Castle Point Strategic Flood Risk Assessment

Surface Water Modelling Technical Note

Project Reference: Castle Point SFRA
Project Number: 60725540
Report Reference: 60725540-SWF-001

February 2025

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Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
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1. Introduction

AECOM has been commissioned to update the Level 1 Strategic Flood Risk Assessment (SFRA) for Castle Point Borough Council (CPBC). The purpose of the SFRA is to assess the risk to an area from flooding from all sources, now and in the future, taking account the impacts of climate change, and to assess the impact that land use changes and development in the area will have on flood risk.

As part of the SFRA, the 2016 South Essex Surface Water model[1] and 2015 Canvey Island Integrated Urban Drainage (IUD) Model[2] have been updated with the latest climate change allowances and the design rainfall from the Flood Estimation Handbook (FEH) 2022 Depth, Duration, and Frequency (DDF) model. The updates to made to the models have been agreed with the Environment Agency.

This Technical Note provides an overview of the existing South Essex Surface Water model and Canvey Island IUD model, and the work undertaken to update both for use in assessing surface water flood risk for the Castle Point SFRA.

2. Existing Models

2.1 South Essex Surface Water Model

The South Essex Surface Water Model is a single direct rainfall ESTRY-TUFLOW model with a cell size of 5m. The use of the TUFLOW Graphical Processing Unit (GPU) solver ensured that model run times remained reasonable[3].

The South Essex Surface Water model was reviewed using AECOM's in-house quality assurance template and summarised in the Proposed Surface Water Modelling Methodology Note[4]. The recommendations from the review were to run the model in the latest available software, along with updating the rainfall estimates. It was also proposed to liaise with Anglian Water Services (AWS) to confirm drainage improvements in Castle Point and agree a methodology for their representation in the existing surface water model. This was proposed so any significant drainage improvements could be incorporated into the SFRA modelling and mapping. As detailed in Section 3, following correspondence with AWS and review of the existing network dataset provided, it was decided to not incorporate any drainage improvements into the South Essex Surface Water Model.

The South Essex Surface Water model does not have any tidal boundaries and drains freely. The gullies represented in the model are assumed to be able to drain freely to the sea and downstream normal depth boundaries were included where it was observed that water was able to flow outside of the model extent. The model includes a tide-locked scenario that assumes the gullies are tide-locked (no water can flow out) and downstream boundaries are removed.

There are a number of other recommended updates which should be made for future uses of the model, but which were not considered necessary for the planning purposes of the Level 1 SFRA. These include:

- Updating the model to the latest Light Detection and Ranging (LiDAR) data;
- Updating the model to use the latest OS Mastermap data;
- Updating the infiltration layers based on the latest available information; and,
- Verification of the gully network and gully types in the model through reference to the latest available information.

2.2 Canvey Island IUD Model

The Canvey Island IUD model is an ICM version 5.5 model that includes all components of the drainage system on Canvey Island.

The Canvey Island IUD model was reviewed using AECOM's in-house quality assurance template and summarised in the Proposed Surface Water Modelling Methodology Note[4]. The recommendations from the review were to run the model in the latest available software along with updating the rainfall estimates. It was also proposed to liaise

[1] British Maritime Technology Messrs Winders, Barlow and Morrison (BMT WBM), South Essex Surface Water Model (2016)
[2] Black & Veatch Ltd, Canvey Island Integrated Urban Drainage Model (2015)
[3] BMT WBM, South Essex Surface Water Management Plan Model Update (2016)
[4] AECOM, Castle Point Strategic Flood Risk Assessment, Proposed Surface Water Modelling Methodology (2024)

with AWS to confirm drainage improvements in Castle Point and agree a methodology for their representation in the existing Caney Island IUD Model. This was proposed so any significant drainage improvements could be incorporated into the SFRA modelling and mapping. As detailed in Section 3, following correspondence with AWS and review of the existing network dataset provided, it was decided to not incorporate any drainage improvements into the Canvey Island IUD model.

3. Drainage Improvements

AECOM received correspondence from AWS on 22nd April 2024, that confirmed AWS were not aware of any significant improvements within Castle Point that were not in the existing network dataset (April 2024). The existing network dataset provided (in shapefile format) was compared to the Canvey Island IUD model drainage network. There are 25 sewer pipes that have been installed in Canvey Island since 2010 in the AWS dataset. These new pipes appear to be sewer connections for individual houses and therefore will not result in significant differences to the surface water flooding results for the purposes of the SFRA. Additionally, the information provided by AWS did not include key information needed to update the models (i.e. pipe diameters, invert levels etc.). Therefore, no drainage improvements were incorporated into the models. The existing model's drainage representation are deemed suitable for use for the strategic purposes of the SFRA.

It is recommended that the drainage network within the South Essex Surface Water model and Canvey Island IUD model should be reviewed prior to future use of the model.

4. Hydrology

4.1 Rainfall Updates

In the South Essex Surface Water model rainfall has been directly applied to the model domain using points (Figure 4-1), each of which has been assigned a range of hyetographs for storms of different return periods and durations. Rainfall is then interpolated across the grids between the hyetographs at each point to allow variation across the model domain between the points. The existing rainfall was derived using FEH13. As this is now superseded the rainfall was updated using FEH22.

Rainfall depths generated by the FEH22 DDF model have been extracted for the 3.3%, 1%, and 0.1% Annual Exceedance Probability (AEP) events from the FEH Web Service at the locations of the 19 centroids in the South Essex Surface Water model. The hydrographs for these three events have been converted to hyetographs in ReFH2.3.

A storm duration of 1-hour was selected for all AEP events based on the findings of the BMT WBM South Essex Surface Water Management Plan Model Update report. The findings of this assessment were checked with the updated hyetographs (Section 3.3). The calculated ARF value for the 1-hour duration event was 0.93. A summer rainfall profile has been selected for all generate hyetographs as the sensitivity tests carried out by BMT showed that the summer rainfall profiles generated the most conservative results for the South Essex study area. The Seasonal Correction Factor on ReFH 2.3 has been set to 1 as the calculated summer Seasonal Correction Factors across the study area exceeded 0.99. The parameters used are summarised in Table 4-1.

Table 4-1: ReFH2.3 Rainfall Parameters

Rainfall Parameters	Value
Rainfall Events	3.3% AEP, 1% AEP, 0.1%
Catchment Area	5 km^2
Critical Storm Duration	1 hour
ARF	0.93
Seasonal Correction Factor	1

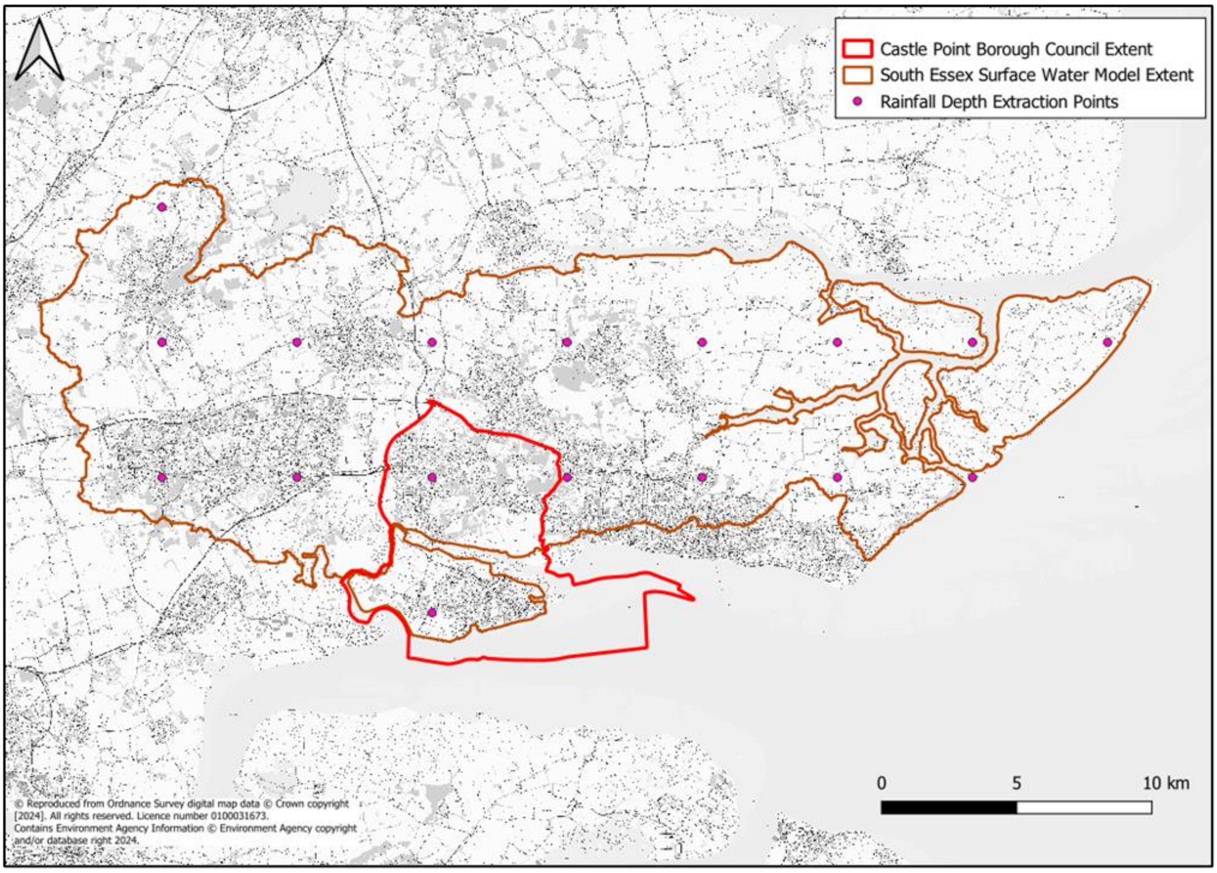


Figure 4-1: Rainfall Depth Extraction Points

4.2 Climate Change Allowances

The Environment Agency released updated climate change allowances guidance for peak rainfall in May 2022[5]. The South Essex Surface Water model falls within both the Combined Essex Management Catchment and South Essex Management Catchment. However, both management catchments have the same recommended climate change allowances for peak rainfall.

Based on the Environment Agency guidance for SFRAs, rainfall hyetographs have also been generated for the 3.3% AEP, 1% AEP, and 0.1% AEP events using the upper end peak rainfall allowance in the 2080s epoch. The upper end peak rainfall allowance in the 2080s epoch for both of these management catchments is 40%.

4.3 Critical Storm Duration

In the 2016 BMT South Essex Surface Water model seven storm durations (15 minute, 30 minutes, 1 hour, 2-hour, 3 hour, 6 hour and 9 hours) were simulated using the 1% AEP event to determine the critical storm duration. The longer durations were found to produce peak depths in rural areas, whilst within the urban areas, the intermediate durations were found to be critical. The 30 minute, 1 hour and 2 hour storms were selected as the critical durations for the South Essex study area. Comparison of the results showed that within the Castle Point administrative area the 1 hour storm duration typically produced the maximum flood depths.

The updated FEH22 rainfall hyetographs for five storm durations (30 minutes, 1 hour, 2 hours, 3 hours and 6 hours) were simulated in the South Essex Surface Water model using the 1% AEP event to determine the appropriate critical storm duration to use following the updates to the rainfall hydrology. The 1-hour storm duration was still found to typically produce the maximum flood depths in urban areas. Therefore, the 1-hour storm duration has been used for the purposes of the SFRA.

[5] Environment Agency Flood Risk Assessments Climate Change Allowances: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

5. Tidal Boundary

The downstream tidal boundary was updated for the Canvey Island IUD model. This is due to updates to the Thames Estuary 2100[6] (TE2100) data in 2022.

Tidal curves were derived based on the most recent extreme water level data and climate change predictions using TE2100 data. The tidal curve boundary derivation is outlined in the Tidal and Breach Modelling Technical Note[7]. The mean high-water spring (MHWS) for node 3.33 from TE2100 was used as the downstream boundary for the Canvey Island model.

The South Essex Surface Water model does not have tidal boundaries.

6. Model Updates

6.1 South Essex Surface Water Model

The following updates were made to the South Essex Surface Water model:

- Updated rainfall hyetographs (detailed in Section 3). The rainfall point on Canvey Island was used. Due to the small size of Canvey Island it was deemed acceptable to use rainfall from a single point to represent the whole area.
- The model was updated to TUFLOW version 2023-03-AC.
- The model was run for present-day scenarios with updated rainfall hyetographs (1-hour critical storm duration): 3.3% AEP, 1% AEP and 0.1% AEP.
- The model was run for future climate change (CC) scenarios (1-hour critical storm duration): 3.3% AEP + 40%CC, 1% AEP + 40%CC, 0.1% AEP + 40%CC.
- Results have been post-processed based on Environment Agency risk of flooding from surface water guidelines:
    - Flood areas with a low depth (below 0.1) have been removed. The Environment Agency risk of flooding from surface water uses hazard to filter results. However, due to the large model extent the depth cutoff command in TUFLOW was used to reduce processing times. Comparison of filtering by depth and hazard in the Castle Point administrative area shows minimal differences in flood extent and therefore is considered a suitable method for delineating flood risk for use in the SFRA.
    - Areas of flooding with a total area of less than 100 square metres have been removed.
    - Filled in isolated dry areas (within a larger flooded area) of less than 50 square metres.

The surface water flood maps are presented and discussed in the Level 1 SFRA[8].

6.2 Canvey Island IUD Model (Black & Veatch, 2015)

The following updates were made to the South Essex Surface Water model:

- Updated rainfall hyetographs (detailed in Section 3).
- The model was updated to ICM version 2023.2.6.
- The model was run for present-day scenarios with updated rainfall hyetographs (1-hour critical storm duration): 3.3% AEP, 1% AEP and 0.1% AEP.

[6] Environment Agency, Thames Estuary Modelling Extreme Water Levels – Final Report Issue P03 (2022)
[7] AECOM, 60725540-TF-001 Castle Point Strategic Flood Risk Assessment Tidal and Breach Modelling Technical Note (2024)
[8] AECOM, Castle Point Level 1 Strategic Flood Risk Assessment (2024)

- The model was run for future climate change scenarios (1-hour critical storm duration): 3.3% AEP + 40%CC, 1% AEP + 40%CC, 0.1% AEP + 40%CC.
- Results have been post-processed based on Environment Agency risk of flooding from surface water guidelines:
    - Flood areas with a very low hazard rating (below 0.575) have been removed.
    - Areas of flooding with a total area of less than 100 square metres have been removed.
    - Filled in isolated dry areas (within a larger flooded area) of less than 50 square metres.

The surface water flood maps are presented and discussed in the Level 1 SFRA[8].

7. Model Outputs

Two maps have been produced using model outputs. These maps display both the South Essex Surface Water model and Canvey Island IUD model results. The model extents overlap on Canvey Island therefore, for Canvey Island the Canvey Island IUD model results have been used due to the increased level of detail in this model.

The maps are summarised in Table 7-1. These maps are presented and discussed in the Level 1 SFRA[8].

Table 7-1: Model output summary

Map	Map Title	Location in SFRA
1	Modelled Surface Water Flood Risk – Present Day	Appendix E Map 1
2	Modelled Surface Water Flood Risk – Climate Change	Appendix E Map 2

8. Cumulative Impact Testing

In Castle Point there is a concern on the cumulative impact of flooding from a high intensity rainfall event occurring at the same time as a high tide. To understand the potential impact of high tides on fluvial flood risk the follow methodology has been used:

- The downstream boundary in the Canvey Island IUD model was edited to represent a higher water level (whole stage hydrograph increased by +0.5 m). The model was setup for peak tide and peak runoff to coincide to represent the worst-case flood risk scenario.
- The South Essex Surface Water model was run for the tide locked scenario (explained in Section 2.1). This assumes the drainage network is unable to discharge and removed the HQ boundary from tidal locations.
- Both models were run for the 1% AEP event.

The Canvey Island cumulative impact results showed negligible differences with the tidal boundary increased by 0.5m. The results are not mapped as there are no noticeable differences. Therefore, based on the results Canvey Island is not at risk from the cumulative impact of flooding.

Appendix A shows a depth difference map for the South Essex Surface Water model. This shows that for the tide locked scenario the flood depth in the South Benfleet storage area increases by more than 300 millimetres (mm) close to the tidal outfall when compared to the baseline model. The main storage area depth increases from 10mm to 230mm. The flow paths leading to the storage area increases by 10mm. There is an increase in the Prittle Brook flows leading to a typical increase in flood depths of 10mm to 50mm within the Castle Point administrative area. The flow path along Rushbottom Lane that flows to the north increases in depths from 10mm to 90mm within the Castle Point administrative area. This shows the following:

- with no drainage network discharging or HQ boundaries there are depth increases along the major flows paths;
- the increases in maximum flood depth are typically low in residential areas;

- the largest depth difference is seen within the South Benfleet flood storage area; and,
- the extent of flooding does not change significantly.

It is therefore concluded that residential areas are at minimal risk from the cumulative impact of flooding.

9. Urban Greening Scenario

In order to understand the potential impact of Sustainable Drainage Systems (SuDS) interventions an urban greening scenario has been tested using the Canvey Island IUD model. The contributing flows from the urban drainage network were reduced by 10% to represent possible retrofit SuDS options such as raingardens, bioretention basins and swales. The urban greening scenario model was run for the 3.3% AEP event.

Appendix B shows the depth difference between potential retrofit SuDS and the baseline model. The result shows that there is a 10mm reduction in flood levels in Canvey Lake and Thorneycreek Fleet. There are slight reductions in flood extent and depth along the roads of Canvey Island however, these are minimal. The maximum depth reduction is 28mm in the green space to the east of Rattwick Drive.

Overall, the model results show that a 10% reduction in contributing flows does not have a significant impact on flood risk in Canvey Island. This methodology was produced as an indicative way to understand the benefit of reducing flows from the drainage network. Further investigation, such as testing different percentage reductions to contributing flows, is required to gain a more detailed understanding of what would benefit the area.

10. South Benfleet Options Assessment

10.1 Flood Mechanism

As part of the SFRA commission, three potential high-level options for one of the Critical Drainage Areas (CDAs), as identified as part of the 2012 Surface Water Management Plan (SWMP), were assessed. The Client specified during the Inception Meeting on 19th February 2024 that AECOM should focus on the South Benfleet CDA.

Surface water model results produced as part of the SFRA were used to identify and assess these options. The modelled depths for the 1% AEP + 40% Climate Change rainfall event are presented in Figure 10-1. As visible in Figure 10-1 surface water is conveyed from the high ground in the north and east of the CDA via the Benfleet Hall Brook and the eastern tributary of the Benfleet Hall Brook, towards the low-lying ground at Benfleet Marsh, before discharging into East Haven Creek. The highest modelled depths are associated with the eastern tributary to the west of Boyce Hill Golf Course (0.5m - 1.5m), and the low-lying ground at Benfleet Marsh (0.5m - 1.0m), before it is discharged into the tidal East Haven Creek.

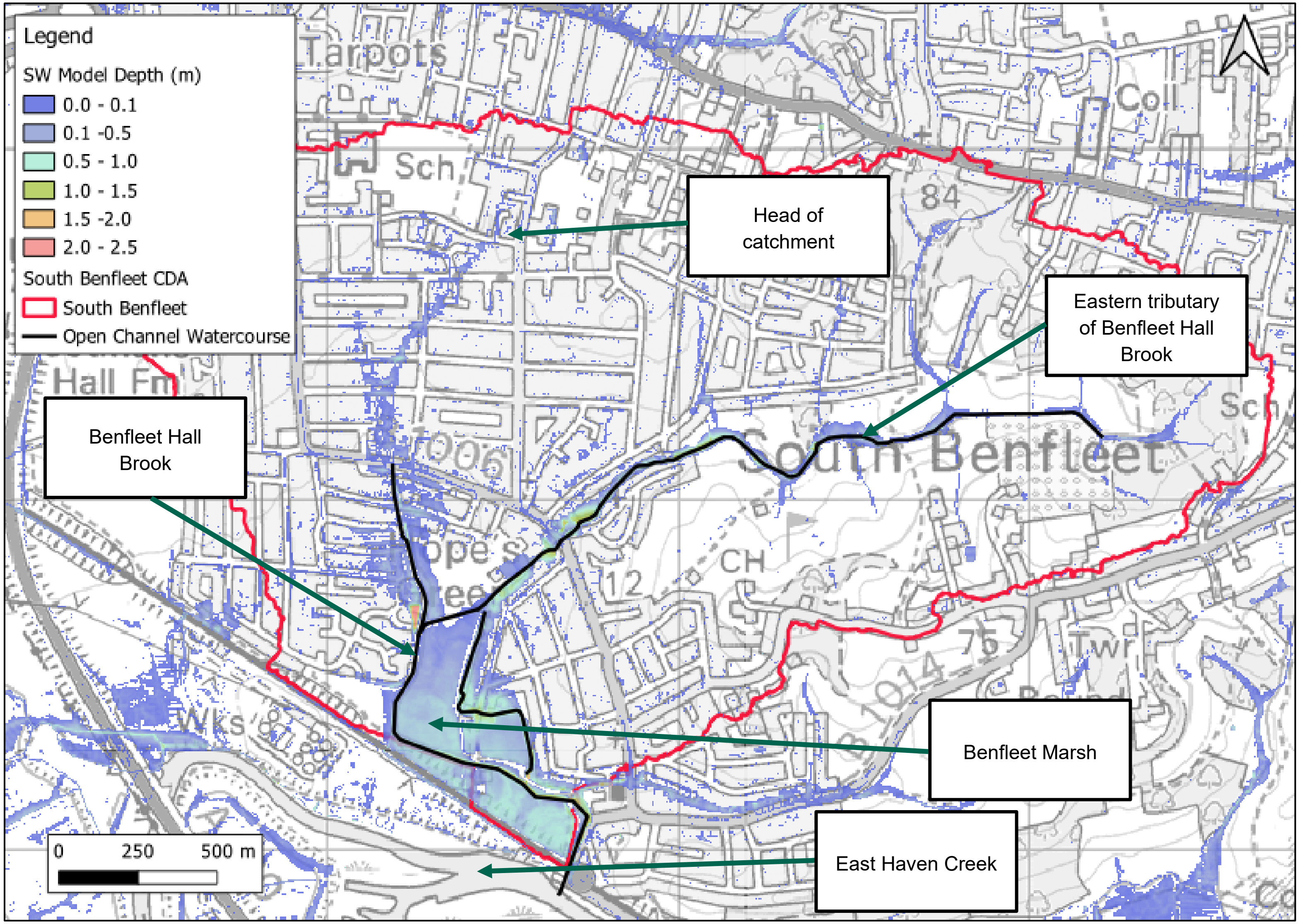


Figure 10-1: Modelled Depths (m) for the 1% AEP + 40% Climate Change Rainfall Event

10.2 Property Counts

The updated model results for the 3.3% AEP + 40% Climate Change and 1% AEP + 40% Climate Change rainfall events have been used to approximate the number of properties that are flooded. A filter has been applied to exclude modelled depths <0.30m, on the assumption that properties have an average threshold level of 0.30m, and therefore will not experience water ingress until this depth is exceeded. The properties have been identified through reference to Ordnance Survey Mastermap data and Google Satellite imagery. In total, 65 and 117 properties across the South Benfleet CDA have been identified as being flooded during the 3.3% AEP + 40% Climate Change and 1% AEP + 40% Climate Change rainfall events respectively.

The locations of these properties are shown in Figure 10-2. The distribution of the affected properties closely follows the catchment of the Benfleet Hall Brook and its eastern tributary, with clusters of affected properties on Saxon Way, Cumberland Avenue, Kimberley Road, Brook Road and Grove Road.

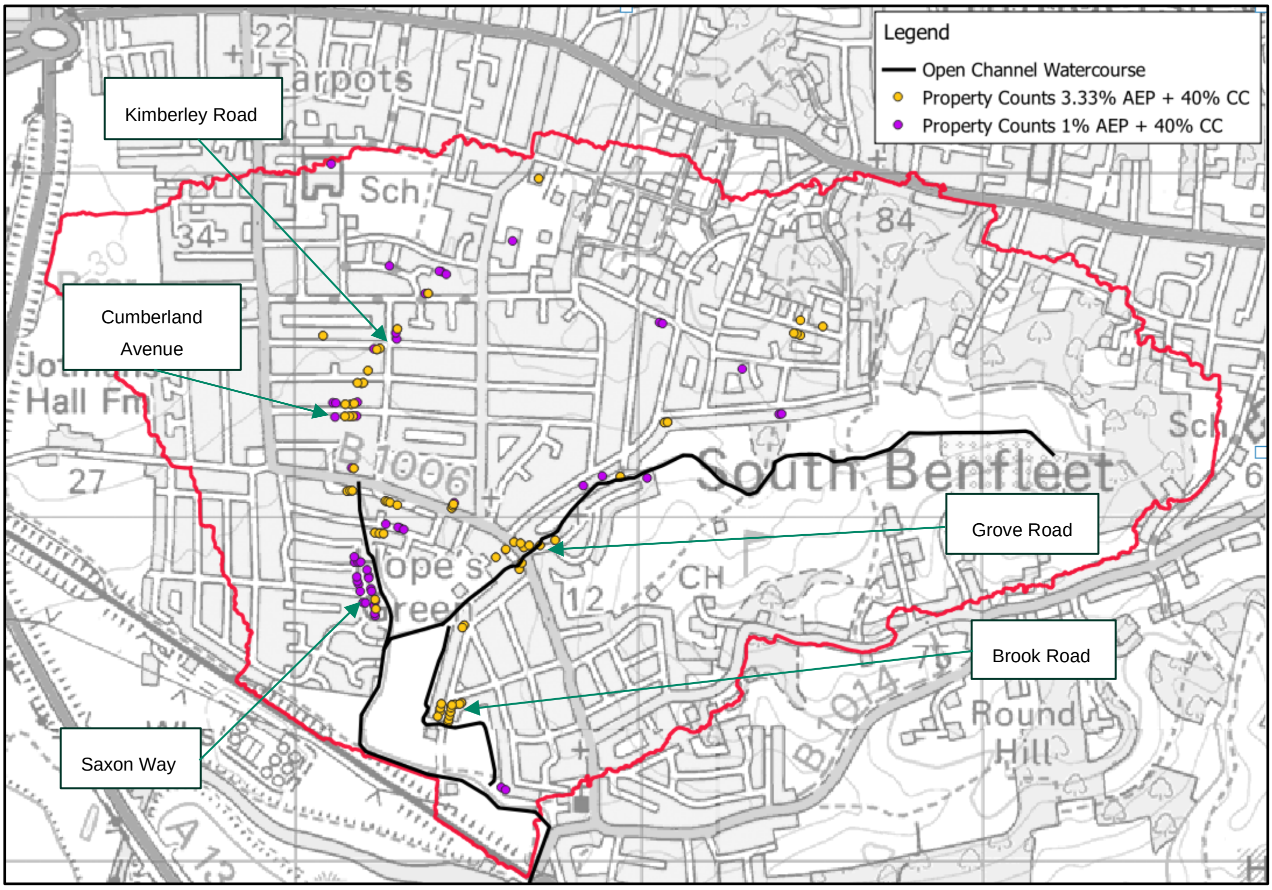


Figure 10-2: Property Counts in the South Benfleet CDA for the 3.3% AEP + 40% Climate Change and 1% AEP + 40% Climate Change Events

10.3 Historic Records of Flooding

The DG5 register for the South Benfleet CDA has been provided by Anglian Water, which provides details of the number of properties within a four digit postcode area where either internal or external flooding has been reported to Anglian Water over the last 10 years. The flooding incidents in the Anglian Water DG5 register are shown for the South Benfleet CDA in Figure 10-3. Whilst the incidents of flooding in the DG5 register are scattered across the South Benfleet CDA, there are clusters of incidents associated with the catchment of the Benfleet Hall Brook and the eastern tributary of the Benfleet Hall Brook.

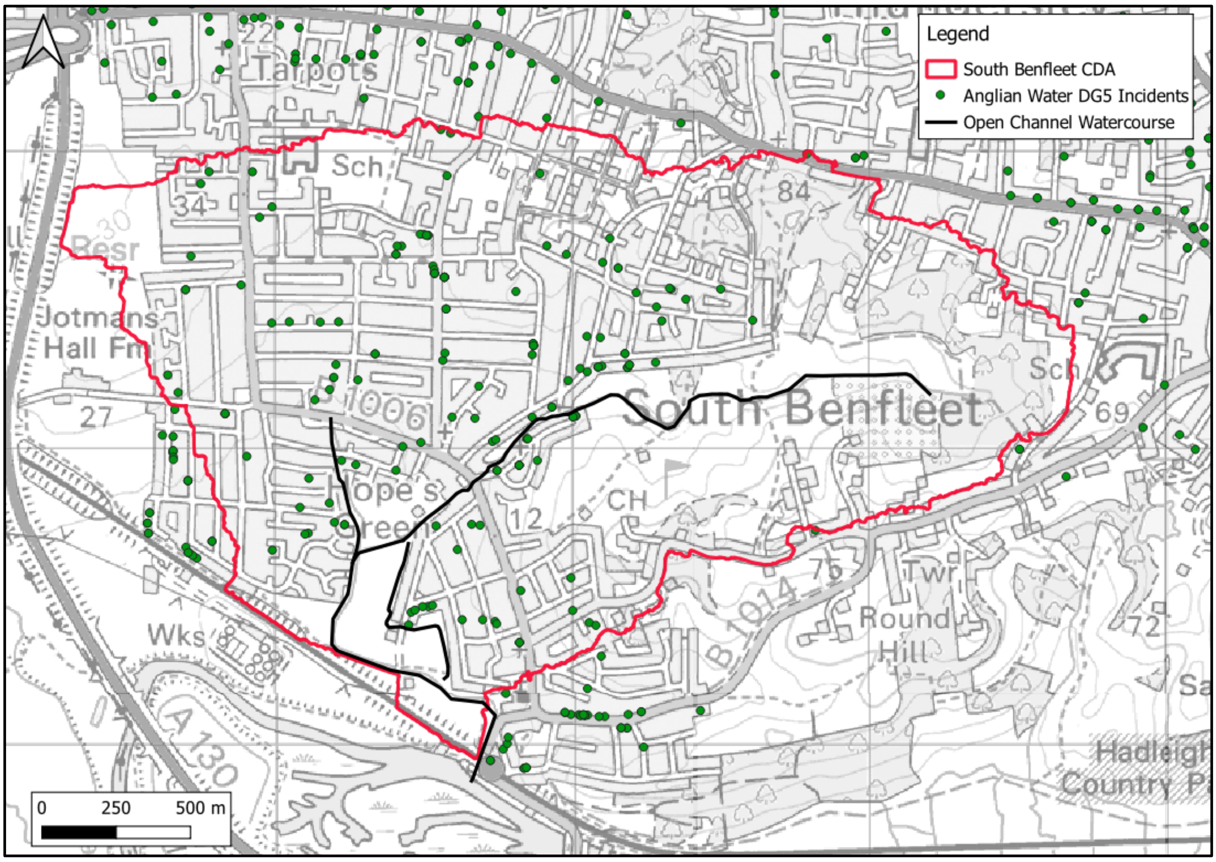


Figure 10-3: Anglian Water DG5 Incidents in South Benfleet CDA Area

The Environment Agency Recorded Flood Outlines dataset[9] has been downloaded from the Defra Data Services Platform, which comprises a GIS layer that includes all records of historic flooding from rivers, the sea, groundwater, and surface water held by the Environment Agency since 1946. The Recorded Flood Outlines that intersect the boundary of the South Benfleet CDA area are shown in Figure 10-4. These include an incident of tidal flooding in 1953 that affected properties in the far south of the CDA area which are situated in proximity to East Haven Creek, and a second incident of fluvial flooding in September 1968 associated with the Benfleet Hall Brook and the eastern tributary of the Benfleet Hall Brook.

[9] Environment Agency Recorded Flood Outlines: https://environment.data.gov.uk/dataset/8c75e700-d465-11e4-8b5b-f0def148f590 [Accessed September 2024].

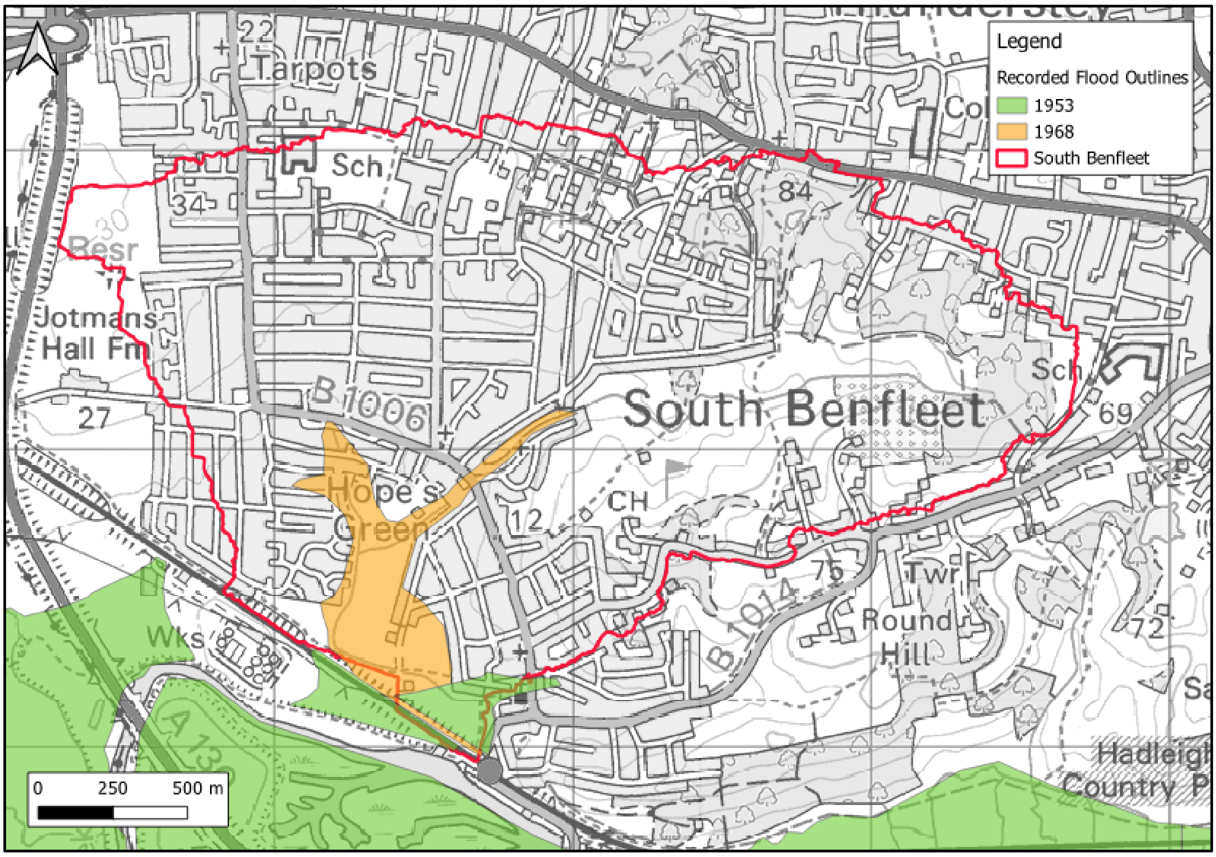


Figure 10-4: Recorded Flood Outlines in South Benfleet CDA Area

10.4 High-Level Options

Following a review of model results and property counts the most effective and feasible methods were taken forward to the short-list assessment stage. These shortlisted options included the following:

- Option 1: Extension to existing above ground Flood Storage Area at Brook Road
- Option 2: Extension to existing above ground Flood Storage Area near Saxon Way
- Option 3: Above ground flood storage area at Boyce Hill Golf Course

The concept of each option has been developed via a desktop review of the constraints and opportunities for surface water flood alleviation measures. The opportunities and constraints have been identified and assessed through reference to the Environment Agency LiDAR Composite 1m Digital Terrain Model (DTM)[10] (flown between 2010 and 2024), and the updated surface water modelling results.

The identified options primarily consist of above ground flood storage areas (FSAs), which serve the purpose of storing water collected from sewerage networks, overland surface water flow routes, or open channel watercourses whose bankfull discharge has been exceeded. The stored water can then be released into the surface water or sewer networks at a controlled rate after the peak of the storm hydrograph has passed. The storage of water at these locations can reduce the surface water flood risk to properties downstream by reducing the volume of water that is conveyed downstream.

A high-level cost has been given for two of the three options, Brook Road FSA and Saxon Way FSA. Boyce Hill FSA was not taken forward due to land ownership issues and therefore costs have not been provided for this option. The high-level costs for the two options have been developed using the SPONs Civil Engineering & Highways Price Book (2024) manual, the Environment Agency's Cost estimation for SuDs – Summary of Evidence (2015) and the Supplementary Green Book Guidance – Optimism Bias (2002).

[10] Environment Agency LiDAR Composite DTM: https://environment.data.gov.uk/dataset/13787b9a-26a4-4775-8523-806d13af58fc [Accessed September 2024].

Due to the lack of local topographical survey data, LiDAR data has been used to identify the elevation of the site to estimate the depths and thus excavation volume has been calculated using average depths applied across the whole site.

It should be noted that these indicative capital costs exclude items such as VAT, Landfill Tax or other taxes, maintenance fees, legal fees that might be incurred or similar. In addition, it is important to note that these are high-level costs to aid with option selection. The actual costs could increase when the designs are finalised.

Option 1 – Extension to existing aboveground Flood Storage Area at Brook Road

Surface Water modelling undertaken with the 2018 BMT South Essex Surface Water model using updated rainfall inputs shows that the sections of playing field to the immediate east and west of Brook Road are flooded in the 3.3% AEP event to depths of 0.1m - 0.5m. Depths in this area for the 1% AEP + climate change event range from 0.5m - 0.9m. The approximate centre of this area is TQ 77487 86321. The Environment Agency Flood Storage Areas[11] layer dataset shows that a flood storage area already exists at Benfleet Marsh covering the playing fields to the immediate south and west. Therefore, this would represent an extension to the existing flood storage area. An outline of the proposed south-east extension to the Benfleet Marsh Flood Storage Area (hereafter known as the 'Brook Road FSA Extension') is shown in Figure 10-5.

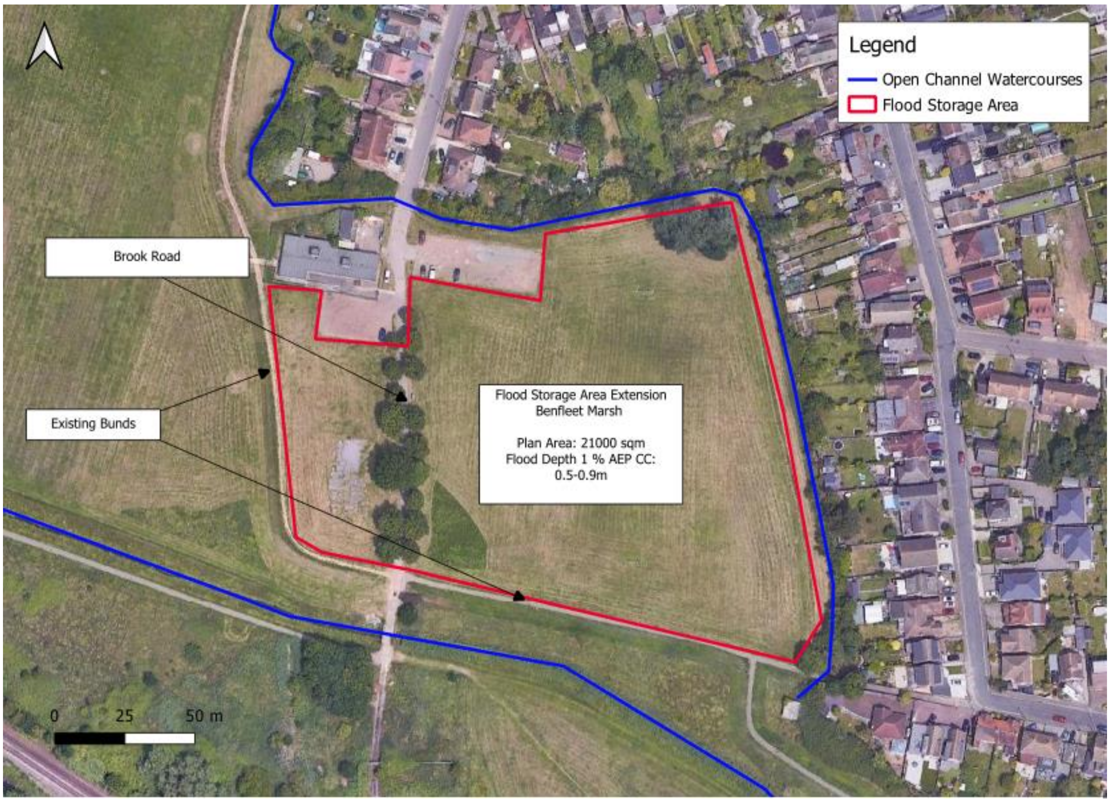


Figure 10-5: Outline of proposed Brook Road FSA Extension

The ground within the Brook Road FSA Extension should be re-graded to a base level of approximately 3.0m AOD. Ground levels within the proposed Brook Road FSA Extension currently range between 3.1m AOD and 3.9m AOD according to the 1m LiDAR Composite DTM. The existing bunds flanking the southern and western boundaries of the Brook Road FSA Extension should be retained. It is proposed that overbank flows enter and leave the Brook Road FSA Extension via the unnamed open watercourse that runs along its eastern and northern boundaries.

Approximate Cost	£1,300,000

[11] Environment Agency Flood Storage Areas: https://environment.data.gov.uk/dataset/86ca7c80-d465-11e4-afe1-f0def148f590 [Accessed September 2024].

Option 3 – Extension to existing aboveground Flood Storage Area near Saxon Way	

There is another area of open ground to the immediate north of the of the existing Benfleet Marsh FSA. The lower-lying western third of this open area is partially flooded in the 3.3% AEP rainfall event to depths of 0.1m - 0.4m. In the 1% AEP + climate change rainfall event the majority of this western third is flooded to depths of 0.2m - 0.6m. The approximate centre of the area is at TQ 77279 86817. This second extension to the Benfleet Marsh FSA will be referred to henceforth as the 'Saxon Way FSA Extension'.

Within the boundary of the 'Saxon Way FSA Extension', the ground gently slopes from north to south, and from west to east, with the elevations ranging from 4.1m AOD in the north to 3.2m AOD in the south. Water levels in the open channel watercourse to the west of the proposed area must exceed the 0.6m - 0.7m high left bank, before beginning to inundate the 'Saxon Way FSA Extension'.

It is recommended that land reprofiling be undertaken such that the maximum elevations within the proposed area are <3.9m AOD. New bunds should be formed along the northern, eastern, and southern boundaries. It is anticipated that these bunds will be approximately 1m high and have a side slope width of 3m (1 in 3 side slopes). The left bank of the open channel watercourse should be retained in its existing state. Once the peak of the storm hydrograph has passed, water stored here could be discharged at a controlled rate, or via natural drainage into the open channel watercourse that runs along the western boundary of the proposed area. An outline map of the 'Saxon Way FSA Extension' is shown in Figure 10-6.

Figure 10-6: Outline of proposed Saxon Way FSA Extension

Approximate Cost	£500,000

It should be noted that key risks associated with these options include unidentified constraints i.e. buried utilities which may impact construction, stakeholder agreement and funding. To confirm the suitability of these options, detailed hydraulic modelling will need to be undertaken alongside other environmental studies and engineering feasibility to confirm the benefits of each options. When it comes to roles, responsibilities and implementation, these will all be dependent on the funding process.

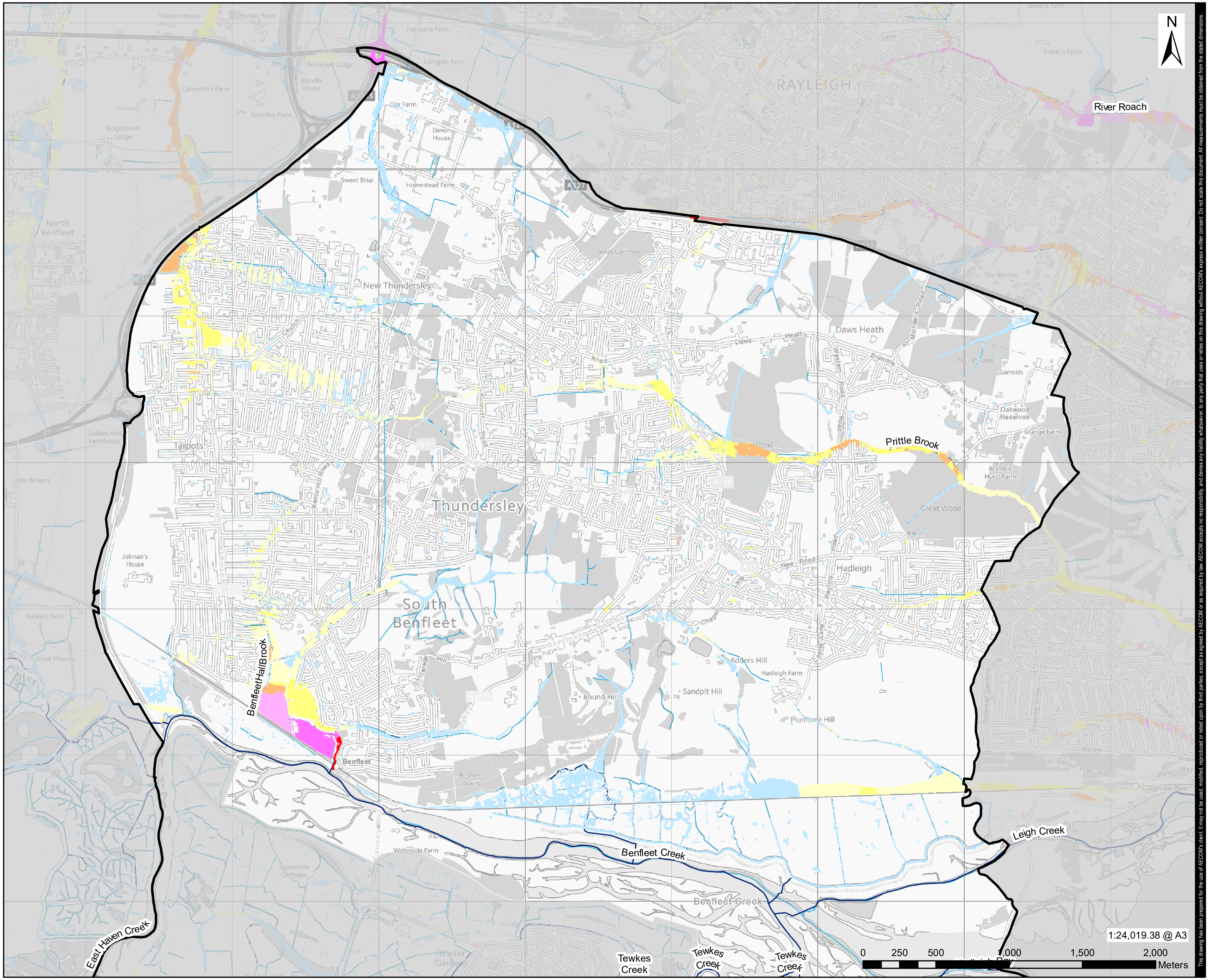
11. Assumptions & Limitations

When considering the results and discussion throughout this technical note, it is important to understand the assumptions and limitation of the models and their outputs. For the South Essex Surface Water model and the Canvey Island IUD model, the key assumptions and limitations include:

- Assumed that the topography and LiDAR used in the existing models is appropriate for the purposes of the Level 1 SFRA.
- Assumed that the methodology used for losses in both models is appropriate for the purposes of the Level 1 SFRA.
- Assumed that a 1-hour critical storm duration is suitable for the purposes of the Level 1 SFRA mapping.
- Assumed that the roughness values in the existing models are appropriate for the purposes of the Level 1 SFRA.
- Assumed that the representation of defences in the existing models are appropriate for the purposes of the Level 1 SFRA.
- Assumed that the hydrology methodology, as originally used in the South Essex Surface Water Management Plan Model Update[3] is appropriate for use in this assessment.
- The drainage network represented in the South Essex Surface Water model and Canvey Island IUD model is assumed to be appropriate for this assessment. It is recommended that this is updated for future uses of the model.
- There is no tidal boundary in the South Essex Surface Water model. Therefore, cumulative impact has been assessed assuming no water can flow out of the model domain or gullies.
- The model results are assumed to be suitable for the strategic purposes of the SFRA. For future use these models should be updated with the latest data available.
- Urban greening methodology only provides output for 10% reduction in contributing flow to provide an indication of the potential benefits to the drainage network. Further detailed investigation is required to understand whether greater benefit could be realistically achieved.

Appendix A - South Essex Surface Water Model Cumulative Impact Depth Difference Map

Revision: 1 Drawn: CG Checked: RC Approved: RM Date: 2024-09-25



AECOM

PROJECT

Castle Point Borough Council Level 1 Strategic Flood Risk Assessment

CLIENT

Castle Point Borough Council

CONSULTANT

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Basingstoke, Hampshire
RG21 7PP
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LEGEND

- Castle Point Borough Council
- EA Main River
- Watercourse

Cumulative Impact minus Baseline1% AEP Depth Difference (mm)

- > -300
- -200 to -300
- -100 to -200
- -50 to -100
- -20 to -50
- -5 to -20
- -5 to 5
- 5 to 20
- 20 to 50
- 50 to 100
- 100 to 200
- 200 to 300
- > 300
- Was Wet - Now Dry
- Was Dry - Now Wet

NOTES

1: This map shows the depth difference between the South Essex Surface Water baseline model and cumulative impact scenario
2: Refer to the Surface Water Modelling Technical Note and SFRA report for details of the cumulative impact assessment, assumptions and limitations.

ISSUE PURPOSE

Surface Water Modelling Technical Note

PROJECT NUMBER

60725540

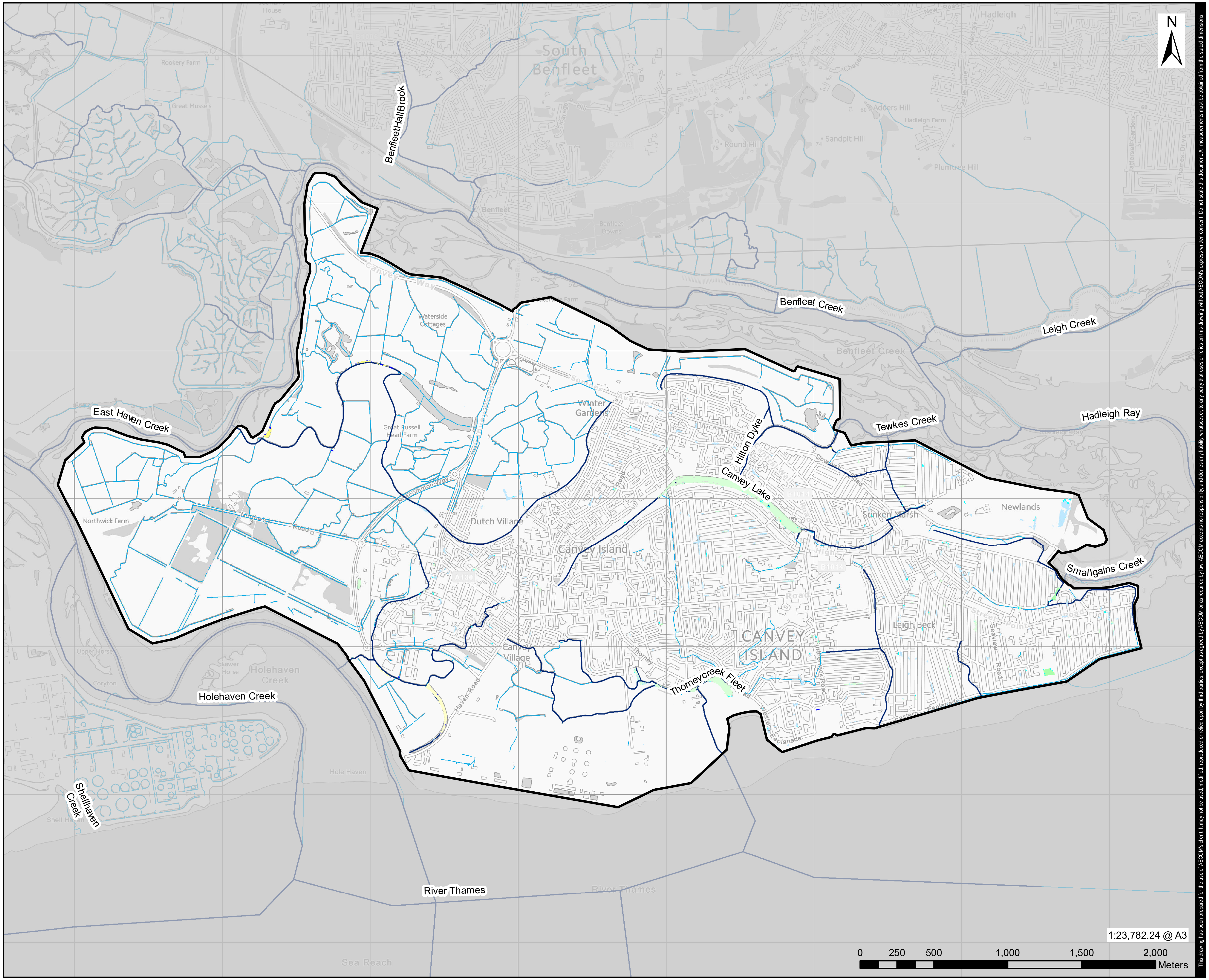
MAP TITLE

South Essex Surface Water Model Cumulative Impact minus Baseline 1% AEP Depth Difference

MAP NUMBER

Appendix A Map 1

Appendix B – Canvey Island IUD Model Urban Greening Depth Difference Map



Revision: 1 Drawn: CG Checked: RC Approved: RM Date: 2024-09-25

AECOM

PROJECT

Castle Point Borough Council Level 1 Strategic Flood Risk Assessment

CLIENT

Castle Point Borough Council

CONSULTANT

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LEGEND

- Canvey Island IUD Model Extent
- EA Main River
- Watercourse

Urban Greening minus Baseline 3.3% AEP Depth Difference (mm)

- > -300
- -200 to -300
- -100 to -200
- -50 to -100
- -20 to -50
- -5 to -20
- -5 to 5
- 5 to 20
- 20 to 50
- 50 to 100
- 100 to 200
- 200 to 300
- > 300
- Was Wet - Now Dry
- Was Dry - Now Wet

NOTES

1: This map shows the depth difference between the Canvey Island IUD baseline model and Urban Greening scenario
2: Refer to the Surface Water Modelling Technical Note and SFRA report for details of the urban greening assessment, assumptions and limitations.

ISSUE PURPOSE

Surface Water Modelling Technical Note

PROJECT NUMBER

60725540

MAP TITLE

Canvey Island IUD Model
Urban Greening minus Baseline
3.3% AEP Depth Difference

MAP NUMBER

Appendix B Map 1

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