Technical Note

Project number	60653132		
Project (Client)	Partnership for South Hampshire Strategic Flood Risk Assessment (Portsmouth City Council)		
Subject	Fluvial River Floodplain Analysis		
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1. Introduction

1.1 Overview

Guidance for the preparation of Strategic Flood Risk Assessments (SFRAs)[1] in England states that a Level 1 SFRA should include maps of the 'expected effects of climate change'.

For some of the fluvial watercourses in the Partnership for South Hampshire (PfSH) SFRA study area, modelled flood extents including the expected impacts of climate change are available from catchment scale hydraulic models held by the Environment Agency. However, for a large number of fluvial watercourses in the study area, available information on the risk of flooding is limited to JFLOW flood zones. JFLOW applies a generalised methodology and simplified assumptions to produce national datasets of Flood Zone 2 (0.1% (1 in 1000 year) Annual Exceedance Probability (AEP)) and Flood Zone 3 (1% AEP (1 in 100 year)), but no additional outputs regarding the impact of climate change.

It is not achievable to develop catchment scale hydraulic models for all the watercourses within the PfSH SFRA study area. Where there is little growth and development proposed by LPAs, there is little justification for such work.

On the other hand, there are some watercourses where the Environment Agency have commenced work to develop catchment scale hydraulic models, but the outputs are not available for this issue of the SFRA. For example, the River Test and the Monk's Brook which are currently being surveyed prior to the development of hydraulic models. Outputs from these studies will need to be incorporated into future iterations of the SFRA.

In the meantime, to inform this version of the PfSH SFRA, GIS analysis has been undertaken to help identify those areas of fluvial floodplain that may be sensitive to increases in flood levels. The GIS analysis uses a LiDAR digital terrain model (DTM) to identify the water levels along the edge of the Flood Map for Planning Flood Zone 3 extent. Additional flood extents have then been generated by increasing the water levels by pre-defined amounts and comparing the newly created water surfaces with the LiDAR DTM.

This analysis **does not** map the anticipated impacts of climate change and is not a substitute for hydraulic modelling. However, it does identify those areas of floodplain which could be sensitive to increases in flood levels. This provides a useful indication to LPAs for where additional modelling may be required in the future, should these areas be considered for future growth or development.

[1] Environment Agency, March 2022. *How to prepare a strategic flood risk assessment.* https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment

2. Fluvial River Floodplain Analysis Methodology

2.1 Study Area

For the purposes of this Fluvial River Floodplain Analysis, the PfSH study area has been divided into five regions based upon broad characteristics of the river catchments, as shown in Figure 2-1.

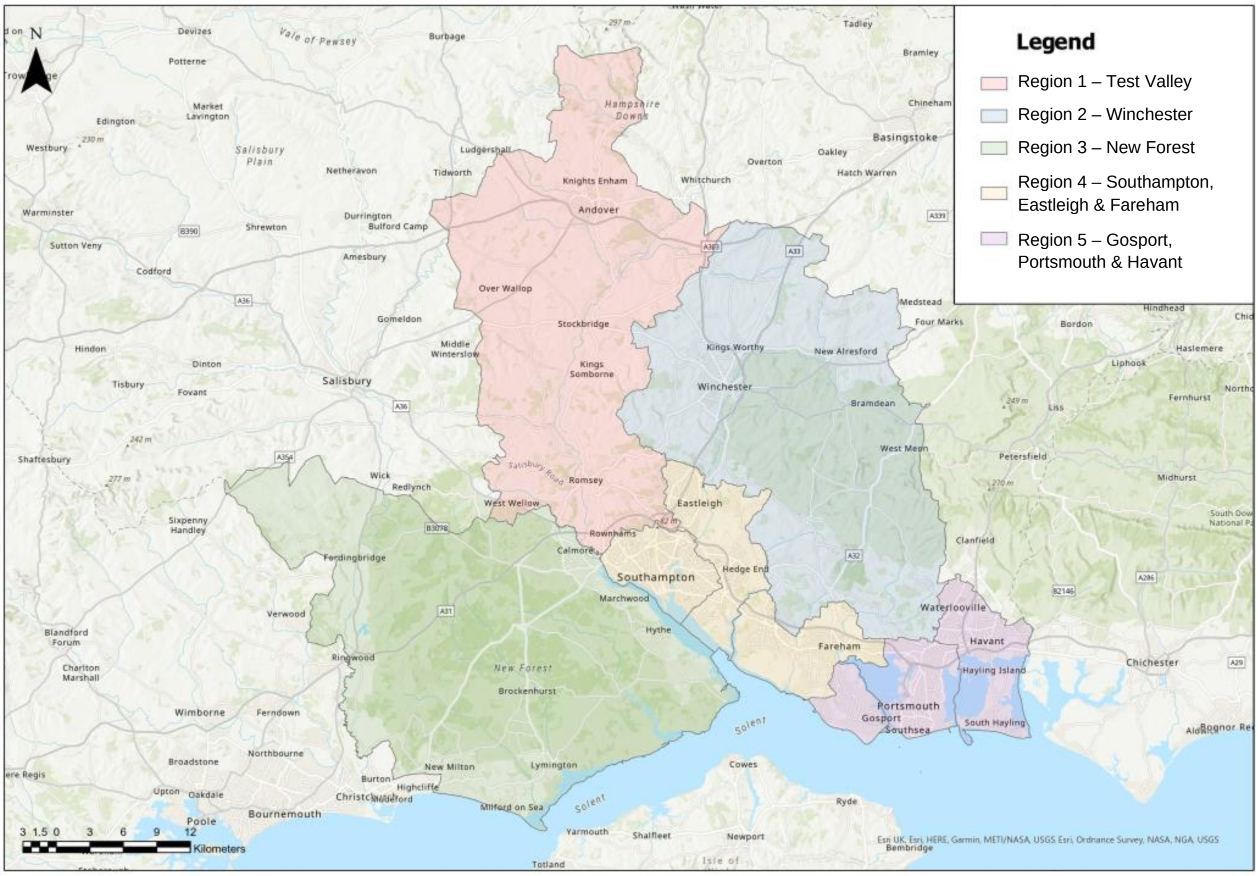


Figure 2-1 PfSH GIS Floodplain Analysis Study Areas

2.2 Software

The GIS analysis was undertaken using ArcGIS Pro 2.9.

2.3 Input Data

Table 2-1 identifies the datasets used within the GIS analysis.

Table 2-1 Input datasets

Dataset	Description
Digital Terrain Model	2m resolution DTM obtained in .asc format from the Defra Data Services Platform. This provides suitable coverage and resolution for the chosen approach.
EA Flood Zones	Environment Agency Flood Zones 2 and 3 in .shp file format from the Defra Data Services Platform
Detailed River Network	DRN layer supplied to AECOM in .shp file format
LPA Boundaries	PfSH Local Authority Area boundaries supplied in .shp file format
OS Land Boundary	England land boundary obtained in .shp file format

2.4 Data Pre-processing

Prior to completion of the GIS analysis, the individual 2m LiDAR DTM tiles were joined to create a continuous mosaic (referred to hereafter as the LiDAR DTM).

The Flood Map for Planning Flood Zone 2 and Flood Zone 3 GIS layers were obtained and a 500m buffer applied to the polygons. The output layers will be referred to as flood zone buffers.

The LIDAR DTM and flood zone buffers were added to a GIS workspace alongside the other datasets included in Table 2-1 Input datasets. A 2,000m buffer was applied around each study area region and the analysis was applied within this region. The outputs were cropped to the actual study area after all flood zones has been created. This ensured there were no edge effects and all data appropriately joined up between regions.

2.5 Method

The Fluvial River Floodplain GIS Analysis involved six key steps, detailed below and summarised in Figure 2-2.

Step 1- Create Flood Zone extent points and assign elevations

- Points were created at equal 50m intervals along the boundaries of the Flood Zone polygons.
- Manual editing was undertaken to remove:
  - Points far away from the main flood zone corresponding to very small detached flooded areas, ensuring a water surface was not interpolated from the main flood zone to these points, and
  - Points corresponding to tidal flooding in coastal areas; this analysis is based on the recreation of fluvial flooding only. In areas where flood extents could not clearly be established as from tidal flooding only, flood extents were retained.
- Elevations for the boundary points were extracted from the LiDAR DTM, with these elevations assumed to coincide with the maximum flood level for the 1% AEP event (Flood Zone 3) and 0.1% AEP event (Flood Zone 2).

Step 2- Create estimated water level surface

- An estimated water level surface for the 1% AEP event (Flood Zone 3) and 0.1% AEP event (Flood Zone 2) were generated through ‘natural neighbour’ interpolation using the point elevations generated in Step 1.
- The estimated water level surface was created with a 2m grid resolution, to match the LIDAR DTM.
- The estimated water level surface was visually inspected to identify discontinuities in the estimated water level surface, likely resulting from inaccurate LiDAR elevations. Where discontinuities were identified the point layer was edited to remove points where LiDAR was considered inaccurate.

Step 3- Create estimated depth grid

- An estimated flood depth grid for the 1% AEP event (Flood Zone 3) and 0.1% AEP event (Flood Zone 2) was created through subtracting the LIDAR DTM from the estimated water level surfaces generated in Step 2.
- The output grid had a resolution of 2m, in line with the LiDAR DTM and estimated flood level surfaces.

Step 4- Create final flood extent polygons

- The estimated depth grids for the 1% AEP event (Flood Zone 3) and 0.1% AEP event (Flood Zone 2), produced in Step 3, were used to create a binary flood extent raster grid. Within this grid flooded areas where assigned a value of 1 and not flooded areas a value of 0.
- The binary raster grid was subsequently converted into a flood extent polygon, depicting the predicted flood extent.
- The 500m buffer zone, generated within the pre-processing step, was applied in order to remove areas shown as flooded that were located more than 500m away from the flood zone. This typically removed areas of low lying topography remote from any watercourses that were errantly shown as being flooded, from the flood extent polygon.
- The flood zones were clipped to each actual study area at this stage, as stated in Section 2.4.

- The areas considered attributed to tidal flooding, for which points were deleted in Step 1, were removed from the generated flood extents.

Step 5- Accuracy Assessment

- In order to verify the methodology applied, basic qualitative accuracy assessment and sense checking was carried out on the outputs generated from Steps 1-4.
- The flood extent polygons generated for the 1% AEP event (Flood Zone 3) and 0.1% AEP event (Flood Zone 2) were overlain with the original flood zones and compared to ensure that they were acceptably reproduced. This check provided confidence in the processing methodology adopted, prior to completion of step 6.
- Manual editing was undertaken to remove:
    - Flood extents located where fluvial flood inundation was not considered possible, for example in low lying areas clearly disconnected from watercourses by topography or features such as roads and railway lines, and
    - Flood extents that extended the floodplain horizontally, i.e., extended it beyond the original modelled length of the watercourse.

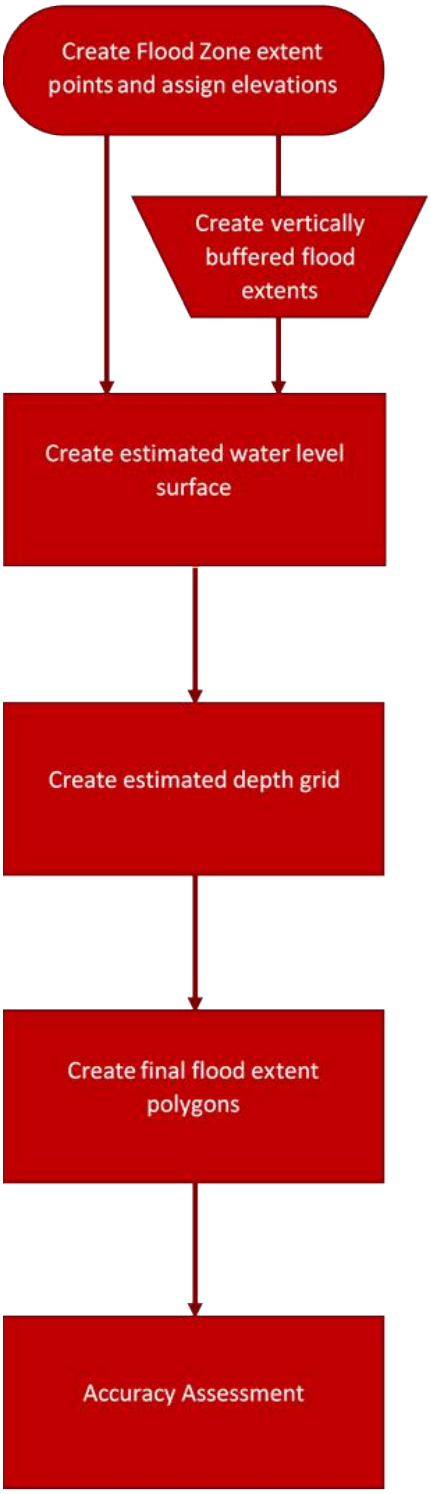
Step 6- Create vertically buffered flood extents

- In order to create vertically buffered flood extents, the point elevations extracted from the LIDAR DTM for Flood Zone 3 (1% AEP) in Step 1 were increased by 300mm and 600mm.
- Steps 2-5 were then repeated using the Flood Zone 3 water level points, with additional elevations included.
- Overall, this resulted in the production of predicted flood extents that would occur if water levels were to increase uniformly across the floodplain by 300mm and 600mm.

It is important to note that the increases in flood level of 300mm and 600mm do not correspond to a specific future climate change allowance. Rather, they have been selected in order to demonstrate a range of potential future change in water levels and to identify areas where the floodplain may be sensitive to such a change.

2.6 Post-processing

The flood extent outputs from the analysis were cleaned using a flood outline cleaning GIS routine. This routine fills small gaps present in order to create a more consistent extent.



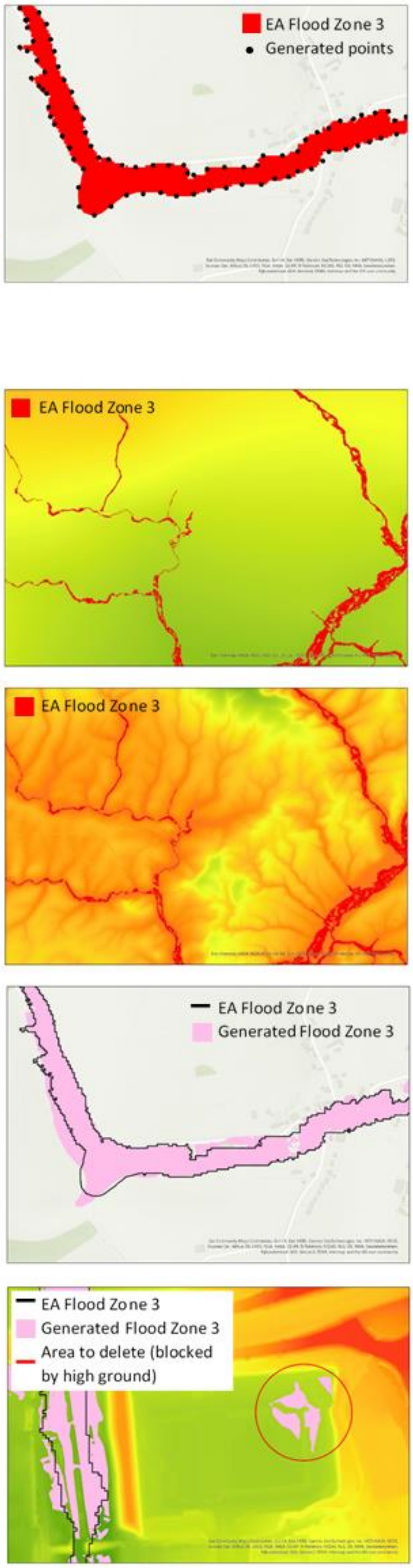


Figure 2-2 Methodology Flowchart

3. Results

3.1 Outputs

Vertically buffered flood extents produced through application of the methodology detailed in Section 2 are displayed in the Level 1 SFRA mapping for each of the LPAs.

3.2 Flood Zone Comparison

Figures 3-1 to 3-3 show comparisons between the Flood Map for Planning Flood Zone 3 and the 1% AEP flood extent created through application of the methodology detailed in Section 2.

It can be seen that in general the methodology applied represents Flood Zone 3 relatively well.

There are a number of areas created in the generated flood extent that are not present in the Flood Map for Planning Flood Zone. Where these areas are present in Figures 3-1 to 3-3, there was not enough evidence to suggest water would not flow here, for example if a flow path was blocked by high ground. This may be due to the updated DTM LiDAR information used in this analysis compared to what would have been used to create the Flood Map for Planning Flood Zones, or it may be due to inaccuracies in the methodology. This Fluvial River Floodplain GIS Analysis was undertaken in the absence of available hydraulic models, as a way to identify locations that may be sensitive to increase in flood levels based on an understanding of the relative ground levels. It is not expected to be as accurate as a model or a substitute for a model.

It can be seen from Figure 3-3 that the majority of the flooding in the Gosport BC, Portsmouth CC, and Havant BC administrative areas is considered to be tidal, or tidally influenced, and therefore not relevant to this analysis.

Figure 3-3 also shows that the generated flood zone significantly overpredicts the Flood Map for Planning Flood Zone in several locations within the Havant study area close to the coast. The land is relatively flat and low lying here, making the methodology less effective. On the other hand, further from the coast in the Winchester CC and Test Valley BC administrative areas, where the watercourses flow through more well defined valleys, the analysis produces more representative results.

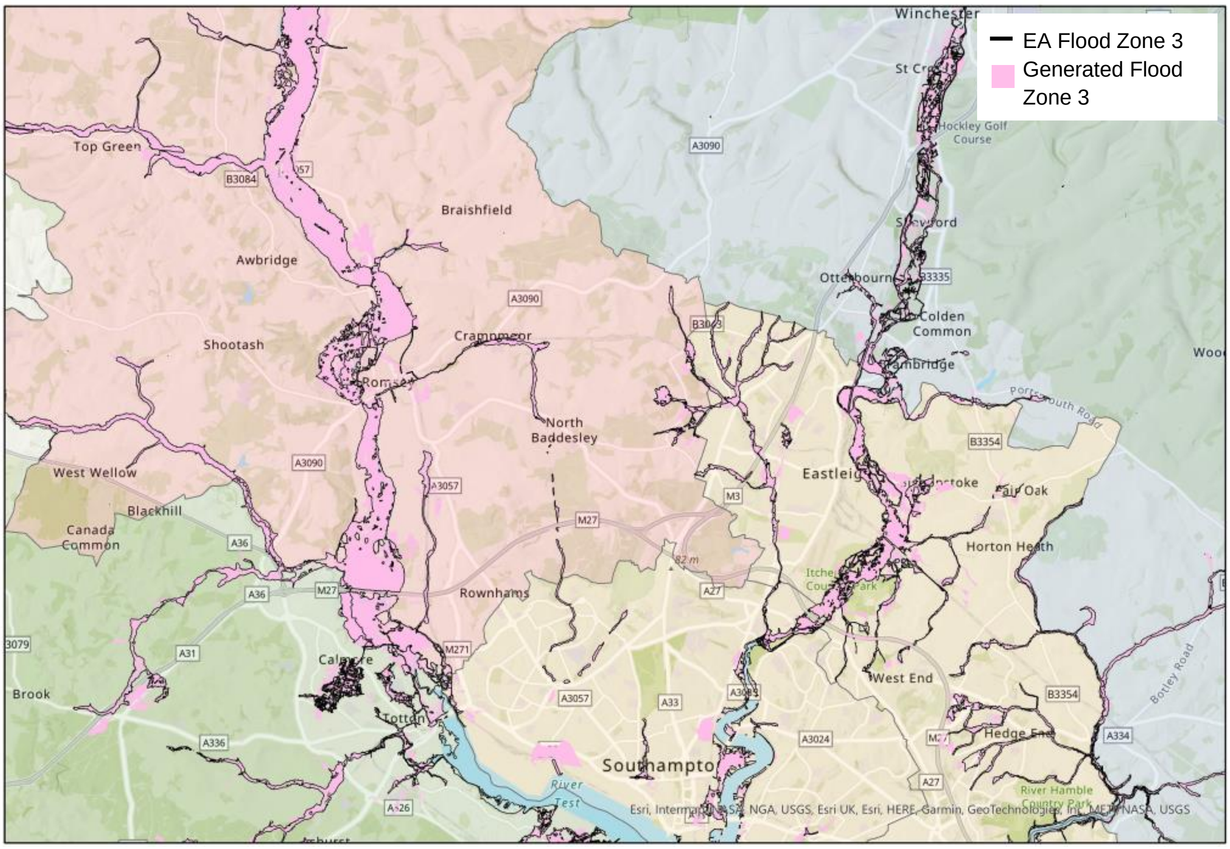


Figure 3-2 Flood Zone Comparison 1

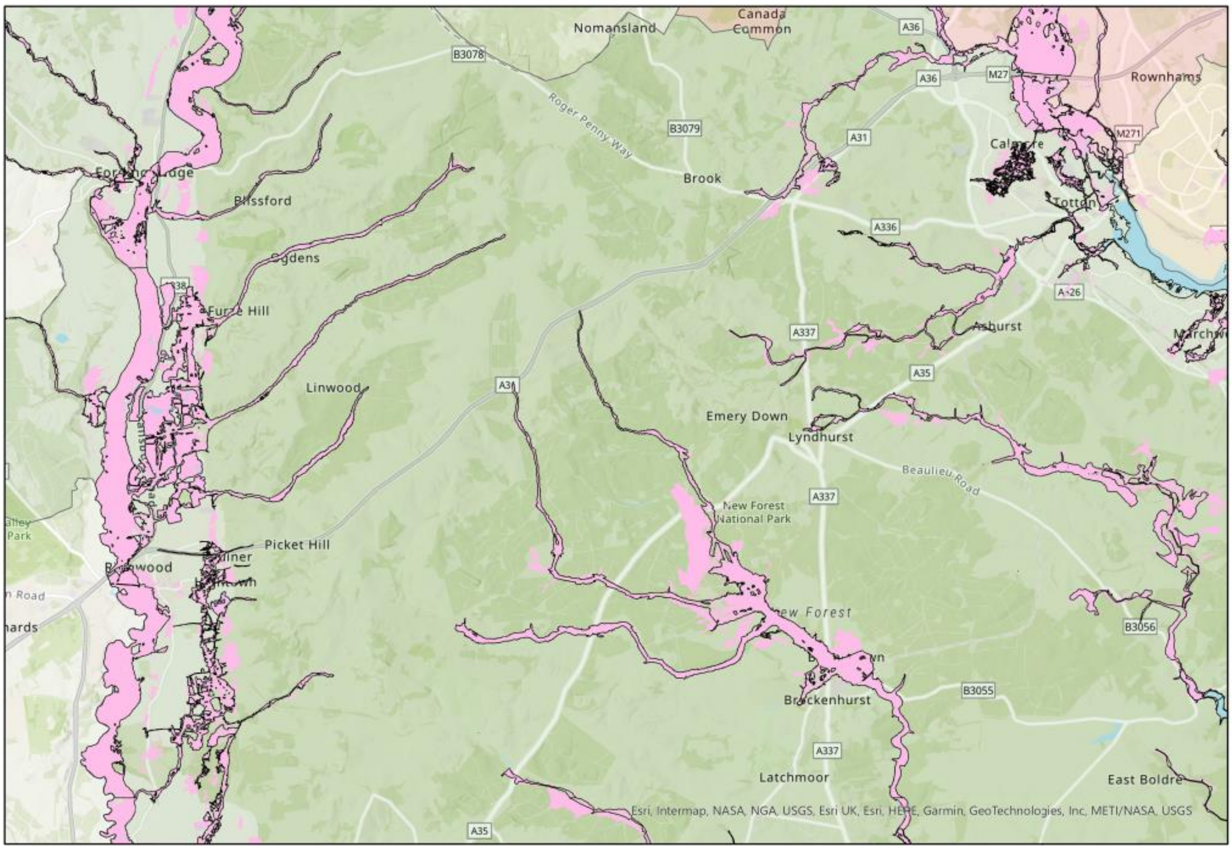


Figure 3-1 Flood Zone Comparison 2

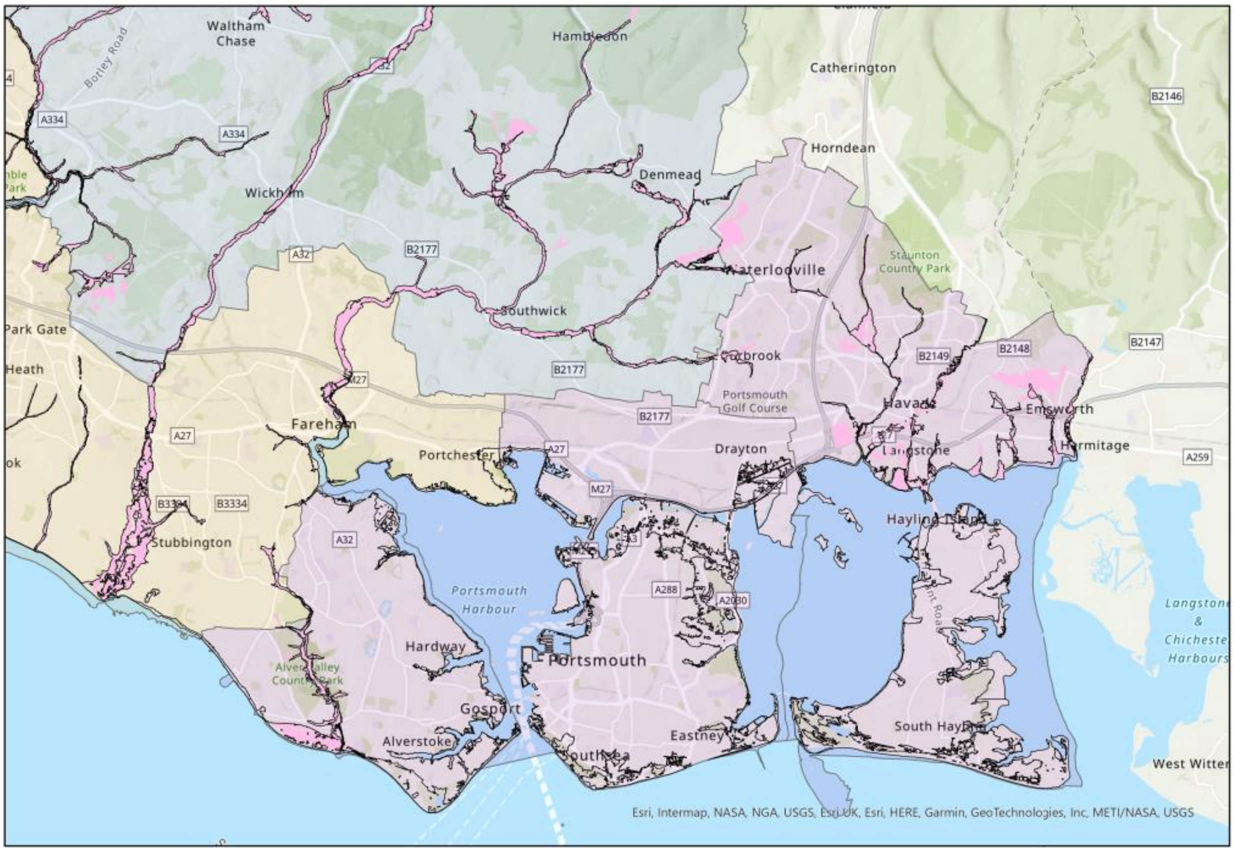


Figure 3-3 Flood Zone Comparison 3

3.3 Key Limitations

The Fluvial River Floodplain GIS Analysis estimates flood levels based upon Flood Map for Planning Flood Zones and LiDAR data and generates new 'vertically buffered' flood extents assuming a fixed increase in flood level across the study catchment. The outputs from this GIS Floodplain Analysis are simplified and do not take into account the complex hydraulic processes and flooding mechanisms that would actually take place when flows are increased in the watercourses.

It is recommended that outputs from the Fluvial River Floodplain GIS Analysis (the 'vertically buffered' flood extents) should only be used to provide an indication of low lying areas adjacent to the existing floodplain that could be sensitive to changes in flood levels.

The outputs from the Fluvial River Floodplain GIS Analysis should not be used as a substitute for hydraulic modelling to quantify flood risk to and from a development. Site specific hydraulic modelling may be required to inform a Flood Risk Assessment (FRA). Refer to SFRA Part 1 Section 5.1.

4. Summary

Hydraulic models identifying the ‘expected effects of climate change’ are not available for every watercourse in the PfSH SFRA study area. For some areas, little growth is anticipated and in other locations, there are hydraulic models under development as part of the Environment Agency’s programme of flood modelling studies (for example the River Test, Monk’s Brook).

As part of the PfSH SFRA, Fluvial River Floodplain GIS Analysis has been undertaken using Flood Zone 3 and LiDAR DTM to identify areas of floodplain that may be sensitive to increases in flood levels. Vertical buffers of 300mm and 600mm have been applied to the Flood Zone 3 flood extent.

Qualitative visual accuracy assessment of the generated flood zones, achieved through comparison with original Flood Map for Planning Flood Zones, is favourable and shows a good level of agreement. This demonstrates that the GIS methodology is robust.

The results of this analysis can be used by the LPAs as a high level screening tool. Where a LPA is considering growth or development adjacent to the floodplain (as defined by the extents of Flood Zone 2, Flood Zone 3, and the outputs of this Fluvial River Floodplain GIS Analysis), detailed hydraulic modelling should be undertaken to assess more accurately the risk of flooding in the future as a result of climate change.