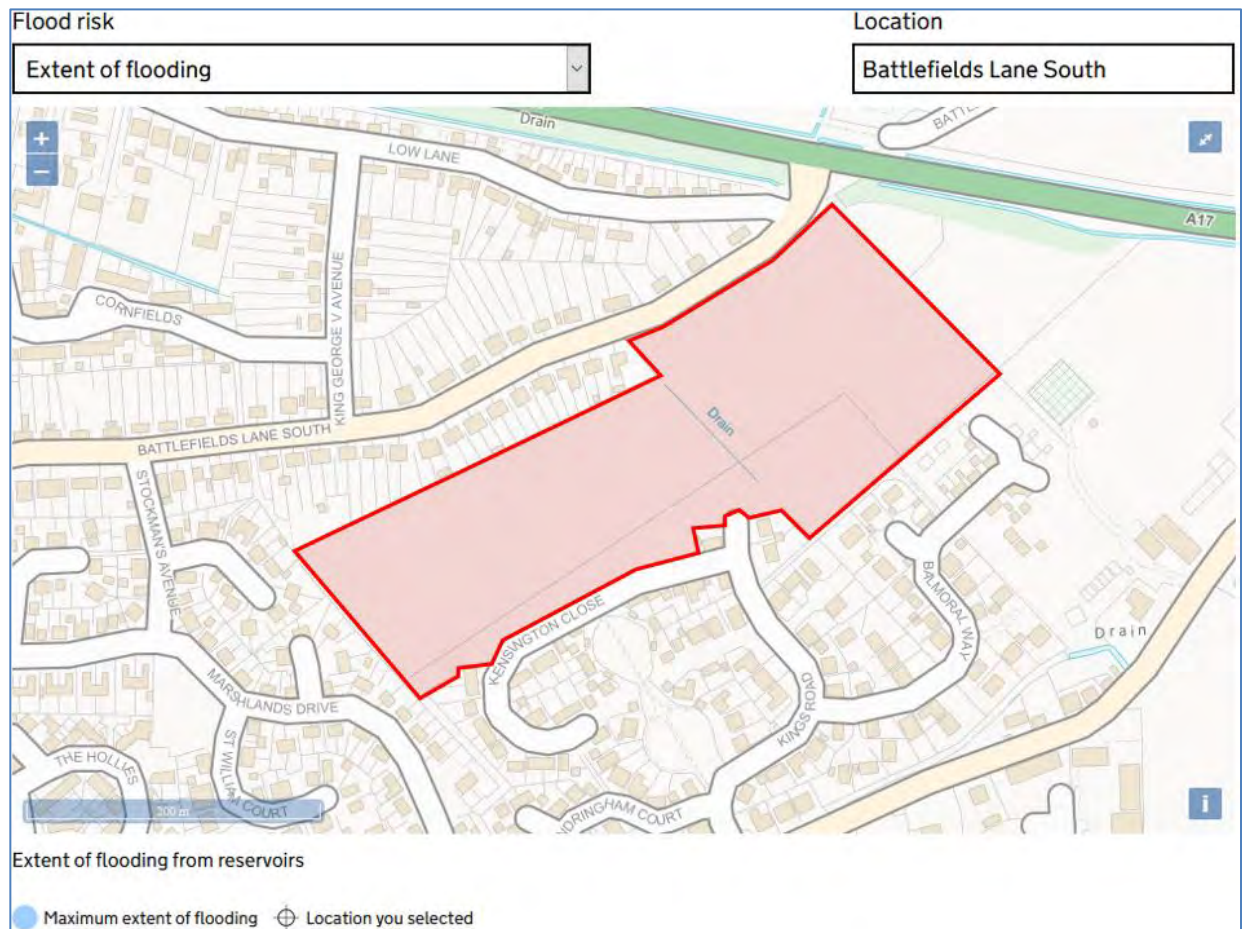


Figure 18: Long term flood risk from reservoirs map

Long-term surface water flood risk

- 5.11 Surface water or 'pluvial' flooding results from rainfall running over ground before eventually entering a watercourse or sewer. It is usually associated with high intensity rainfall events but can also occur with lower intensity rainfall or melting snow where the ground is already saturated, frozen, developed (for example in an urban setting), or otherwise has low permeability.
- 5.12 Isolated areas of the site's western half are shown to be at low risk of surface water flooding; the remainder of the site is considered to be at very low risk. See **Figure 19**.

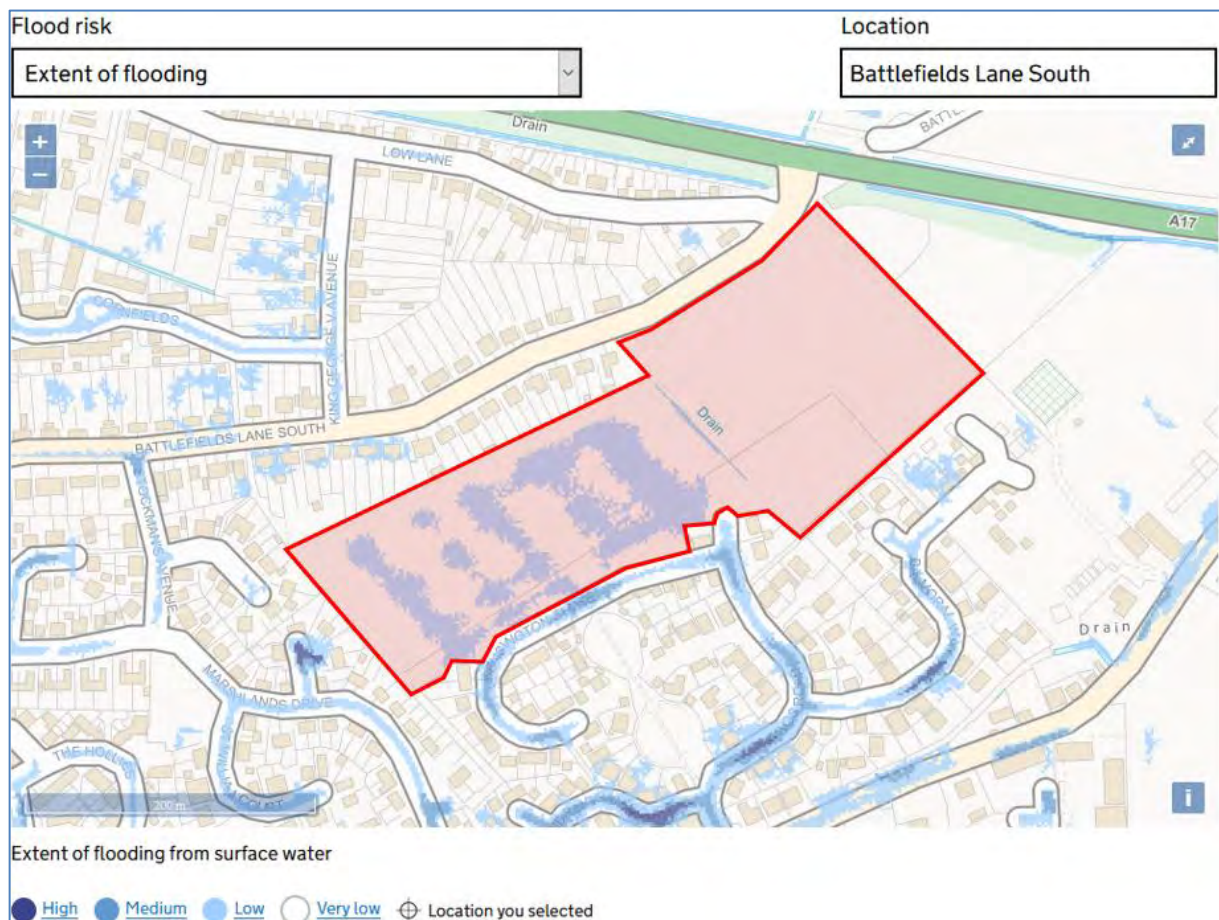


Figure 19: Long term flood risk from surface water

5.13 Areas of the site shown to be at low risk from surface water flooding are predominantly at risk of flooding up to 300mm. There are some small, isolated areas where surface water flooding is expected to be between 300 to 900mm. See **Figure 20**.

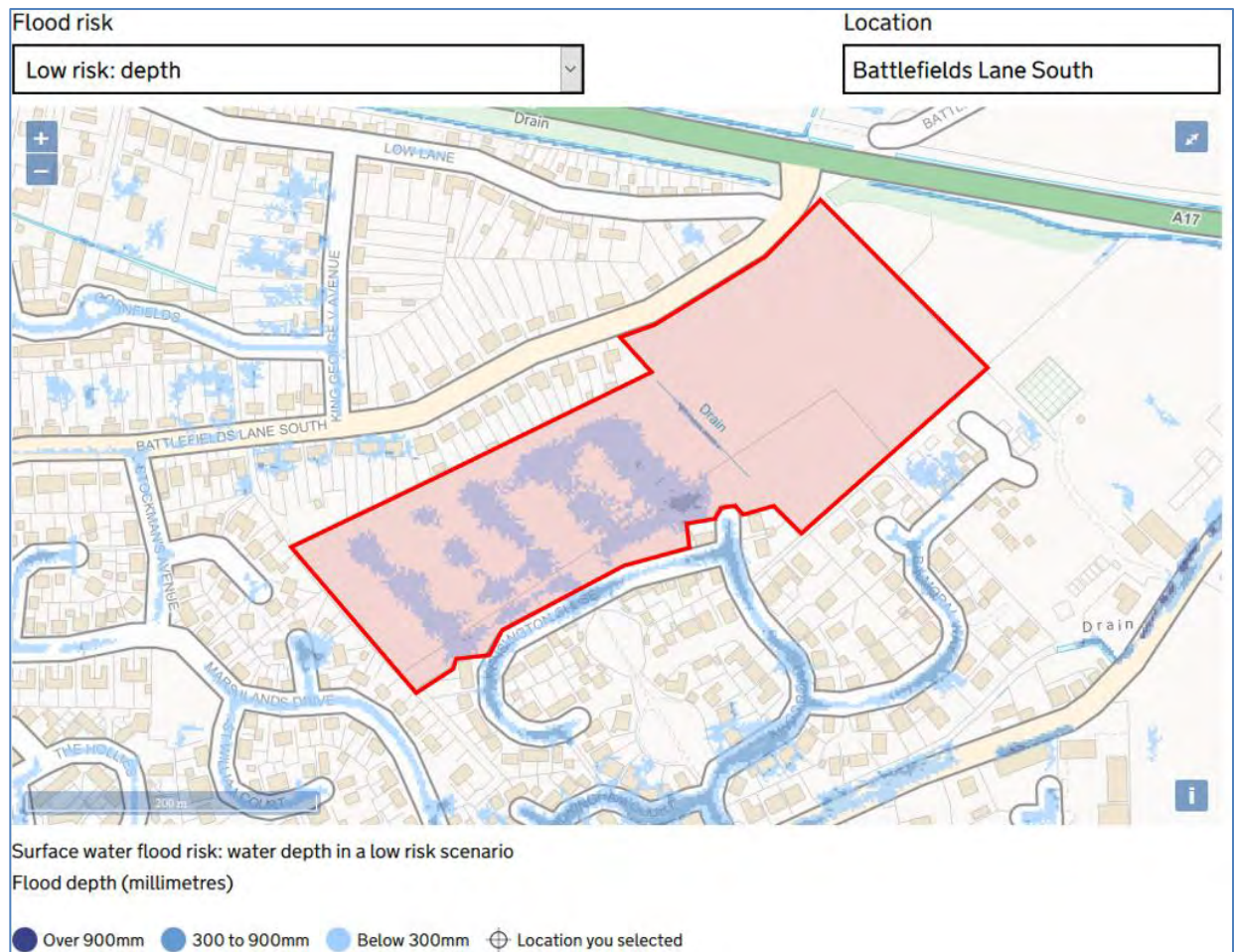


Figure 20: Surface Water Flood Risk: Water Depth in a Low-Risk Scenario

National Planning Policy Framework (NPPF)

- 5.14 This report has been prepared considering the National Planning Policy Framework (NPPF) Technical Guidance and the Environment Agency's (EA) flood risk standing advice.
- 5.15 Table 3 from the NPPF Technical Guidance has been included as **Figure 21** below. Table 3 provides the classes of development (based on flood risk vulnerability) that are permitted within each of the flood zones. The Flood Risk Vulnerability Classification for the site is 'More Vulnerable' as it is a housing development, as defined in Table 2 of the Planning Practice Guidance. The development is in Flood Zone 3a.
- 5.16 Although classed as more vulnerable, and situated in Flood Zone 3a, the development does not require an additional sequential test as it has been allocated for residential development in the South East Lincolnshire Adopted local plan. The development will be required to pass exception test; however, that is beyond the scope of this report.

Flood Zones	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	X	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	X	X	X	✓*

Table 3 - Flood risk vulnerability and flood zone 'compatibility'

Key: ✓ Development is appropriate X Development should not be permitted.

Notes to table 3:

- This table does not show the application of the [Sequential Test](#) which should be applied first to guide development to Flood Zone 1, then Zone 2, and then Zone 3; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;
- The Sequential and [Exception Tests](#) do not need to be applied to [minor developments](#) and changes of use, except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site;
- Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.

† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

* "In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere

Figure 21: NPPF Planning Practice Guidance Table – Flood Risk Vulnerability and Flood Zone Compatibility

Groundwater Flooding

- 5.17 Groundwater flooding occurs when groundwater levels increase sufficiently for the water table to intersect the ground surface. Groundwater flooding can occur in a variety of geological settings including valleys and in areas underlain by chalk, and in river valleys with thick deposits of alluvium and river gravels.
- 5.18 The site is not considered to be at high risk from groundwater flooding. The ground investigation was completed on the 20th of January 2021, during storm Christopher and following a period of wet weather. However, the highest groundwater level encountered was 0.75mbgl, see **Figure 5**.
- 5.19 The EA Product 4 flood risk report, **Appendix G**, confirms there are no records of groundwater flooding in the vicinity of the site.

6. DRAINAGE STRATEGY

Potential Surface Water Drainage Strategy

- 6.1 In line with the Building Regulations Part H3, surface water shall discharge to one of the following, listed in order of priority:
- An adequate infiltration system: or, where not reasonably practicable,
 - A watercourse; or, where not reasonably practicable,
 - A sewer.
- 6.2 The records from the ground investigation undertaken on the 20th of January 2021 confirm the geology shown in the BGS mapping, encountering very clayey soils from 0.1m-5mbgl and high groundwater, see **Appendix D**.
- 6.3 Based on the site's geology, superficial deposits of clay underlain by clay bedrock, an infiltration system is not considered feasible for this development.
- 6.4 As infiltration is not considered to be feasible, the surface water will discharge to a watercourse and a pipeline (Foxes Low Drain), both maintained by the South Holland Internal Drainage Board.
- 6.5 The proposed outfall point for the site's eastern catchment is the watercourse running across the centre of the site, flowing in a southerly direction. After leaving the site, it connects into the Foxes Low Drain (maintained by the South Holland IDB) running along Foxes low Road. The Invert level of the watercourse is approximately 2.15m AOD.
- 6.6 The proposed outfall point for the site's western catchment is the Foxes Low drain, which runs parallel to the site's western boundary; the Foxes Low drain is maintained by South Holland IDB. South Holland IDB have confirmed they aim to maintain a maximum water level of 2.1m AOD within the Foxes Low drain.
- 6.7 In accordance with the *DEFRA Sustainable Drainage Systems Non-statutory technical standards for sustainable drainage systems March 2015*, and the *Lincolnshire County Council Sustainable Drainage Design and Evaluation Guide*, surface water run-off from the proposed development will be limited to greenfield rates. See **Table 1** for the site's developed area greenfield rates.
- 6.8 The proposed drainage system will include attenuation capacity designed to accommodate surface water run-off for a 1-in-100-year storm event, including a 40% allowance for climate change, with no flooding.

MicroDrainage Calculations

- 6.9 The eastern catchment is 2.9ha, assuming a proposed impermeable area of 62.5%, the developed impermeable area will be 1.813ha, with a greenfield Qbar rate of 2.7l/s, see **Table 1**. To accommodate a 1-in-100-year storm event, plus 40% climate change, while limiting discharge to 2.7l/s an attenuation capacity of 2188m³ will be required. See **Appendix H** for a copy of the MicroDrainage Calculations, and **Appendix I** for the proposed drainage layout drawing.
- 6.10 The western catchment is 3.3ha, assuming a proposed impermeable area of 62.5%, the developed impermeable area will be 2.063ha, with a greenfield Qbar rate of 3.0l/s, see **Table 1**. To accommodate a 1-in-100-year storm event, plus 40% climate change, while limiting discharge to 3.0l/s an attenuation capacity of 2224m³ will be required. See **Appendix H** for a copy of the MicroDrainage Calculations, and **Appendix I** for the proposed drainage layout drawing.

Catchment	Required attenuation m ³
East – 1.813ha	2188
West – 2.063ha	2224

Table 2: Summary of required attenuation

- 6.11 The MicroDrainage seasonal return period wizard was used to assess storm durations for a 1-in-30-year storm event too, and found no risk of flooding; see **Appendix H** for a summary of the critical storm events.
- 6.12 As shown on drawing 087.5011.501, it is proposed to provide the required attenuation via basins in public amenity spaces within the development. Due to the site's topography, high groundwater levels and the invert level of the proposed outfall points, below-ground storage is unlikely to be a feasible solution.

- 6.13 The attenuation basins can be landscaped and used for open amenity space (see
- 6.14 **Figure 22**) whilst not being used for surface water management; however, suitable access must be provided to avoid erosion of the banks. Residents of the development must be made aware of the function of the attenuation basins, that they will be flooded during storm events and the hazards associated with open water.



Figure 22: Landscaped Attenuation Basin

Flood Mitigation

- 6.15 The proposed attenuation will manage the development's surface run-off during a 1-in-100-year storm event, plus 40% climate change, and ensure flooding risk is not increased elsewhere following the development.
- 6.16 However, as identified in the South East Lincolnshire adopted local plan, South East Lincolnshire Strategic Flood Risk assessment and EA Product 4 report, the site is at risk from tidal flooding in the event of a storm surge breaching the raised engineered coastal defences along The Wash estuary (Environment Agency, 2021).
- 6.17 In the event the sea defences along The Wash estuary are breached, the site could be flooded by water up to 1m in depth, as identified in The South East Lincolnshire adopted local plan;

"The site is within Flood Zone 3a, and the SFRA identifies flood hazard in 2115 as a combination of 'danger for some', 'danger for most', 'no hazard' and 'low hazard' and flood depth in 2115 as 'no hazard' up to 1.0m. Development will be required to include appropriate mitigation." (SE Lincs, 2019)

- 6.18 Site levels should be raised to at least 4.17m AOD (in accordance with the adopted local plan, and above flood levels shown on **Figure 13 & Figure 14**) to protect the proposed dwellings from flooding during a flood event caused by a breach of The Wash estuary defences. Minimum Finished Floor Levels (FFLs) for the residential dwellings should be 4.32m AOD, 150mm above the proposed site levels.

Flood Resilience

- 6.19 Architects and other design professionals should follow the guidance outline in *Improving the flood performance of new buildings: flood resilient construction, 2011*, published by the Ministry of Housing, Communities & Local Government.
- 6.20 As this strategy recommends a minimum FFL of 4.32m, above predicted flood levels, many of the recommendations within the report will be followed by default. However, additional resilience can be provided by ensuring flood water cannot penetrate builds through walls, floors and foundations.
- 6.21 The flood resilience advice within *Improving the flood performance of new buildings: flood resilient construction, 2011*, should be followed for all construction within the development site.

Safe access, Egress, and Refuge

- 6.22 The proposed sites levels and minimum FFL of 4.17m and 4.32m respectively, will provide safe refuge within dwellings if flood waters reach the maximum 1m depth identified in the EA Product 4 mapping shown in **Figure 13 & Figure 14**.
- 6.23 **Figure 13 & Figure 14** identify that the A17, directly north of the site, would not be flooded during a 1-in-200 or 1-in-1000-year flood events. Therefore, emergency access to and from the site should be achievable, and movement throughout the site should be possible providing site levels are raised to 4.17m as specified above.
- 6.24 Battlefields Lane South itself will likely be flooded, but only up to 0.5m max depth during a 1-in-1000-year flood event, see **Figure 14**; therefore, it is reasonable to assume emergency services would be able to access the site from the A17 if required to do so during a flood.
- 6.25 Prior to purchasing a property on the site, residents should be informed of the flood risk and associated mitigation measures. Residents should be encouraged to sign up to the Environment Agencies Floodline flood risk alert service; these alerts should give residents time to prepare for a possible flooding situation.

Potential Foul Water Drainage Strategy

- 6.26 The site is to the south of Battlefields Lane South, and the north of Kings Road and Kensington Close. Anglian Water has adopted sewers in each of these roads, see **Appendix F**. The sewer on Kings Road has a stub (MH Ref 9300, C.L - 3.102m I.L - 0.390m) which could serve as a connection point for the developments foul drainage, See **Figure 9**. The sewer in Kings Road is shown to be 225mm in diameter and of Vitrified Clay.

7. SUDS MANAGEMENT AND MAINTENANCE

- 7.1 The management and Maintenance of SuDS will be responsibility of the developer/freeholder or their appointed management agent.

Attenuation Basin

- 7.2 The proposed drainage strategy comprises two large, landscaped attenuation basins in the development's public open spaces; one to serve the east catchment and one the west. A typical detention/attenuation basin is shown in **Figure 23**.

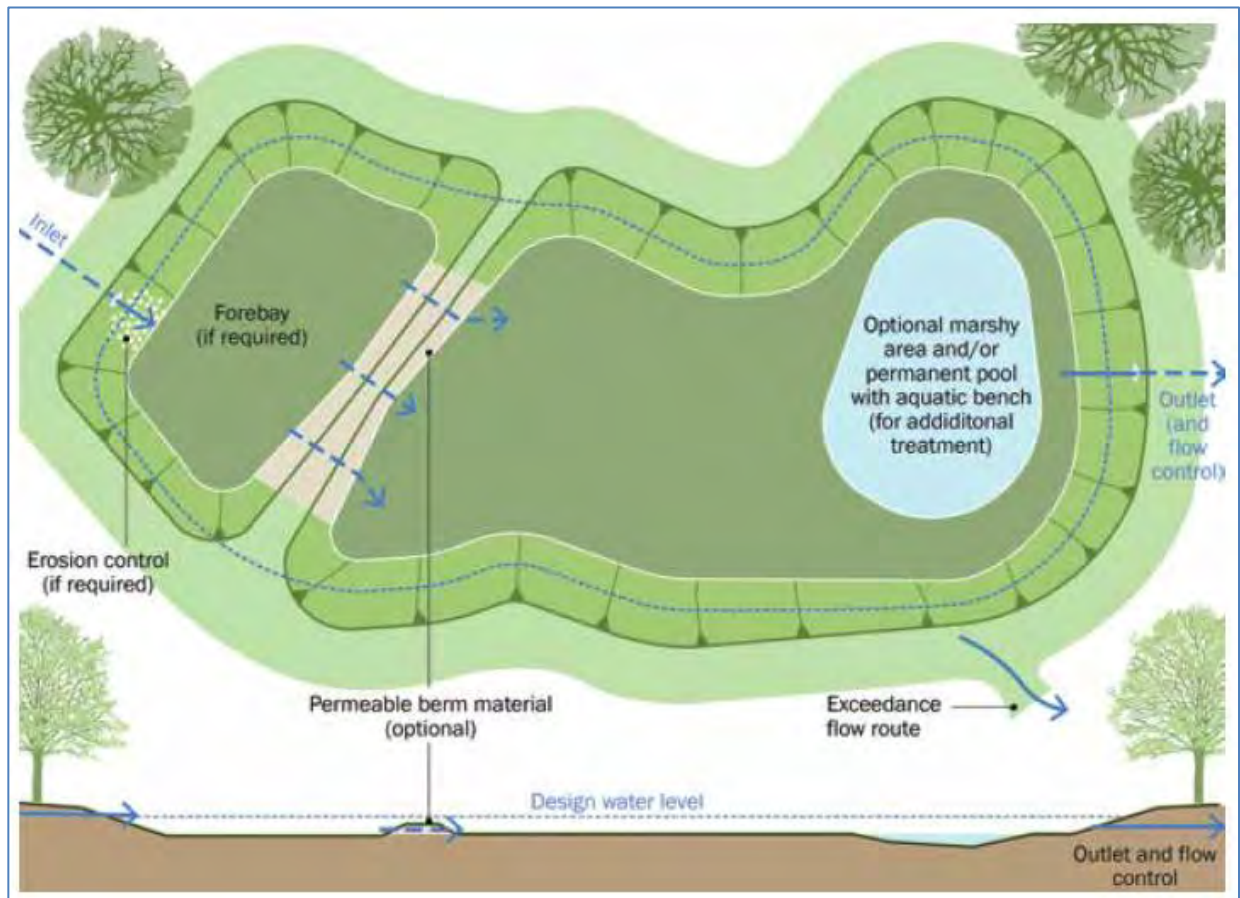


Figure 23: Typical Attenuation Basin, Plan and Elevation (Figure 22.2 CIRIA C753)

7.3 The proposed maintenance schedule for an attenuation basin is shown in **Table 3**.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter, debris and trash.	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season) or as required.
	Cut grass – meadow grass in and around basin.	Half Yearly: Spring (before nesting season) and autumn.
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required.
	Inspect inlets, outlets, and overflows for blockages, and clear if required.	Monthly
	Inspect Banksides, structures, pipework, etc. for evidence of physical damage.	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required.
	Check any penstocks and other mechanical devices.	Annually.
	Tidy all dead growth before start of growing season	Annually
	Remove sediments from inlets, outlets and forebay.	Annually (or as required)
	Manage wetland plants in outlet pool – where provided.	Annually (or as required)
Occasional Maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every two years, or as required
	Remove sediment from inlets, outlets forebay and main basin when required	Every 5 years or as required
Remedial Actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Re-align the rip-rap	As required
	Repair or rehabilitate inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

Table 3: Attenuation Basin Typical Maintenance Schedule

Vortex flow control device (HydroBrake, or similar)

- 7.4 Vortex flow control devices (HydroBrake or similar) are proposed to limit the discharge from the proposed attenuation basins to developed area greenfield rates.
- 7.5 A flow control device usually comprises of a fixed orifice or an alternative form of throttle such as a vortex flow control unit. Its principal function is to throttle the discharge passed down stream and thereby retain water upstream within associated storage facilities.
- 7.6 Vortex flow controls provide a non-linear flow curve and as such, can respond to both high and low intensity rainfall events. The drainage strategy proposes to utilise a vortex flow control device (HydroBrake or similar) to control the discharge from the attenuation basins. The device will usually contain a sump within the flow control chamber and associated parts for access and maintenance.
- 7.7 Normally, little maintenance is required as there are no moving parts within the flow control device, and generally, if blockages occur, they do so at the intake and can be due to poor installation or upstream treatment of water entering the system. Vortex flow control devices are to be fitted with a pivoting by-pass door, which allows the manhole chamber to be drained down should a blockage occur. **Figure 24** shows a typical HydroBrake.



Figure 24: Typical HydroBrake Device

- 7.8 The proposed maintenance schedule for a vortex flow control device is shown in **Table 4**.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly	Monthly (for the first 3 months), then six monthly
	Remove sediment from upstream silt trap (sump)	Six monthly, or as required
	Hose down unit/chamber	Six monthly, or as required

Table 4: HydroBrake, Typical Maintenance Schedule

8. WATER TREATMENT

- 8.1 Water treatment will be provided through the incorporation of SuDS features in the development's drainage. If designed per CIRIA C753 guidance, attenuation basins can provide a good level of water treatment according to the C753 pollution mitigation indices.

- 8.2 Under the CIRIA C753 guidance, the development is categorised as having a "Low" pollution hazard level. The proposed attenuation basins would provide sufficient treatment for discharge to a watercourse.

Pollution Hazard Indices	Pollution Hazard Level	Total Suspended Solids	Metals	Hydro-carbons
Individual property driveways, residential car parks, low traffic roads and non-residential parking with infrequent change i.e.<300 movements/day.	Low	0.5	0.4	0.4
SuDS Mitigation Indices for Discharge to Surface Water				
SuDS Component Pollution Hazard Level	Total Suspended Solids		Metals	Hydro-carbons
Attenuation Basin	0.5		0.5	0.5
	Sufficient		Sufficient	Sufficient

Table 5: Water Treatment Indices

9. SUMMARY AND CONCLUSION

- 9.1 This FRA has been prepared by Paul Basham Associates to help assess the suitability of the site south of Battlefields Lane South, Holbeach, for a residential development of up to 185 dwellings.
- 9.2 The site is generally at low risk from flooding. It is not at risk from fluvial flooding and is defended from Tidal flooding events by the engineered flood defences along The Wash Estuary (Environment Agency, 2021). However, if The Wash Estuary defences were to be breached, for which there is a 1-in-150 chance of occurring in any given year (Environment Agency, 2021). Then the site could be flooded with a max flood depth of 1m, see **Figure 10 & Figure 11**.
- 9.3 To protect the development and the provide safe refuge within the dwellings from tidal/sea flooding, occurring as a result of a breach of The Wash Estuary defences site, proposed sited levels shall be;
- Site Levels = 4.17m
 - Finished Floor levels for residential dwellings – 4.32m
- 9.4 Surface water discharge from the development will be limited to developed area greenfield rates. Assuming 62.5% of the site will be impermeable post development, the following attenuation capacities shall be required to maintain developed area greenfield run-off rates.

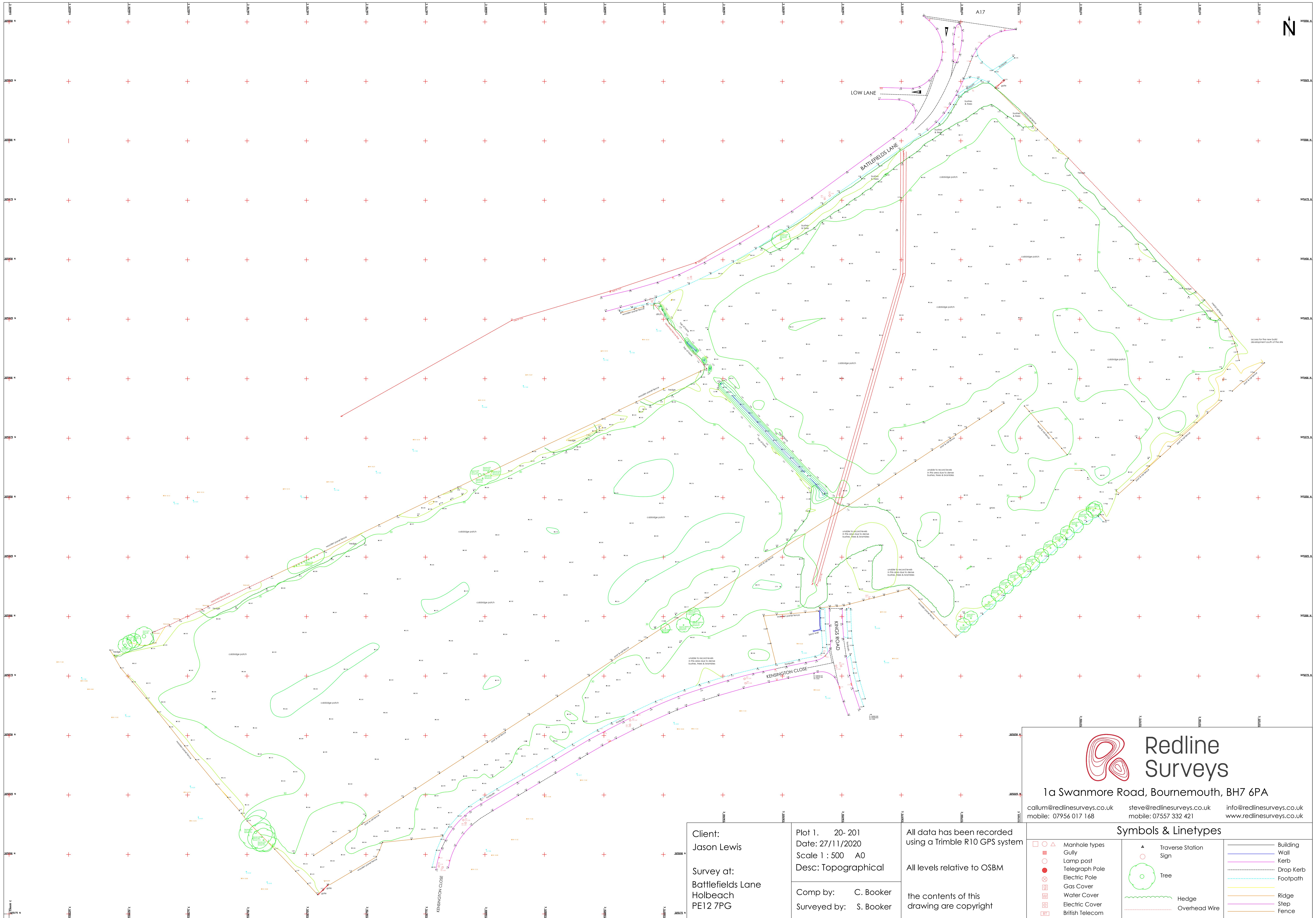
Catchment (developed Area)	Developed Area Greenfield Run-Off Rate (l/s)	Required attenuation m ³
East – 1.813ha	2.7	2188
West – 2.063ha	3.0	2224

- 9.5 The proposed attenuation will manage the development's surface run-off during a 1-in-100-year storm event, plus 40% climate change, and ensure flooding risk is not increased elsewhere following the development.
- 9.6 During the detailed design phase, it should be possible to reduce the footprint of the two main attenuation basins through spreading attenuation capacity across the site. For example, highway swales, permeable pavements and attenuation basins on roundabout islands could all contribute to providing the required attenuation capacity.
- 9.7 Given the overall low risk of flooding to the site, it's allocation in the South East Lincolnshire Adopted Local Plan, the ability to provide safe refuge and protection from flooding if site levels are increased as per **para 9.3**, and the practicality of attenuating additional surface run-off onsite; this report concludes that the site is suitable for residential development in terms of flood risk.

10. REFERENCES

- Environment Agency. (2021). *CCN/2020/198662, Product 4, Flood Risk Report*. Lincoln: Environment Agency.
- SE Lincs. (2018). *South East Lincolnshire Strategic Housing Land Availability Assessment*. South East Lincolnshire Joint Strategic Planning Committee.
- SE Lincs. (2019). *South East Lincolnshire Local Plan 2011-2036*. South East Lincolnshire Joint Strategic Planning Committee.
- SE Lincs, JSPC. (2017). *South East Lincolnshire Strategic Flood Risk Assessment*. South East Lincolnshire Joint Strategic Planning Committee.

Appendix A





**Redline
Surveys**
1a Swanmore Road, Bournemouth, BH7 6PA
callum@redlinesurveys.co.uk steve@redlinesurveys.co.uk info@redlinesurveys.co.uk
mobile: 07956 017 168 mobile: 07557 332 421 www.redlinesurveys.co.uk

Symbols & Linetypes

Manhole types	Traverse Station	Building
Gully	Sign	Wall
Lamp post	Tree	Kerb
Telegraph Pole	Hedge	Drop Kerb
Electric Pole	Overhead Wire	Footpath
Gas Cover		Ridge
Water Cover		Step
Electric Cover		Fence
British Telecom		

Client:
Jason Lewis

Survey at:
Battlefields Lane
Holbeach
PE12 7PG

Plot 1. 20- 201
Date: 27/11/2020
Scale 1 : 500 A0
Desc: Topographical

Comp by: C. Booker
Surveyed by: S. Booker

All data has been recorded using a Trimble R10 GPS system

All levels relative to OSBM

the contents of this drawing are copyright

Appendix B



Appendix C

RECORD OF BOREHOLE 1, HOLBEACH

TF 32 SE 24

BORING: STARTED 15/4/82

BORING: FINISHED 15/4/82

GROUND LEVEL

O.D.

3648-2455

HOLE SIZE 150mm dia to 3.0m
25mm dia probe to 5.1m

SAMPLE OR TEST		CHANGE OF STRATA			
DEPTH	TYPE	LEGEND	DEPTH	O.D. LEVEL	DESCRIPTION
0.3	D1				MADE GROUND - topsoil with brick fragments and gravel. Site: c 365 2/5
0.6	D2				
0.8	W1				
0.9	D3		1.0		
1.0-1.15	U(1)1				MADE GROUND - very soft dark grey and brown, organic silty clay with twigs, traces of peat and occasional brick fragments.
1.2	D4				
1.5	D5				
1.8	D6		1.8		
2.5	D7				Very soft/soft dark grey slightly organic silty CLAY
3.0	D8				
3.0-3.3	M(20)				
3.3-3.6	M(24)				
3.6-3.9	M(31)				
3.9-4.2	M(35)				
4.2-4.5	M(48)				
4.5-4.8	M(43)				
4.8-5.1	M(52)				
			5.1		

REMARKS Water met at 1.0m. It rose to 0.8m within 5 hours of completion.

KEY: D - DISTURBED SAMPLE
S - BULK DISTURBED SAMPLE
W - WATER SAMPLE
U - UNDISTURBED SAMPLE

S () STANDARD PENETRATION TEST
C () CONE PENETRATION TEST
NO. OF BLOWS FOR 300 mm PENETRATION IN BRACKETS

M () Mackintosh probe

TRIAL PIT/BORE HOLE LOG

NGR: 3607 2554

BH/TP No. 27 Machine Type Light Cable Percussion Dimension of Hole 200mm Dimension of Casing 200mm Sheet 1 of 2
 Site A151 Cherry Lane, Hobbsch Subway Location - See Plan Ground Level - m AOD
 Remarks (DD) = Drillers Description Head of water maintained from 4.00m Stand pipe installed at 4.50m

Date and Time 1986	Depth of Casing (m)	Depth of Water (m)	Sample		Change of Strata			Description of Strata	S.P.T.			Atterberg Limits			Density			Shear Strength			Chemical								
			No.	Type	Depth (m)	Section	Depth below GL (m)		Reduced Level OD (m)	Thick- ness of Stratum (m)	Pen't mm	N	NMC %	LL %	PL %	PI %	Bulk kg/m ³	Dry kg/m ³	CBR %	C kN/m ²	φ Degrees	Type of Shear Test	SO ₂ Class	pH	Organic %				
29/9						X X X	0.10		0.10	Soft light brown slightly sandy SILT (DD)																			
			1	D	0.00 - 0.50	X X X			0.70	Soft to firm dark brown SILT			17.7																
			2	S	0.50 - 0.95	X X					300	7	18.3																
						X X X	0.60		0.30	Soft to firm dark brown SILT with traces of light brown fine sand																			
			3	S	1.00 - 1.45	X X X			0.40	Soft to firm brown and light brown SILT with a little fine sand		10	22.8	GRADING															
						X X X	1.10																						
			4	S	1.50 - 1.95	X X X				Loose wet brown fine SAND and SILT		4	30.2																
						X X X	1.50		1.50	(becoming saturated at 2.0m)																			
			5	U100	2.00 - 2.45	X X X						8	26.4	GRADING			1851	1464											
						X X X																							
			6	S	2.60 - 3.05	X X X					300	5	31.7																
		3.00	8	W	3.00	X X X																							
			7	S	3.05 - 3.50	X X X				Loose gray/brown slightly silty fine SAND with traces of black fine sand		4	29.7	GRADING															
						X X X			3.00																				
			9	S	3.50 - 3.99	X X X					300	6																	
						X X X																							
			10	S	4.00 - 4.45	X X X					300	6																	
						X X X																							
Scale: As Shown			Disturbed Samples W Ground Water J Jar D Small Bag S SPT B Large Bulk			Undisturbed Samples U100 105 mm diameter U38 38 mm diameter			Rock Core			90 Recovery % 60 ROD % End of Core Run			In situ Tests Ground water Level Core Cutter Density			Core Cutter Density / CBR Sand Bottle Density CBR P Probe CBR			Symbols N SPT Blow Count d Dynamic CBR S Static CBR			Shear Test Type: V Shear Vane SB Shear Box TX Triaxial			C Cohesive Strength φ Internal Friction Angle C', φ' Effective Stress Results		

TF 32 NE / 1

TRIAL PIT/BORE HOLE LOG

BH/TP No. 27 Machine Type Light Cable Percussion Dimension of Hole 200mm Dimension of Casing 200mm Sheet 2 of 2
 Site A151 Cherry Lane, Hobbeach Subway Location See Plan Ground Level - m AOD
 Remarks (OD) = Drillers Description Head of water maintained from 4.00m Stand pipe installed at 4.50m

Date and Time	Depth of Casing (m)	Depth of Water (m)	Sample			Change of Strata			Description of Strata	S.P.T.			Atterberg Limits			Density		CBR	Shear Strength			Chemical		
			No.	Type	Depth (m)	Section	Depth below GL (m)	Reduced Level OD (m)		Thick-ness of Stratum (m)	Pen't mm	N	NMC %	LL %	PL %	PI %	Bulk γ kg/m ³		Dry γ_d kg/m ³	C kN/m ²	ϕ Degrees	Type of Shear Test	SO ₂ Class	pH
29/9	6.00		11	S	4.50 - 4.95	X X			Loose grey/brown slightly silty fine SAND with traces of black fine sand becoming medium dense at 5.00m	300	7													
		12	S	5.00 - 5.45	X X		3.00	300		7	GRADING													
		13	S	5.50 - 5.95	X X			300		8														
								6.00	Bottom of borehole															
												</												

GROUND LEVEL

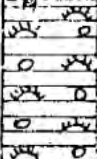
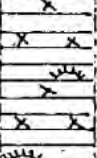
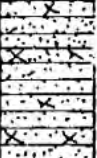
O.D.

TF32SE117

BORING: FINISHED

HOLE SIZE

27.3.79 362 246
150 mm dia to 9.0 m

SAMPLE OF TEST		CHANGE OF STRATA			
DEPTH	TYPE	LEGEND	DEPTH	O.D. LEVEL	DESCRIPTION
			0.6		MADE GROUND (Concrete followed by hardcore, ashes and soft silty clay).
1.0 1.0 1.65 - 1.95 1.95 - 2.25	B1 W1 S(3) S(6)		1.8		Very soft dark grey peaty clay with occasional gravel (probably MADE GROUND).
2.0 - 2.45	U(4)1				
2.5	D1				Soft grey silty peaty CLAY.
3.5 - 3.95	U(4)2				
4.0	D2				
5.0 5.0 - 5.45	D3 U(4)3		5.0		
7.0 - 7.45	U(4)4				Interbedded very soft grey silty CLAY and grey fine SAND.
7.5	U4				
8.5 - 8.95 8.5	U(4)5 B2		9.0		

REMARKS

- Groundwater entered the borehole at a depth of 1.0 m. Standing water level on withdrawal of casing on completion of boring 0.6 m.
- The upper 2.3 m was rebored in an attempt to get an undisturbed sample before 2 m depth.

This second sampling attempt failed also.

KEY: D — DISTURBED SAMPLE S () STANDARD PENETRATION TEST
 B — BULK DISTURBED SAMPLE C () CONE PENETRATION TEST
 W — WATER SAMPLE NO. OF BLOWS FOR 300 mm
 U — UNDISTURBED SAMPLE PENETRATION IN BRACKETS

Appendix D

Ref: J21-001-R01

Date: 21st January 2021

FAO: Chris Owen-Hughes

Paul Basham Associates

The Bothy, Cams Hall Estate
Fareham, Hampshire
PO16 8UT

Dear Chris,

Re: Targeted Site Investigation – Holbeach, Spalding, Lincolnshire

GCC was commissioned by Paul Basham Associates in January 2021 to undertake a targeted site investigation comprising the installation of groundwater wells and subsequent groundwater monitoring at the site. The location of the site and location of installed monitoring wells are shown on Figure 1.

The British Geological Survey Geology of Britain Viewer (online) shows the site to be underlain by superficial Tidal Flat Deposits (clay and silt) over bedrock Ampthill Clay Formation (mudstone).

5no. windowless sample boreholes were drilled on the 20th January and monitoring wells were installed in all boreholes to depths between 1.6mbgl and 3.1mbgl, comprising unslotted pipe with a bentonite seal around it, followed by slotted pipe to the base of installation with a gravel filter pack and approximately 0.5m of unslotted pipe extending above ground level to be visible to farm machinery. The monitoring well installation depths were limited by blowing silt in the borehole casing.

The ground conditions encountered in the boreholes were as follows:

WS101:

0.0-0.1m Soft brown silty CLAY (Topsoil)

0.1-2.9m Brown very clayey SILT

2.9-5.0m Grey very clayey SILT

Well: 0.72m unslotted, 2.0m slotted

WS102:

0.0-0.2m Soft brown silty CLAY (Topsoil)

0.2-3.2m Brown very clayey SILT

3.2-5.0m Grey very clayey SILT

Well: 0.56m unslotted, 1.0m slotted

WS103:

0.0-0.3m Soft brown silty CLAY (Topsoil)

0.3-3.0m Brown very clayey SILT

Well: 0.47m unslotted, 2.0m slotted

WS104:

0.0-0.2m Soft brown silty CLAY (Topsoil)

0.2-2.7m Brown very clayey SILT

2.7-3.5m Grey very clayey SILT

Well: 1.0m unslotted, 2.0m slotted

WS105:

0.0-0.2m Soft brown silty CLAY (Topsoil)

0.2-3.1m Brown very clayey SILT

3.1-3.5m Grey very clayey SILT

Well: 1.0m unslotted, 2.0m slotted

Groundwater monitoring was undertaken on completion of the site works with groundwater monitored between 0.75mbgl and 1.24mbgl. The full results are shown in Attachment 1.

Due to the shallow groundwater levels encountered & measured in the installed monitoring wells, no falling head testing were carried out.

Soil samples were also recovered from the boreholes for laboratory CBR testing. The results of the testing will be presented in a separate letter.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Antony Platt', enclosed within a rectangular box.

ANTONY PLATT

Director

For Ground Condition Consultants Ltd

A handwritten signature in black ink, appearing to read 'Rasmus Palmgren', enclosed within a rectangular box.

RASMUS PALMGREN

Director

For Ground Condition Consultants Ltd

Encl: Figure 1: Location plan
Groundwater monitoring data



GROUND GAS AND GROUNDWATER MONITORING RESULTS



SITE/REF: Holbeach						General Site comments			
DATE: 20/01/2021		1... of 1...							
OPERATOR(S): RP									
Ambient Conditions:		Barometric Pressure (mb)	CH ₄ (%v/v)	CO ₂ (%v/v)	O ₂ (%v/v)				PID (ppm)
Before Monitoring							EQUIPMENT		
After Monitoring									
Atmospheric Pressure Trend:							Instrument / Model Type Serial Number Comments Dip metre		
Ground Conditions:									
Weather Conditions:									

Ground Gas Note: "0" readings to be recorded as instrument detection limit

Borehole ID	Time	Flow (l/hr)	Relative Pressure (mb)	Steady CH ₄ (%v/v)	CO ₂ (%v/v)	O ₂ (%v/v)	Peak CH ₄ (%v/v)	% of Lower Explosive Limit	CO (ppm)	H ₂ S (ppm)	Balance (%)	PID (ppm)	Response Zone		Response Strata	Gas screening value CH ₄	Gas screening value CO ₂
													From (mbgl)	To (mbgl)			

Groundwater

Borehole ID	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	Free Phase LNAPL Thickness (m)	Free Phase DNAPL Thickness (m)	Water Quality Indicators					Well Volume (l)	Purge Volume (l)	Comments (samples)
					Eh	EC	pH	DO	Temp			
WS101	0.79	2.72										
WS102	0.93	1.56										
WS103	0.75	2.47										
WS104	1.08	3.02										
WS105	1.24	3.10										

Well volume (l) = (3.14 x (hole diameter (m)/2)² x (base dip (m) - standing water level (m)))x1000 (2l/m in 50mm well) Gas screening value = gas concentration (%) x gas flow rate (l/hr)

%v/v - Percentage volume by total volume; mbgl - metres below ground level; ppm - parts per million; mb - milibars; l/hr - litres per hour; wv - water vial; gb - 1l glass bottle; pb - 1l plastic bottle

Appendix E

Paul Basham Associates		Page 1
Lancaster Court Fareham Hampshire, PO15 5TU		
Date 06/01/2021 14:17 File 087.5011 - SOURCE CONTR...	Designed by MicroDrainage Checked by	
Innovyze Source Control 2019.1		

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	3.875	Urban	0.000
SAAR (mm)	581	Region Number	Region 5

Results l/s

QBAR Rural	5.7
QBAR Urban	5.7
Q100 years	20.2
Q1 year	4.9
Q30 years	13.6
Q100 years	20.2

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Paul Basham Associates		Page 1
Lancaster Court Fareham Hampshire, PO15 5TU		
Date 06/01/2021 14:22 File 087.5011 - SOURCE CONTR...	Designed by MicroDrainage Checked by	
Innovyze		Source Control 2019.1
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 Soil 0.300 Area (ha) 1.813 Urban 0.000 SAAR (mm) 581 Region Number Region 5 Results 1/s QBAR Rural 2.7 QBAR Urban 2.7 Q100 years 9.5 Q1 year 2.3 Q30 years 6.4 Q100 years 9.5		
©1982-2019 Innovyze		

Paul Basham Associates		Page 1
Lancaster Court Fareham Hampshire, PO15 5TU		
Date 06/01/2021 14:24 File 087.5011 - SOURCE CONTR...	Designed by MicroDrainage Checked by	
Innovyze		Source Control 2019.1
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 Soil 0.300 Area (ha) 2.063 Urban 0.000 SAAR (mm) 581 Region Number Region 5 Results l/s QBAR Rural 3.0 QBAR Urban 3.0 Q100 years 10.8 Q1 year 2.6 Q30 years 7.3 Q100 years 10.8		
©1982-2019 Innovyze		

Appendix F



(c) Crown copyright and database rights 2021 Ordnance Survey 100022432 Date: 08/01/21 Scale: 1:1000 Map Centre: 536928.325275 Data updated: 30/11/20 Our Ref: 472271 - 2 Wastewater Plan A1

This plan is provided by Anglian Water pursuant to its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2020 Ordnance Survey 100022432. This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other users of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

Foul Sewer	--- --	Outfall*	---
Surface Sewer	---		
Combined Sewer	---		
Final Effluent	---	Inlet*	●
Rising Main*	---		
Private Sewer*	---	Manhole*	●
Decommissioned Sewer*	---		

Ⓔ	Sewage Treatment Works
Ⓔ	Public Pumping Station
●	Decommissioned Pumping Station
	(Colour denotes effluent type)

c.owenhughes@paulbshamassociates.com
Battlefields Lane



Appendix G

Chris Owen-Hughes
c.owenhughes@paulbashamassociates.com

Our ref: CCN/2020/198662

Date: 13 January 2021

Dear Chris

Provision of Flood Risk Information for Battlefields Lane, Holbeach.

Thank you for your request to use our flood risk information for the above site. The information is set out below and attached. It is important you read any contextual notes on the maps provided.

If you are preparing a Flood Risk Assessment (FRA) for this site, please note this information may not be sufficient by itself to produce an adequate FRA to demonstrate the development is safe over its lifetime. Additional information may be required to carry out an appropriate assessment of all risks, such as the consequences of a breach in defences.

We aim to review our information on a regular basis, so if you are using this data more than twelve months from the date of this letter, please contact us again to check it is still valid.

1. Flood Map

The attached map includes the current Flood Map for your area. The Flood Map indicates the area at risk of flooding, **assuming no flood defences exist**, for a flood with a 0.5% chance of occurring in any year for flooding from the sea, or a 1% chance of occurring for fluvial (river) flooding. It also shows the extent of the Extreme Flood Outline which represents the extent of a flood with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

In some locations, such as around the fens and the large coastal floodplains, showing the area at risk of flooding assuming no defences may give a slightly misleading picture in that if there were no flood defences, water would spread out across these large floodplains. This flooding could cover large areas of land but to relatively shallow depths and could leave pockets of locally slightly higher land as isolated dry islands. It is important to understand the actual risk of the flooding to these dry islands, particularly in the event of defence failure.

The Flood Map also shows the location of formal raised flood defences and flood storage reservoirs. It represents areas at risk of flooding for present day only and does not take account of climate change.

The Flood Map only indicates the extent and likelihood of flooding from rivers or the sea. It should also be remembered flooding may occur from other sources such as surface water sewers, road drainage, etc.

2. History of Flooding

With regards to the history of flooding I can advise we do not have any records of flooding in this area. It is possible recent flooding may have occurred which we are currently investigating, therefore this information may be subject to change. It is possible other flooding may have

occurred which other organisations, such as the Lead Local Flood Authority (ie top tier council), Local Authority or Internal Drainage Board (where they exist), may have records.

3. Schemes in the area

There are no ongoing capital projects to reduce or sustain the current flood risk to this site.

4. Fluvial Flood Risk Information

This site is not considered to be at risk of flooding from main rivers.

The site may be at risk from local ordinary watercourses for which other risk management authorities, such as the Lead Local Flood Authority (ie top tier council) or Internal Drainage Board (where they exist) have responsibility.

5. Tidal Flood Risk Information

5.1 Tidal Defence Information

The existing tidal defences protecting this site consist of earth embankments. They are in fair condition and reduce the risk of flooding (at the defence) to a 0.67% (1 in 150) chance of occurring in any year. We inspect these defences routinely to ensure potential defects are identified.

Refer to paragraph 3.1 for details of any ongoing capital projects to reduce the flood risk to this site.

5.2 Tidal Flood Levels

The attached table shows our current best estimate for extreme tide levels.

Levels for the Humber Estuary have an assessment date of 2014, with others having an assessment date of 2017, which should be used in any consideration of future increases due to climate change.

6. Modelled Hazard Mapping

For certain locations we have carried out modelling to map the maximum values of flood depth, velocity and hazard rating (danger to people) resulting from overtopping and / or breaching of defences at specific locations for a number of scenarios.

At present this information is available along the full coastal / tidal floodplain, except the tidal Witham Haven in Boston (upstream of Hobhole) where only breaching and not overtopping has been modelled and the tidal River Welland upstream of Fosdyke Bridge where neither breaching nor overtopping are available. Hazard mapping is also available for fluvial flood risk in Northampton, Lincoln, Wainfleet and some isolated rural locations.

The number of locations we have this information for is expected to increase in time.

6.1 Hazard Mapping – Breaching

The attached maps show the maximum values of flood depth, velocity and hazard rating (danger to people) resulting from breaching of the defences at specific locations for the scenarios below. For some locations the breach mapping also includes flooding from overtopping if this is expected in that scenario. The location of modelled tidal breaches is shown on a separate attached map.

- Year 2115 0.5% (1 in 200) chance
- Year 2115 0.1% (1 in 1000) chance

Your site is not affected by breaching of the defences for the present day (2006) scenarios.

7. Development Planning

If you would like local guidance on preparing a flood risk assessment for a planning application, please contact our Sustainable Places team at Inplanning@environment-agency.gov.uk. It will help if you mention this data request and attach your site location plan.

We provide free preliminary advice; additional/detailed advice, review of draft FRAs and meetings are chargeable at a rate set to cover our costs, currently £100 (plus VAT) per hour of staff time. Further details are available on our website at <https://www.gov.uk/guidance/developers-get-environmental-advice-on-your-planning-proposals>.

General advice on flood risk assessment for planning applications can be found on GOV.UK at <https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications>

Climate change will increase flood risk due to overtopping of defences. Please note, unless specified otherwise, the climate change data included has an allowance for 20% increase in flow. Updated guidance on how climate change could affect flood risk to new development - 'Flood risk assessments: climate change allowances' was published on GOV.UK in February 2016. The appropriate updated climate change allowance should be applied in a Flood Risk Assessment.

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

8. Data Licence and Other Supporting Information

We respond to requests for recorded information we hold under the Freedom of Information Act 2000 (FOIA) and the associated Environmental Information Regulations 2004 (EIR).

This information is provided in accordance with the Open Government Licence which can be found here: <http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

Further information on flood risk can be found on the GOV.UK website at: <https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather>

9. Other Flood Risk Management Authorities

The information provided with this letter relates to flood risk from main river or the sea. Additional information may be available from other risk management authorities, such as the Lead Local Flood Authority (ie top tier council) or Internal Drainage Board (where they exist).

I hope we have correctly interpreted your request. If you have any queries or would like to discuss the content of this letter further please contact James Beckett using the details below.

Yours sincerely,



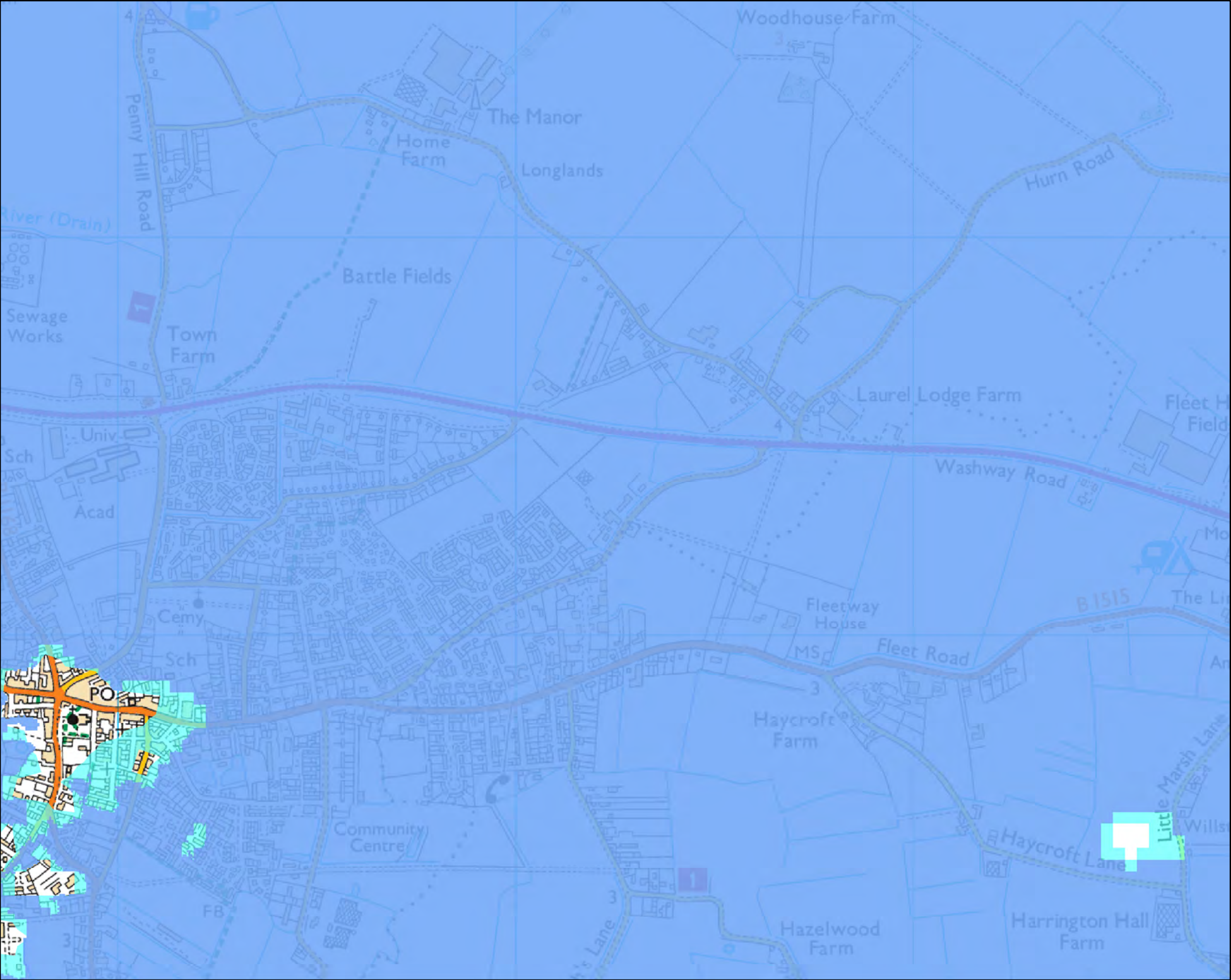
p.p.

Alistair Windler
Partnerships and Strategic Overview Team Leader –Welland and Nene

Direct dial 020 302 53535
Direct e-mail PSOWN@environment-agency.gov.uk

Enc.
Flood Map
Estimated Tide Levels
Tidal Breach Locations Map
Hazard Mapping – Breaching (2 maps)

Flood Map centred on TF 37252 25364 - created January 2021 [Ref: CCN-2020-198662]



Scale 1:10,000



- Legend**
- Main River
 - Raised Defences
 - Flood Storage Areas
 - Area at Risk of Flooding from Rivers or The Sea
 - Extreme Flood Outline

Dark blue shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded:

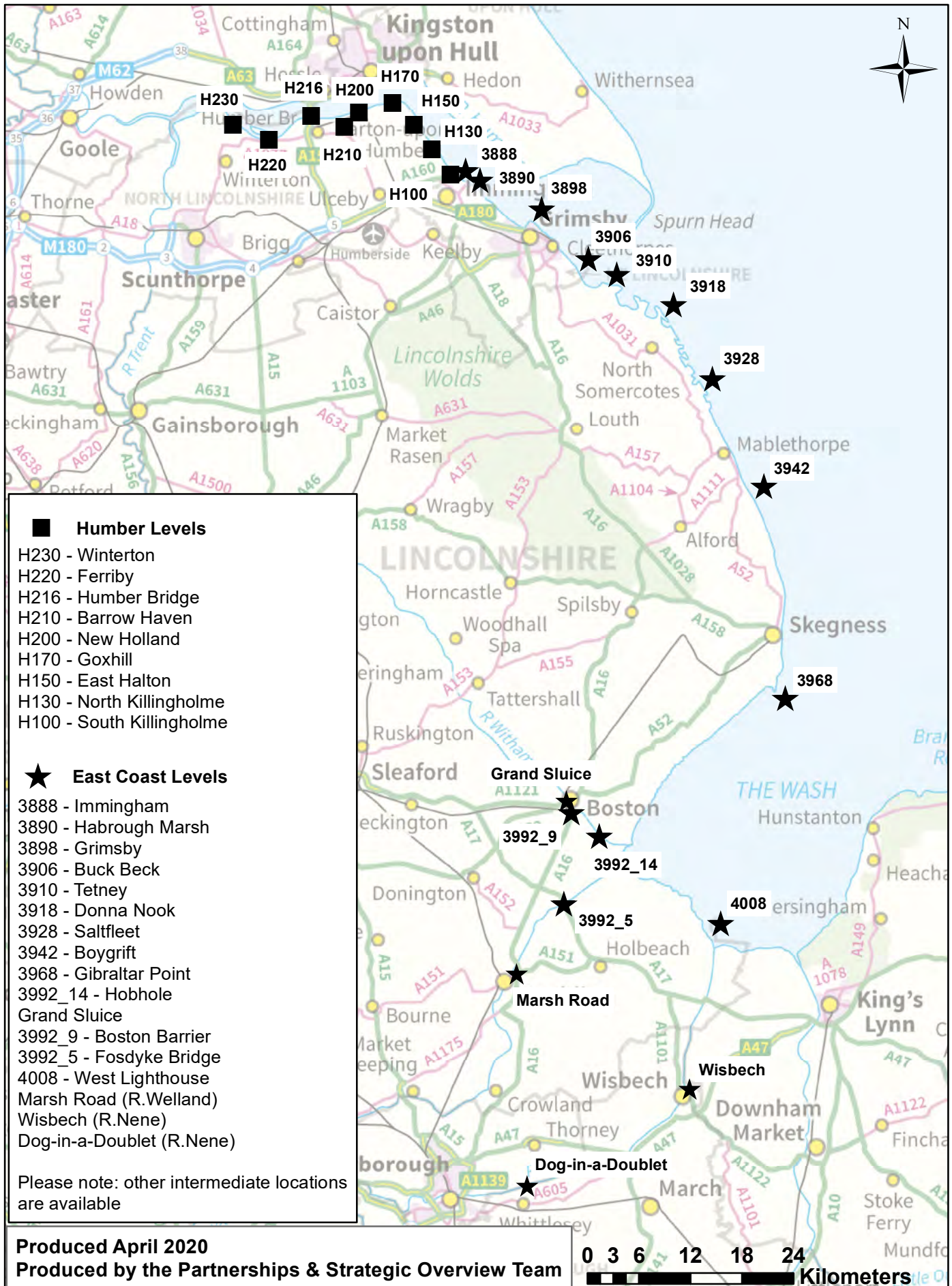
- from the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year.
- or from a river by a flood that has a 1% (1 in 100) or greater chance of happening each year.

Light blue shows the extent of the Extreme Flood Outline, which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements. Sites outside the two extents, but behind raised defences, may be affected by flooding if the defences are overtopped or fail.

Created by the Partnerships and Strategic Overview Team, Kettering

Tidal Level Location Map Lincolnshire & Northamptonshire Area



2014 Interim Water Level Profile

REF	LOCATION	EASTING	NORTHING	ANNUAL CHANCE (1 IN X) OF TIDE LEVEL METRES ODN																				
				1			10			50			100			200			300			1000		
				Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound		
				5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%
H230	Winterton	493420	422830	5.13	5.14	5.15	5.47	5.51	5.56	5.67	5.74	5.82	5.74	5.83	5.92	5.81	5.90	6.00	5.84	5.94	6.03	5.94	6.02	6.06
H220	Ferriby	497550	421150	5.03	5.04	5.05	5.38	5.42	5.47	5.59	5.67	5.77	5.67	5.77	5.89	5.74	5.86	6.00	5.78	5.91	6.06	5.91	6.04	6.19
H216	Humber Bridge	502478	423914	4.97	4.98	4.99	5.33	5.37	5.42	5.55	5.64	5.74	5.64	5.75	5.88	5.72	5.86	6.02	5.75	5.92	6.10	5.88	6.09	6.31
H210	Barrow Haven	506380	422620	4.91	4.92	4.93	5.27	5.31	5.36	5.50	5.60	5.72	5.60	5.73	5.89	5.69	5.86	6.08	5.74	5.94	6.18	5.87	6.17	6.51
H200	New Holland	508020	424330	4.86	4.87	4.88	5.21	5.26	5.31	5.45	5.55	5.67	5.55	5.68	5.84	5.64	5.81	6.03	5.68	5.89	6.13	5.82	6.12	6.47
H170	Goxhill	511970	425440	4.66	4.67	4.68	5.00	5.04	5.09	5.24	5.34	5.46	5.33	5.47	5.65	5.43	5.61	5.85	5.47	5.69	5.96	5.62	5.95	6.37
H150	East Halton	514450	422870	4.58	4.59	4.60	4.91	4.96	5.01	5.15	5.25	5.38	5.25	5.39	5.57	5.34	5.53	5.77	5.39	5.62	5.90	5.54	5.89	6.33
H130	North Killingholme	516530	420000	4.50	4.51	4.52	4.82	4.87	4.92	5.05	5.15	5.28	5.15	5.28	5.46	5.24	5.42	5.66	5.29	5.51	5.78	5.43	5.77	6.19
H100	South Killingholme	518700	417120	4.41	4.41	4.42	4.72	4.77	4.82	4.95	5.05	5.17	5.05	5.18	5.35	5.14	5.32	5.55	5.18	5.40	5.67	5.33	5.66	6.08
3888	Immingham*	520440	417625	4.16	4.17	4.19	4.50	4.53	4.62	4.73	4.80	5.00	4.83	4.93	5.19	4.93	5.06	5.41	4.98	5.14	5.55	5.15	5.38	6.01

NOTE:

- The base date for the data is 2014.
- The levels are still water levels. Depending on the use of the data it may be necessary to consider wave heights and / or joint probability analysis of water level and other variables.
- Levels for other annual chance probabilities are available if required.
- The information is due to be updated in mid-2020
- *The levels for Immingham are taken from the 2018 Coastal Flood Boundary dataset.

East Coast and Wash: Immingham to the West Lighthouse

2018 Coastal Flood Boundary Extreme Sea Levels

CFB REF	LOCATION	EASTING	NORTHING	ANNUAL CHANCE (1 IN X) OF TIDE LEVEL IN METRES ODN																						
				1			10			50			100			200			300			1000				
				Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound				
				2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%
3888	Immingham	520440	417625	4.16	4.17	4.19	4.50	4.53	4.62	4.73	4.80	5.00	4.83	4.93	5.19	4.93	5.06	5.41	4.98	5.14	5.55	5.15	5.38	6.01		
3890	Haborough Marsh	522100	416512	4.14	4.15	4.17	4.48	4.51	4.60	4.70	4.77	4.97	4.80	4.90	5.16	4.90	5.03	5.38	4.94	5.10	5.51	5.11	5.34	5.97		
3898	Grimsby	529295	413162	3.98	3.99	4.01	4.31	4.34	4.43	4.53	4.60	4.80	4.61	4.71	4.97	4.71	4.84	5.19	4.74	4.90	5.31	4.88	5.11	5.74		
3906	Buck Beck	534709	407369	3.87	3.88	3.90	4.19	4.23	4.31	4.41	4.50	4.68	4.50	4.61	4.86	4.61	4.75	5.10	4.64	4.82	5.22	4.80	5.05	5.66		
3910	Tetney	538035	405537	3.85	3.86	3.89	4.17	4.22	4.30	4.40	4.50	4.67	4.49	4.61	4.86	4.60	4.75	5.10	4.63	4.82	5.21	4.80	5.06	5.66		
3918	Donna Nook	544641	401997	3.82	3.83	3.86	4.14	4.19	4.27	4.38	4.48	4.65	4.47	4.60	4.85	4.58	4.74	5.10	4.63	4.82	5.22	4.81	5.08	5.68		
3928	Saltfleet	549131	393360	3.78	3.79	3.82	4.11	4.16	4.26	4.36	4.46	4.64	4.47	4.59	4.86	4.57	4.74	5.11	4.63	4.83	5.25	4.83	5.11	5.74		
3942	Boygrift	555131	380860	3.72	3.74	3.77	4.06	4.11	4.22	4.33	4.43	4.65	4.43	4.57	4.87	4.56	4.73	5.13	4.62	4.83	5.28	4.85	5.15	5.82		
3968	Gibraltar Point	557652	356181	4.16	4.17	4.20	4.51	4.56	4.67	4.76	4.85	5.08	4.85	4.97	5.27	4.94	5.10	5.49	4.99	5.18	5.63	5.14	5.41	6.09		
3992_14	Hobhole	535990	340116	4.96	4.97	5.01	5.40	5.44	5.56	5.66	5.76	5.98	5.78	5.90	6.20	5.88	6.04	6.44	5.92	6.11	6.57	6.03	6.31	6.99		
	Grand Sluice*	532366	344510	4.93	4.94	4.98	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3		
3992_9	Boston Barrier	532754	342852	4.93	4.94	4.98	5.41	5.45	5.57	5.73	5.83	6.05	5.85	5.97	6.27	5.93	6.09	6.49	5.94	6.13	6.59	5.98	6.26	6.94		
3992_5	Fosdyke Bridge	531886	332234	4.87	4.88	4.92	5.31	5.35	5.47	5.58	5.68	5.90	5.71	5.83	6.13	5.82	5.98	6.38	5.87	6.06	6.52	6.01	6.29	6.97		
4008	West Lighthouse	550094	329971	4.87	4.88	4.91	5.21	5.26	5.37	5.46	5.56	5.78	5.56	5.68	5.98	5.66	5.82	6.21	5.71	5.90	6.35	5.86	6.14	6.81		
-	Marsh Road	525988	324065	-	5.04	-	-	5.44	-	-	5.73	-	-	5.85	-	-	5.98	-	-	-	-	-	-	-		
-	Wisbech	546110	309940	-	4.83	-	-	5.25	-	-	5.53	-	-	5.66	-	-	5.78	-	-	-	-	-	-	-		
-	Dog-in-a-Doublet	527200	299287	-	3.67	-	-	4.00	-	-	4.22	-	-	4.32	-	-	4.42	-	-	-	-	-	-	-		

See next page for notes

2018 Coastal Flood Boundary Extreme Sea Levels

NOTES:

The following notes apply to all CFB sites (ie all on table excluding Marsh Road, Wisbech, Dog-in-a-Doublet)

- The base date for the data is 2017.
- The levels are still water levels. Depending on the use of the data it may be necessary to consider wave heights and / or joint probability analysis of water level and other variables.
- Levels for other annual chance probabilities are available if required.
- For additional information relating to the 2018 Coastal Flood Boundary Extreme Sea Levels or to access the full dataset for the above sites or intermediate locations refer to the Defra Metadata Catalogue at <https://deframetadata.com/geonetwork/srv/eng/catalog.search#/metadata/84a5c7c0-d465-11e4-b0bd-f0def148f590>

The following notes apply to all Marsh Road, Wisbech, Dog-in-a-Doublet

- The base date for the data is 2006
- The levels are still water levels. Depending on the use of the data it may be necessary to consider wave heights and / or joint probability analysis of water level and other variables.
- Levels for other annual chance probabilities are available if required.
- These levels will be updated as their respective tidal river models are updated.

The following notes apply to Grand Sluice

- The data is based on CFB 2018 data for Boston Barrier site, capped at 5.3mAOD to reflect use of the barrier.
- The base date for the data is 2017
- The levels are still water levels. Depending on the use of the data it may be necessary to consider wave heights and / or joint probability analysis of water level and other variables.
- For additional information relating to the 2018 Coastal Flood Boundary Extreme Sea Levels or to access the full dataset for the above sites or intermediate locations refer to the Defra Metadata Catalogue at <https://deframetadata.com/geonetwork/srv/eng/catalog.search#/metadata/84a5c7c0-d465-11e4-b0bd-f0def148f590>



^ Modelled Breach Locations



This map indicates the location of where we have modelled the consequence of breaches along the coastline and tidal rivers. We have mapped the the maximum values of Hazard Rating (Danger to People), Depth and Velocity.

We have not assumed that all breaches occur at the same time, but have modelled each breach individually and overlaid the results to find the maximum values.

Our modelling only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. Our defences generally provide a good standard of flood defence but a risk of breaching remains.

Please contact the Environment Agency for information on how these maps are used in the management of flood risk.



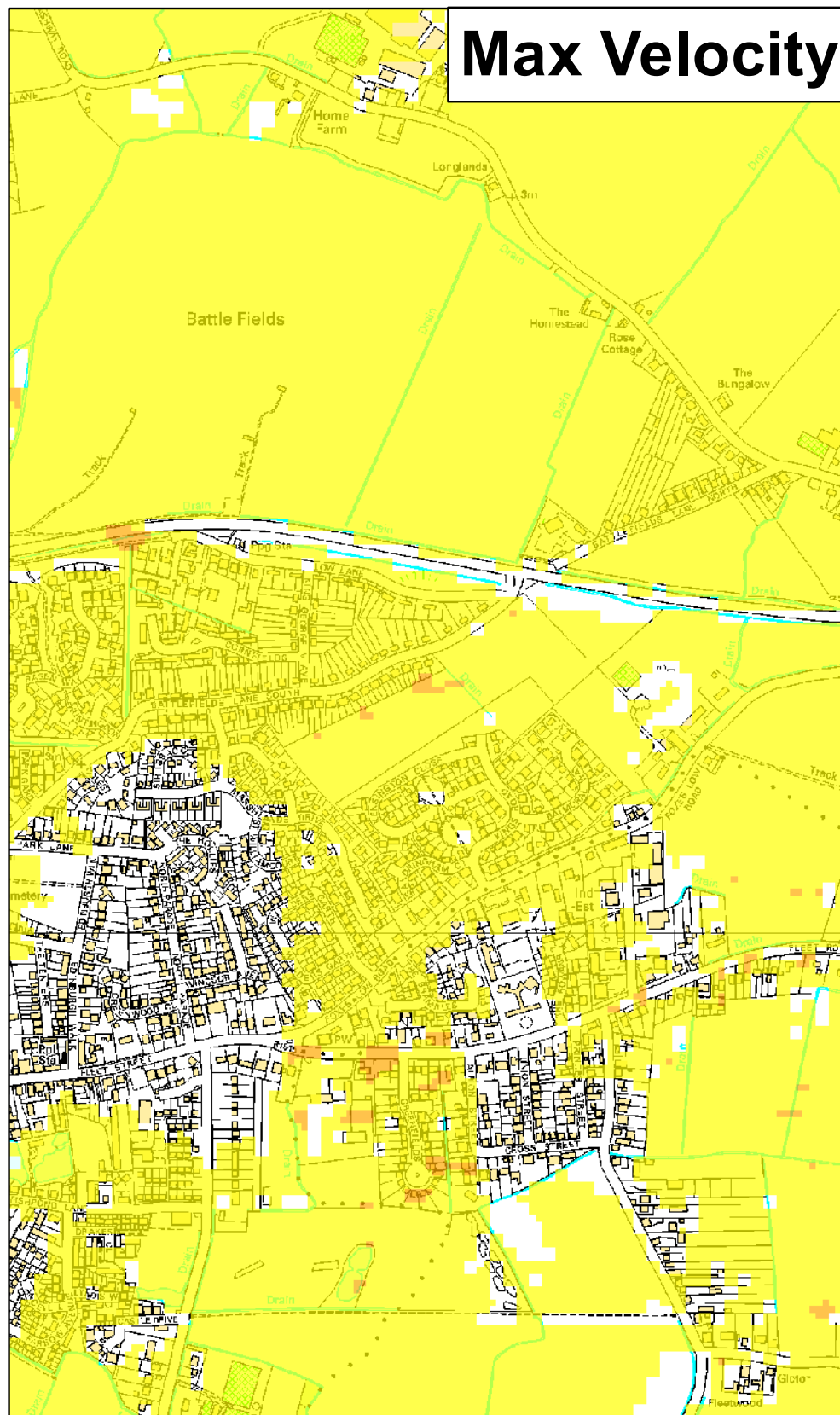
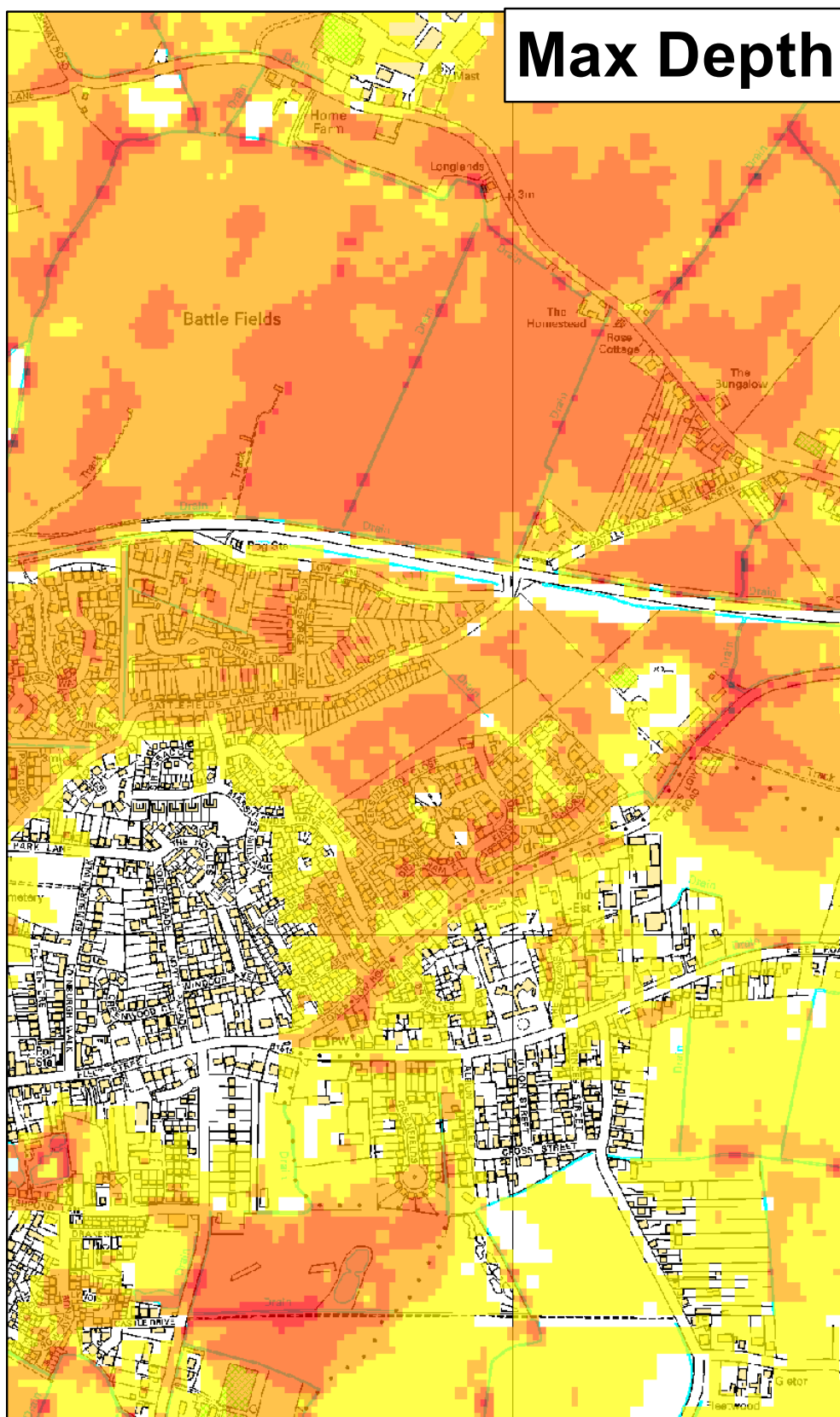
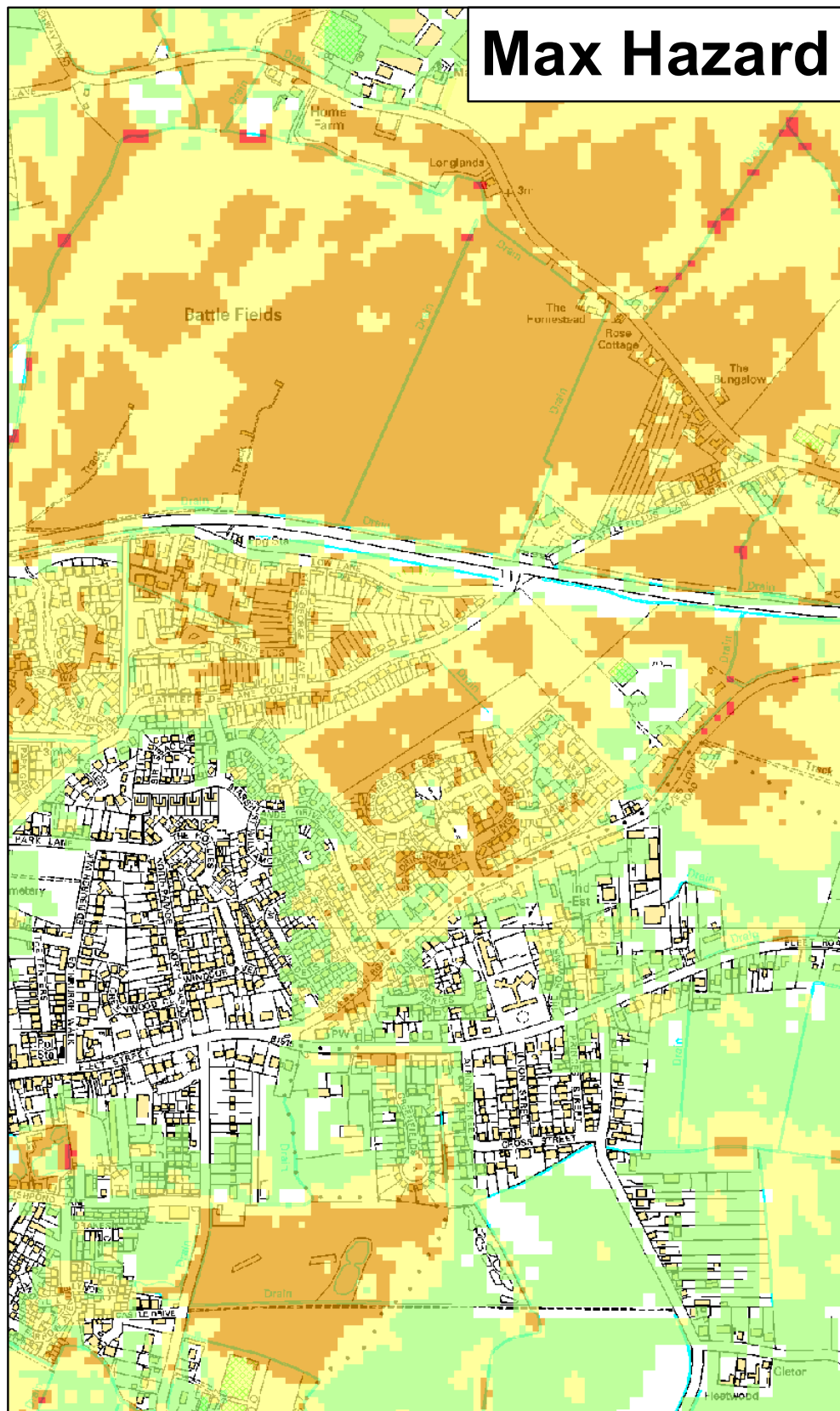
Produced by the Partnership and Strategic Overview Team, Lincoln
General Enquiries No: 03708 506 506

Northern Area Tidal Hazard Mapping

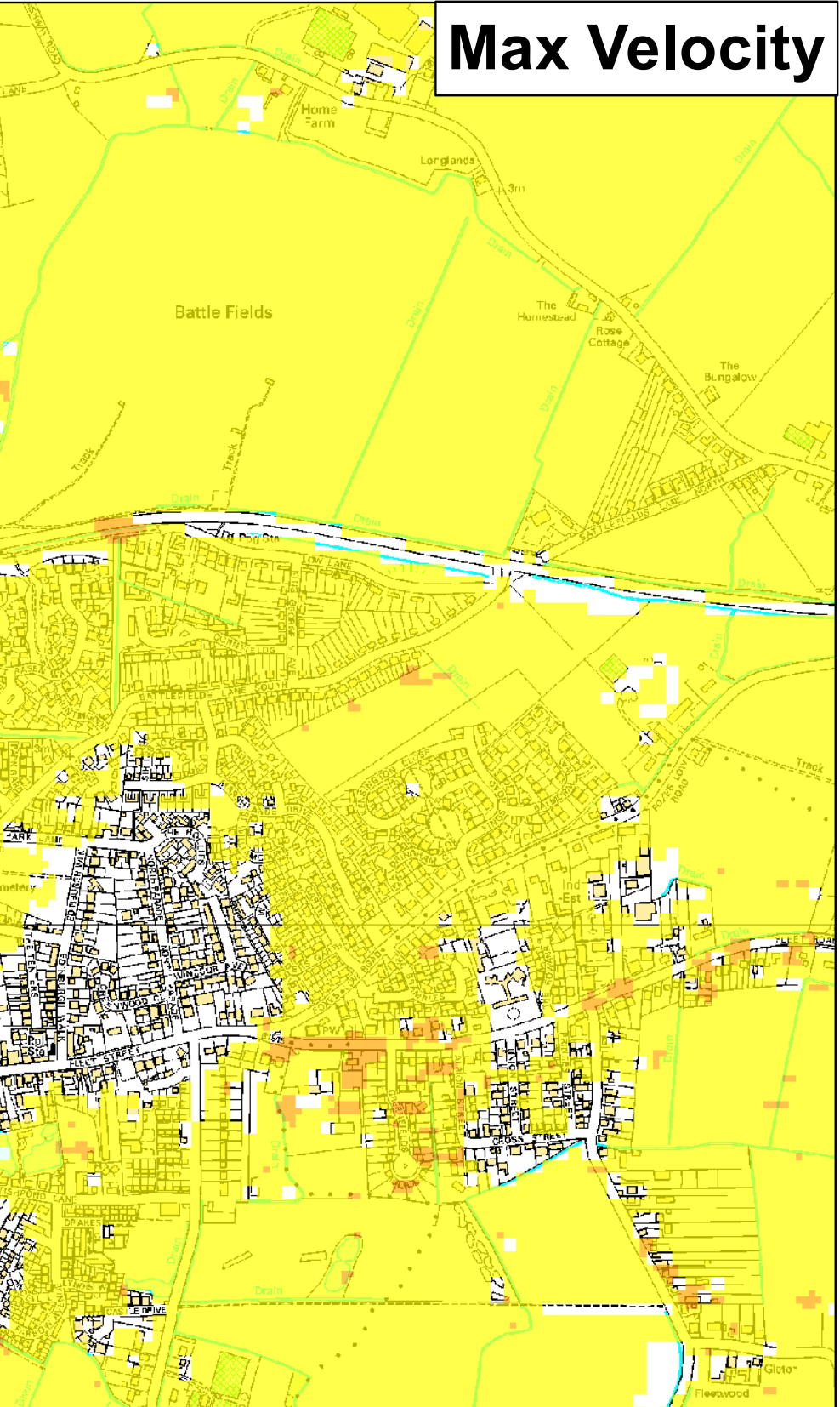
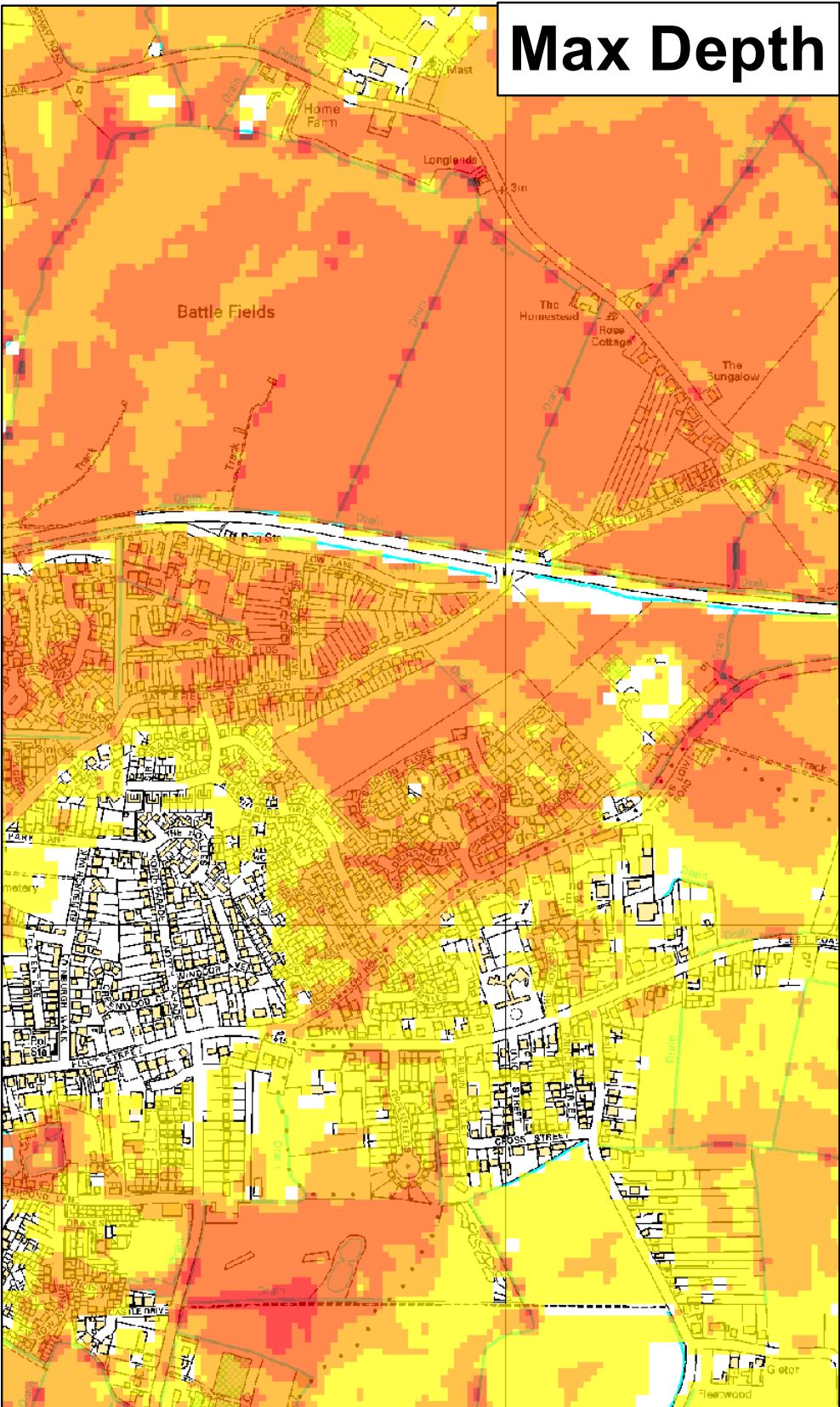
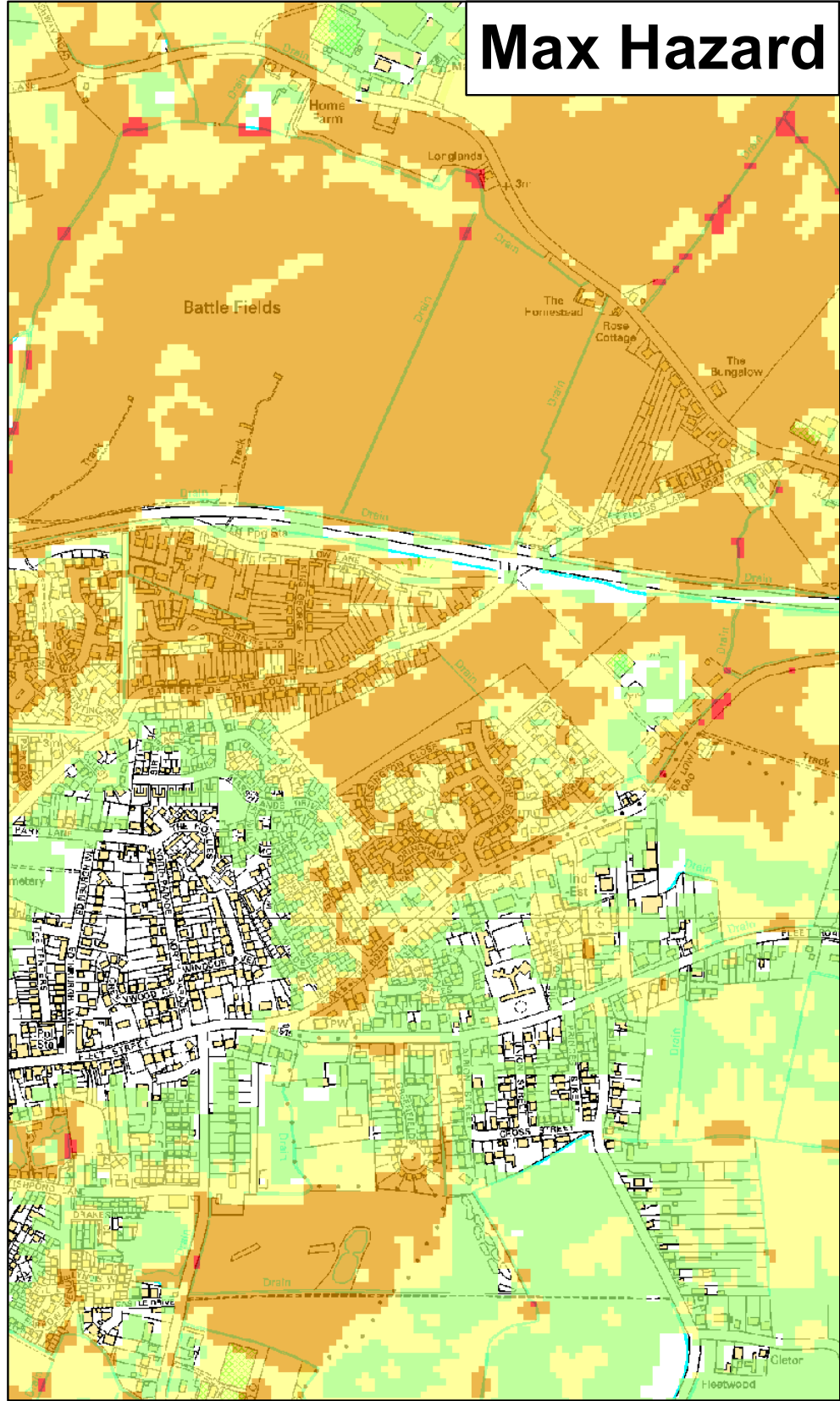
Location of Modelled Breaches

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General Enquiries No: 03708 506 506.
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★ Modelled Breach Locations - see also the accompanying plan "Location of Modelled Breaches"								This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped. The map is based on computer modelling of simulated breaches at specific locations. Each breach has been modelled individually and the results combined to create this map. Multiple breaches, other combinations of breaches, different sized tidal surges or flood flows may all give different results. The map only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. The likelihood of a breach occurring will depend on a number of different factors, including the construction and condition of the defences in the area. A breach is less likely where defences are of a good standard, but a risk of breaching remains.		
Max Hazard (Flood Risk to People : FD2320)		Max Depth (m)		Max Velocity (m/s)		Lincolnshire and Northamptonshire Tidal Breaching Hazard Mapping				
Less than 0.75 (Low Hazard) Between 0.75 and 1.25 (Danger for Some) Between 1.25 and 2.0 (Danger for Most) Greater than 2.0 (Danger for All)		0 - 0.25 0.25 - 0.50 0.50 - 1.0 1.0 - 1.6 1.6 +		0 - 0.3 0.3 - 1.0 1.0 - 1.5 1.5 - 2.5 2.5 +		Map Centred on TF 36867 25334				
Date Printed	January 2021	Scenario year	2115	Scenario Annual Chance	0.5% (1 in 200)	CCN Number	CCN-2020- 198573		This map is reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationary Office. Crown copyright. All rights reserved. Environment Agency 100026380, 2021. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings.	
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★ **Modelled Breach Locations** - see also the accompanying plan "Location of Modelled Breaches"

Max Hazard (Flood Risk to People : FD2320)	Max Depth (m)	Max Velocity (m/s)
Less than 0.75 (Low Hazard)	0 - 0.25	0 - 0.3
Between 0.75 and 1.25 (Danger for Some)	0.25 - 0.50	0.3 - 1.0
Between 1.25 and 2.0 (Danger for Most)	0.50 - 1.0	1.0 - 1.5
Greater than 2.0 (Danger for All)	1.0 - 1.6	1.5 - 2.5
	1.6 +	2.5 +

This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.

The map is based on computer modelling of simulated breaches at specific locations. Each breach has been modelled individually and the results combined to create this map. Multiple breaches, other combinations of breaches, different sized tidal surges or flood flows may all give different results.

The map only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. The likelihood of a breach occurring will depend on a number of different factors, including the construction and condition of the defences in the area. A breach is less likely where defences are of a good standard, but a risk of breaching remains.

Date Printed January 2021

Scenario year 2115

Scenario Annual Chance 0.1%
(1 in 1000)

CCN Number CCN-2020-198573

General Enquiries No: 03708 506 506. Weekday Daytime calls cost 5p plus up to 6p per minute from BT Weekend Unlimited. Mobile and other providers' charges may vary

**Lincolnshire and Northamptonshire
Tidal Breaching Hazard
Mapping**

Map Centred on TF 36867 25334

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Appendix H

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Lancaster Court Fareham Hampshire, PO15 5TU	BATTLEFIELDS HOLBEACH FRA	
Date 26/01/2021 File 087.5011 - East network...	Designed by COH Checked by AJS	
Innovyze	Network 2019.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.700	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Surface Network 2

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.000	8-12	0.000	16-20	0.000	24-28	1.410
4-8	0.000	12-16	0.000	20-24	0.000	28-32	0.403

Total Area Contributing (ha) = 1.813

Total Pipe Volume (m³) = 9.826

Network Design Table for Surface Network 2

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	171.645	0.000	0.0	1.813	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	5.517	0.055	100.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	24.299	0.243	100.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	45.660	0.952	48.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL E (m)	I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	28.33	3.500	1.813	0.0	0.0	0.0	0.12	4.9«	245.5
1.001	50.00	28.40	3.500	1.813	0.0	0.0	0.0	1.31	52.0«	245.5
1.002	50.00	28.71	3.445	1.813	0.0	0.0	0.0	1.31	52.0«	245.5
1.003	50.00	29.11	3.202	1.813	0.0	0.0	0.0	1.89	75.3«	245.5

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Innovyze		Network 2019.1

Manhole Schedules for Surface Network 2

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S10	4.100	0.600	Open Manhole	1200	1.000	3.500	225				
S11	4.100	0.600	Open Manhole	1050	1.001	3.500	225	1.000	3.500	225	
S12	4.100	0.655	Open Manhole	1200	1.002	3.445	225	1.001	3.445	225	
S13	4.100	0.898	Open Manhole	1200	1.003	3.202	225	1.002	3.202	225	
S14	4.100	1.850	Open Manhole	0		OUTFALL		1.003	2.250	225	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S10	537121.713	325408.775	537121.713	325408.775	Required	
S11	536978.454	325314.229	536978.454	325314.229	Required	
S12	536973.130	325312.784	536973.130	325312.784	Required	
S13	536949.635	325306.584	536949.635	325306.584	Required	
S14	536942.686	325351.712			No Entry	

Free Flowing Outfall Details for Surface Network 2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D, L (mm)	W (mm)
---------------------	--------------	--------------	--------------	------------------	-----------	--------

1.003	S14	4.100	2.250	0.000	0	0
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Lancaster Court Fareham Hampshire, PO15 5TU	BATTLEFIELDS HOLBEACH FRA	
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Simulation Criteria for Surface Network 2

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.700	Storm Duration (mins)	30
Ratio R	0.400		

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Lancaster Court Fareham Hampshire, PO15 5TU	BATTLEFIELDS HOLBEACH FRA	
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Innovyze	Network 2019.1	

Online Controls for Surface Network 2

Hydro-Brake® Optimum Manhole: S12, DS/PN: 1.002, Volume (m³): 0.9

Unit Reference	MD-SHE-0085-2700-0555-2700
Design Head (m)	0.555
Design Flow (l/s)	2.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	85
Invert Level (m)	3.445
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.555	2.7
Flush-Flo™	0.168	2.7
Kick-Flo®	0.382	2.3
Mean Flow over Head Range	-	2.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.5	1.200	3.8	3.000	5.9	7.000	8.8
0.200	2.7	1.400	4.1	3.500	6.3	7.500	9.1
0.300	2.6	1.600	4.4	4.000	6.8	8.000	9.4
0.400	2.3	1.800	4.6	4.500	7.1	8.500	9.7
0.500	2.6	2.000	4.9	5.000	7.5	9.000	10.0
0.600	2.8	2.200	5.1	5.500	7.9	9.500	10.3
0.800	3.2	2.400	5.3	6.000	8.2		
1.000	3.5	2.600	5.5	6.500	8.5		

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Innovyze	Network 2019.1	

Storage Structures for Surface Network 2

Tank or Pond Manhole: S10, DS/PN: 1.000

Invert Level (m) 3.500

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	3179.8	0.201	3500.8	0.401	3822.9	0.501	3984.8
0.101	3340.7	0.301	3661.5	0.500	3983.2		

Volume Summary (Static)

Length Calculations based on Centre-Centre

Storage			
Pipe Number	USMH Name	Structure Volume (m ³)	Total Volume (m ³)
1.000	S10	2188.427	2188.427
1.001	S11	0.000	0.000
1.002	S12	0.000	0.000
1.003	S13	0.000	0.000
Total		2188.427	2188.427

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Innovyze	Network 2019.1	

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 2

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
 Number of Online Controls 1 Number of Time/Area Diagrams 0
 Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
 Region England and Wales Cv (Summer) 0.750
 M5-60 (mm) 18.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
 DVD Status OFF
 Inertia Status OFF

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600,
 720, 960, 1440, 2160, 2880, 4320, 5760,
 7200, 8640, 10080
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 40, 40, 40

									Water
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Level (m)
1.000	S10	2880 Winter	100	+40%	30/180 Winter				3.942
1.001	S11	7200 Winter	30	+40%	30/240 Winter				3.950
1.002	S12	7200 Winter	30	+40%	1/5760 Winter				3.955
1.003	S13	7200 Winter	30	+40%					3.229

Surcharged Flooded				Pipe		Level	
PN	US/MH Name	Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status
1.000	S10	0.217	0.000	0.20		3.2	FLOOD RISK
1.001	S11	0.225	0.000	0.31		10.2	FLOOD RISK
1.002	S12	0.285	0.000	0.05		2.6	FLOOD RISK
1.003	S13	-0.197	0.000	0.04		2.6	OK

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Innovyze	Network 2019.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.700	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Surface Network 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.000	4-8	0.000	8-12	1.049	12-16	1.014

Total Area Contributing (ha) = 2.063

Total Pipe Volume (m³) = 7.051

Network Design Table for Surface Network 1

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	56.262	0.000	0.0	2.063	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	7.707	0.564	13.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	61.178	0.408	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	52.199	0.348	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL Σ (m)	I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	12.65	3.500	2.063	0.0	0.0	0.0	0.12	4.9«	279.4
1.001	50.00	12.68	3.500	2.063	0.0	0.0	0.0	3.56	141.5«	279.4
1.002	50.00	13.64	2.936	2.063	0.0	0.0	0.0	1.07	42.4«	279.4
1.003	50.00	14.46	2.528	2.063	0.0	0.0	0.0	1.07	42.4«	279.4

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Innovyze		Network 2019.1

Manhole Schedules for Surface Network 1

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1	4.100	0.600	Open Manhole	1200	1.000	3.500	225				
S2	4.100	0.600	Open Manhole	1050	1.001	3.500	225	1.000	3.500	225	
S3	4.100	1.164	Open Manhole	1200	1.002	2.936	225	1.001	2.936	225	
S4	4.100	1.572	Open Manhole	1200	1.003	2.528	225	1.002	2.528	225	
S5	4.100	1.920	Open Manhole	0		OUTFALL		1.003	2.180	225	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	536844.601	325305.731	536844.601	325305.731	Required	
S2	536790.774	325289.357	536790.774	325289.357	Required	
S3	536783.162	325290.561	536783.162	325290.561	Required	
S4	536732.708	325255.961	536732.708	325255.961	Required	
S5	536689.417	325226.794			No Entry	

Free Flowing Outfall Details for Surface Network 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D, L (mm)	W (mm)
1.003	S5	4.100	2.180	0.000	0	0

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Simulation Criteria for Surface Network 1

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1
Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.700	Storm Duration (mins)	30
Ratio R	0.400		

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Innovyze	Network 2019.1	

Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S3, DS/PN: 1.002, Volume (m³): 1.6

Unit Reference	MD-SHE-0081-3000-1064-3000
Design Head (m)	1.064
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	81
Invert Level (m)	2.936
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.064	3.0
Flush-Flo™	0.320	3.0
Kick-Flo®	0.660	2.4
Mean Flow over Head Range	-	2.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	3.2	3.000	4.8	7.000	7.2
0.200	2.9	1.400	3.4	3.500	5.2	7.500	7.5
0.300	3.0	1.600	3.6	4.000	5.5	8.000	7.7
0.400	3.0	1.800	3.8	4.500	5.9	8.500	7.9
0.500	2.9	2.000	4.0	5.000	6.2	9.000	8.1
0.600	2.7	2.200	4.2	5.500	6.4	9.500	8.4
0.800	2.6	2.400	4.4	6.000	6.7		
1.000	2.9	2.600	4.5	6.500	7.0		

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Innovyze	Network 2019.1	

Storage Structures for Surface Network 1

Tank or Pond Manhole: S1, DS/PN: 1.000

Invert Level (m) 3.500

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	3496.7	0.201	3639.7	0.401	3785.2	0.501	3858.8
0.101	3567.9	0.301	3712.1	0.500	3858.1		

Volume Summary (Static)

Length Calculations based on Centre-Centre

Storage			
Pipe Number	USMH Name	Structure Volume (m ³)	Total Volume (m ³)
1.000	S1	2223.794	2223.794
1.001	S2	0.000	0.000
1.002	S3	0.000	0.000
1.003	S4	0.000	0.000
Total		2223.794	2223.794

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Lancaster Court
Fareham
Hampshire, PO15 5TU

FRA
BATTLEFIELDS
WEST BASIN

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Network 2019.1

Micro
Drainage

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor 1.000

Additional Flow - % of Total Flow 0.000

Hot Start (mins) 0

MADD Factor * 10m³/ha Storage 2.000

Hot Start Level (mm) 0

Inlet Coefficient 0.800

Manhole Headloss Coeff (Global) 0.500

Flow per Person per Day (l/per/day) 0.000

Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0

Number of Storage Structures 1

Number of Online Controls 1

Number of Time/Area Diagrams 0

Number of Offline Controls 0

Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model

FSR

Ratio R 0.400

Region England and Wales Cv (Summer) 0.750

M5-60 (mm)

18.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm)

300.0

Analysis Timestep 2.5

Second Increment (Extended)

DTS Status

ON

DVD Status

OFF

Inertia Status

OFF

Profile(s)

Summer and Winter

Duration(s) (mins)

15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080

Return Period(s) (years)

1, 30, 100

Climate Change (%)

40, 40, 40

US/MH

PN

Name

Storm

Return Period

Climate Change

First (X) Surcharge

First (Y) Flood

First (Z) Overflow

Overflow Act.

Water Level (m)

1.000

S1

2880 Winter

100

+40%

30/120 Winter

3.982

1.001

S2

2880 Winter

100

+40%

30/180 Summer

3.987

1.002

S3

2880 Winter

100

+40%

1/60 Summer

3.985

1.003

S4

2880 Winter

100

+40%

2.568

Surcharged

Flooded

Pipe

US/MH

Depth

Volume

Flow /

Overflow

Pipe

Status

Level

PN

Name

(m)

(m³)

Cap.

(l/s)

(l/s)

Exceeded

1.000

S1

0.257

0.000

0.27

4.2

FLOOD RISK

1.001

S2

0.262

0.000

0.04

4.0

FLOOD RISK

1.002

S3

0.824

0.000

0.07

3.0

FLOOD RISK

1.003

S4

-0.185

0.000

0.07

3.0

OK

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Appendix I



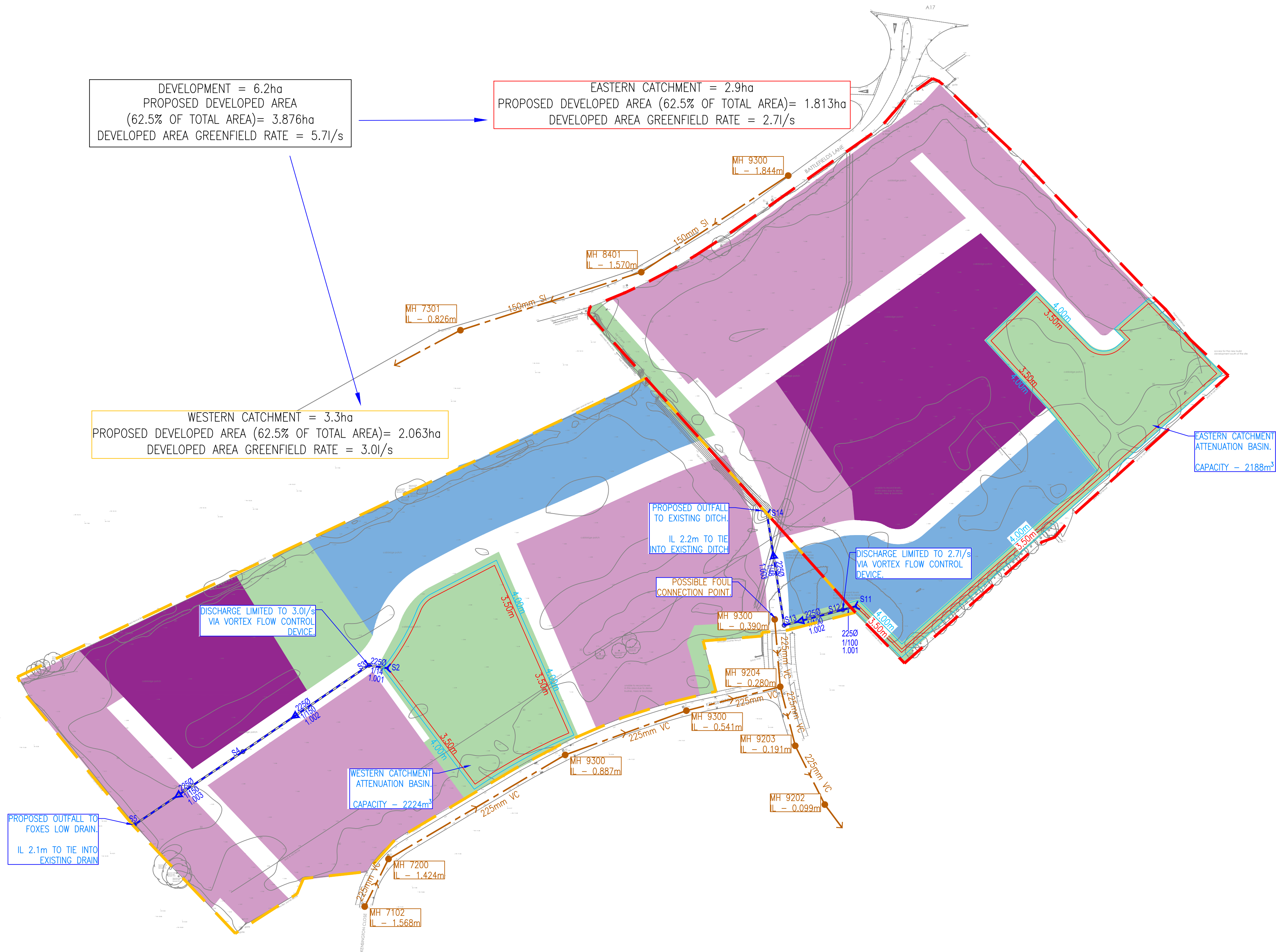
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LEGEND

-  HIGH DENSITY 40-45 DPH: FLATS AND TERRACES
-  2-3 BED SEMI DETACHED UNITS 30 DPH
-  3-4 BED SEMI DETACHED AND DETACHED UNITS WITH SPACIOUS FRONTAGE 25 DPH
-  PUBLIC OPEN SPACE
-  ADOPTED ANGLIAN WATER FOUL SEWERS



A	Drawing revised following masterplan update	27/01/2021	COH	RJW
Rev	Description	Date	By	Chkd



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Project Name
BATTLEFIELDS LANE SOUTH, HOLBEACH
OUTLINE PLANNING APPLICATION

Title
DRAINAGE STRATEGY

Project Phase
PRELIMINARY

Checked By	Checked Date	Drawn By	Drawn Date
AJS	22/01/2021	COH	22/01/2021

Client Drawing No.	Scale	(AT A1 SIZE)
-		

PBA Drawing No.	Revision
087.5011.501	A

1:1000 0m 50m