BURO HAPPOLD

Technical Note

Project	Begbroke Innovation District
Subject	Technical Note – Secondary School Hydraulic Modelling
Project no	052188
Date	19 September 2024

Revision	Description	Issued by	Date	Approved (signature)
00	Final for Issue	GJ	19/09/2024	Duncan Ker-Reid

1 Introduction

1.1 Background

An Outline Planning Application for Begbroke Innovation District ('BID') at land to the east of the A44 between Yarnton, Begbroke and Kidlington ('the Site') was submitted on 27th July 2023 (LPA Ref: 23/02098/OUT). A Flood Risk Assessment (FRA) (BEG-BUR-XX-XX-RP-XX-00001-FRA.pdf (July 2023)) was submitted in support of the planning application.

The Environment Agency (EA) has provided consultation responses to the planning application on 15th February, 3rd June and the 2nd July. These responses have been considered with detailed responses provided on the 22nd February, 13th March, 21st June and the 6th August 2024.

A request was made by the EA at the meeting held on the 18th July for further hydraulic modelling in respect of the land reserved for a Secondary School Site, identified on Parameter Plan 1 (Figure 1-1). The purpose of this additional modelling was to consider the potential effects of the land reprofiling needed for the southern section of the Secondary School Expansion land and infilling of small stretch of Ordinary Watercourse. The Flood Risk Assessment (July 2023) proposes a Flood Storage Area (FSA) to the west of the school site to provide effective mitigation on a volume-for-volume basis. A preliminary design was established to ensure the FSA acts to store the water contributing to any observed increases in flood extent and flood depth for both the 1:100 year + 41%CC and the 1:1000 year event.

The detailed design of the flood storage area would be secured by a planning condition attached to the Outline Planning Permission, which would secure the mitigation set out in the FRA and allow the local planning authority to approve the design of the FSA and ensure that the proposed development does not increase the risk of flooding.

As explained at the meeting on the 18th July, the secondary school would only be provided if required by the County Council. The Secondary School site comprises a core land area of 6.77ha (the northern section) and an expansion area of 1.26ha (the southernmost section), referred to as the 'Expansion Land', if required (as seen in Figure 1-1). As defined by Parameter Plan 1, the school building would be located in the norther section of the site, outside of Flood Zone 3. The Expansion Land would only be used for school playing fields, should the County Council need to expand the school site. That 1.26ha of land would be limited to playing fields and outdoor sports uses, which would be flood compatible uses. This approach avoids locating 'more vulnerable' uses in areas with a higher risk of flooding, and is wholly consistent with the sequential approach set out in the NPPF.

The land reprofiling and infilling associated with the very southern part of the overall Secondary School site is necessary in order for the overall combined land allocation to meet the County Council's design specification. Therefore the measures outlined in the FRA have been developed to show how this could be implemented should this area be required. The Applicant and LPA have agreed that a Planning Condition could control the use of this southern area and which could only come forward if further detailed modelling was prepared to demonstrate the effectiveness and compliance to NPPF of the future proposed solution.

The EA has requested that further hydraulic modelling should be carried out now to demonstrate that the mitigation proposals within the FRA represent a feasible solution.

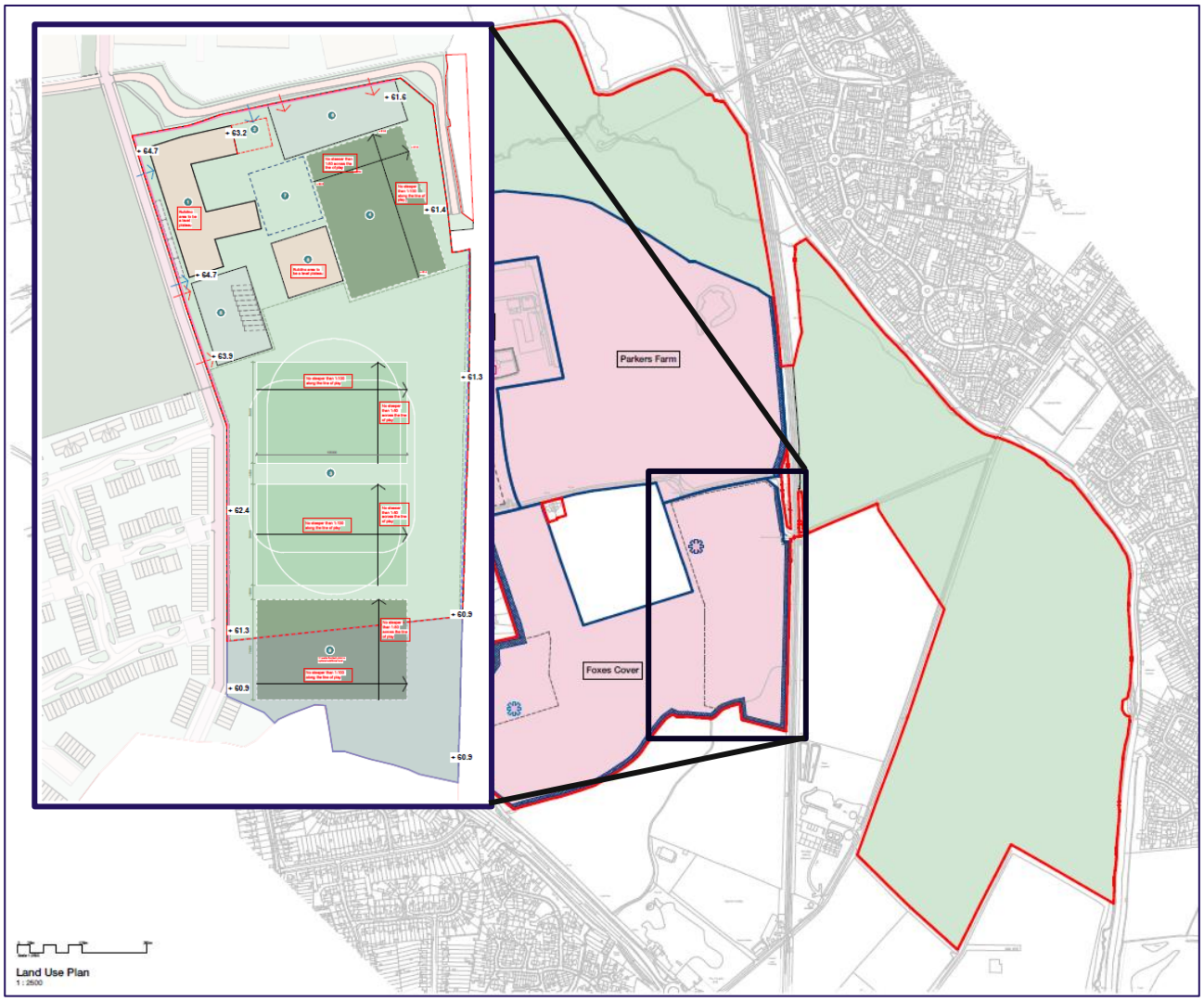

Figure 1-1 Parameter Plan indicating location of the Secondary School site, and the location of the School building. Zoomed-in image shows the indicative Secondary School Plan, outlining the area for proposed expansion.

1.2 Purpose of this Note

This Technical Note provides a description and presents the results of the hydraulic modelling undertaken to demonstrate that a solution similar to that of the FSA outlined in the FRA is feasible.

This Technical Note should be read in conjunction with the hydraulic modelling report published by Edenvale Young on the 27th March 2024, issued to the EA 27th March 2024. It is noted that additional sensitivity testing has been undertaken in response to the EA's responses through consultation, which is to be shared with the EA. This sensitivity modelling has been incorporated within the Hydraulic Modelling Report and so the version to be shared with the EA dated 28th June 2024 (Revision E) represents the latest Hydraulic Modelling Report.

This report contains full details of the development of the hydraulic model and the hydrological analysis which was carried out as a part of this study.

2 FSA Objectives

To mitigate negative impacts arising from the reprofiling of the school site and infilling of small stretch of Ordinary Watercourse, the FSA is to be designed to store the water contributing to any observed increases in flood extent and

flood depth for both the 1:100 year + 41%CC and the 1:1000 year event both within the red line boundary and outside of the red line boundary.

This is in accordance with the OCC Design Criteria for Secondary Schools outlined in Section 2.5 of the FRA, whereby no part of the proposed Secondary School should be located in an area of Flood Zone 2 or 3, or have any ditches on the site. In the event that the extension of the Secondary School site is required, the objective of the mitigation measure would be to remove any flood extents from the Secondary School Site in all events up to and including the 1:1000 year event by re-grading the land within the school site so that the flood risk from outside of the school site is removed.

Water which would have drained to the ordinary watercourse within the expansion land would be directed to the FSA before discharging onward to the ditch network outside of the site boundary.

Figure 2-1 below shows the Statutory *Main Rivers*. All other watercourses or ditches on the site represent *Ordinary Watercourses*. As noted in the FRA, the principle of infilling a stretch of *Ordinary Watercourse* would require approval from the LLFA. The LLFA have raised no objection to the infilling of a stretch of *Ordinary Watercourse* within the secondary school expansion zone and consider that it could be appropriate.

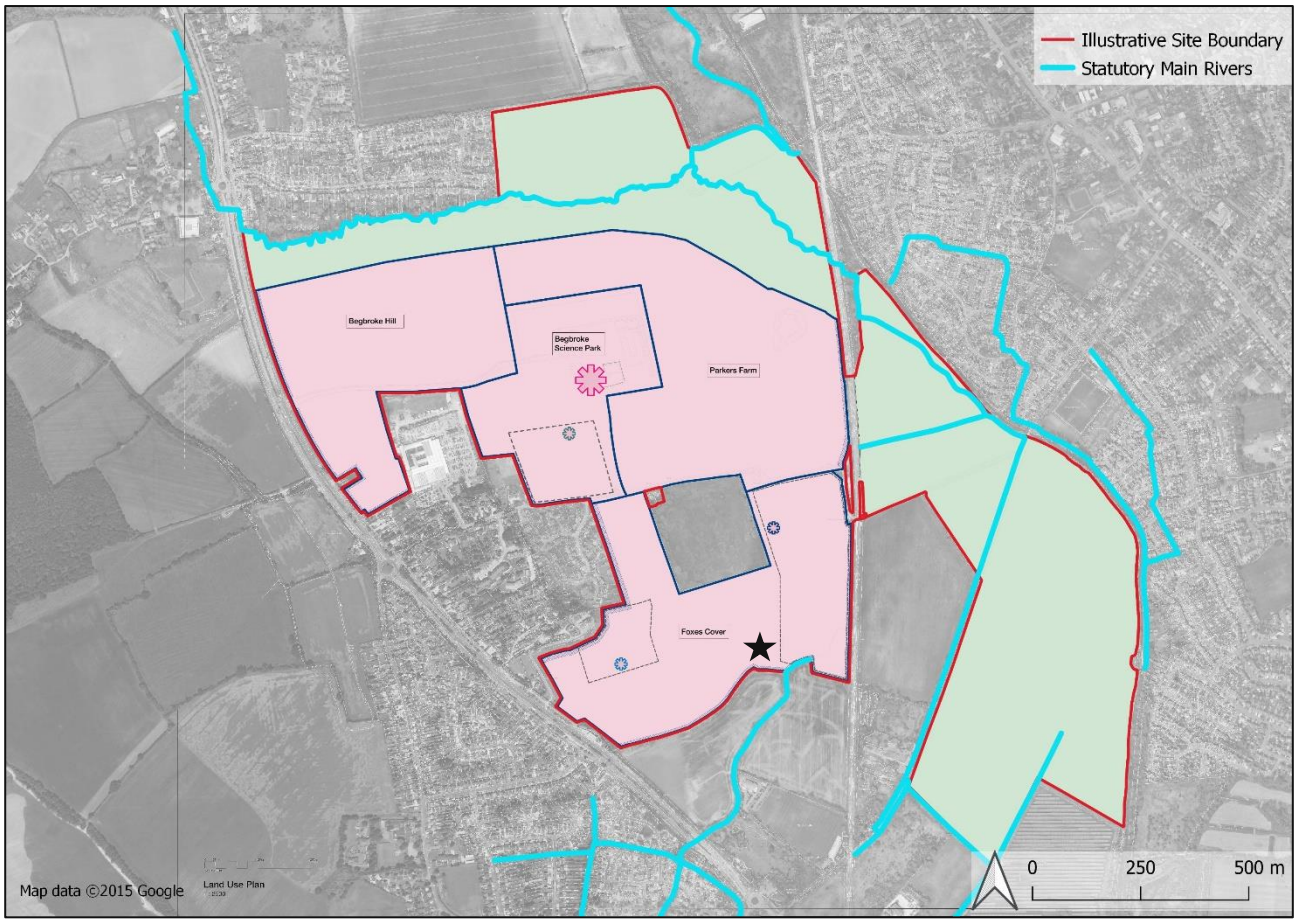

Figure 2-1 Parameter Plan 1, with Statutory Main Rivers in Blue and approximate location of FSA with black star

3 Preliminary FSA Design

Section 4.1.2 of the FRA and Section 5.3 of the Flood Risk Technical Note (*240312 Begbroke Innovation District Flood Risk Technical Note.pdf*) outline the results of the hydraulic modelling that was undertaken to assess the impacts associated with re-grading the school site. Mitigation measures were then designed to manage the consequent change in flood risk on site, within the red line boundary. The purpose of the mitigation measures is to ensure that there is no increase in flood extent or flood depth outside the red line boundary and that no proposed buildings within the development are at flood risk.

Within the FRA, a FSA with plan area of 2,960m^2, with graded side slopes down to a depth of 1.3m, was proposed. This was located in the area shown with the black line in Figure 22 of the FRA, replicated below in Figure 3-1. It was proposed that in addition to the maximum 1m depth of water, a 300mm allowance for freeboard be provided.

The size and volume of the FSA was based on the 1% AEP + 41% climate change event with a 300mm allowance for freeboard. The requirements of the FSA have been updated for this assessment and are outlined in Section 4.1.

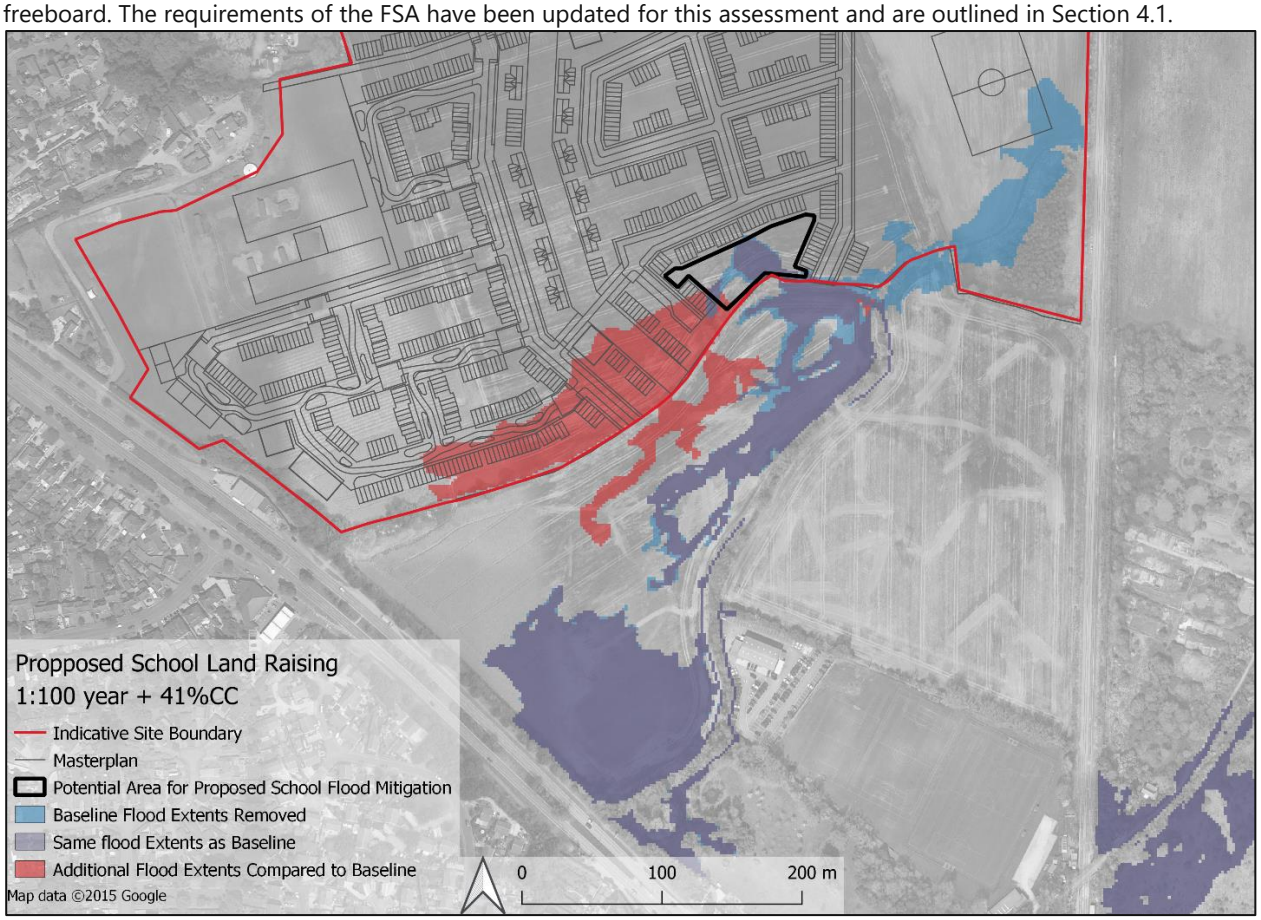

Figure 3-1 Potential location for flood storage area, sized to mitigate any increase in flood extents and flood depths resulting from the proposed land raising on the Secondary School site (Figure 22 of the FRA (July 2023))

4 Progressed FSA Design

4.1 Methodology

The design of the FSA has been informed by the following design events:

- 3.33% AEP;
- 1% AEP event + 41% allowance for climate change, including a 300mm freeboard; and
- 0.1% AEP event.

The 3.33% AEP event has been modelled to assess any potential impact to Flood Zone 3b. For further information on the hydrological analysis, please see the full Hydraulic Model Report (dated 28/06/24).

The baseline condition is consistent with the hydraulic modelling undertaken as part of the FRA. General changes have been made to the proposed solution modelling (compared to the hydraulic modelling carried out to understand the impacts of re-grading the Secondary School site) including:

- The upstream extent of the SDD 1D network has been extended, matching the baseline extents, to ensure that the modelling is reflective of the proposed works which do not involve any in-filling of sections of *Main River*.
- The field ditch, which is represented using the LiDAR data in the baseline condition, has been explicitly modelled in the new proposed scenario using TUFLOW's Z Shape function. A GULLY line has been utilised as well as left and right banklines, based on topographic survey data points in this location. This has been done on the assumption that this ditch will be appropriately maintained in order to allow for flow into the flood storage area.

4.2 FSA Design

The FSA was the result of an iterative design process, with testing of the FSA design outlined in the FRA and considering adjustments to the location of the FSA and it's dimensions to obtain a solution which resulted in no negative impact. This was considered when comparing the proposed scenario with the baseline for the 1 in 100-year scenario plus 41% CC allowance (1% AEP) and the 1 in 1000-year scenario (0.1% AEP).

The following scenarios were tested which gave positive results in terms of resulting in no negative impact when comparing the proposed scenario with the baseline for the 1 in 100-year scenario plus 41% CC allowance.

Table 4-1: Key dimensions for the FSA in the successful options tested.

FSA Options	Invert level (mAOD)	Depth (m)	Freeboard (m)	Area (m^2)
D6	59.85	1.0	0.3	4,074
D7	59.55	1.3	0.3	4,074
D8	59.35	1.5	0.3	4,074

The elevation of invert level in Option D6 was chosen based on the average existing ground level around the edges of the proposed storage area, however minor terrain adjustments might be required in order to maintain the required freeboard. The sides slopes of the flood storage area have been modelled using Z shapes which slope up to existing ground level at a 1:3 gradient. A Digital Elevation Map (DEM) showing the proposed layout of the flood alleviation scheme is shown in Figure 4-1.

The area of the FSA is proposed to be increased from approximately 2,960^2, as presented in the FRA to 4,074m^2, approximately a 37% increase in area. The north bank of the ditch, where it runs alongside the flood storage area, acts as a weir with a crest level of 60.5mAOD. For modelling purposes, the side slopes of the storage area leading up to this bank are shallower than the proposed 1:3 slope of the remaining banks, however, this will not impact the conclusions of the study and the proposed internal profiling is expected to be addressed during the next design stage.

Figure 4-1 FSA initial (FRA) and developed layouts

4.3 Hydraulic Model Outputs

4.3.1 Assessment of 1 in 100-year + 41% CC and 1 in 1000-year flood extents

All options outlined in Table 4-1 successfully remove the 1 in 100-year +41% CC and 1 in 1000-year flood extents from the Secondary School site and within the site boundary, all increases in flood depth and extent as a result of the re-profiling of the Secondary School site are isolated to within the FSA.

Table 4-2 presents a summary of the assessed offsite impacts for the three options. This demonstrates that all options tested produce either no change from the baseline, <10mm, or reductions in flood depths offsite for the 1 in 100-year +41% CC allowance event. Scenario D6, with an invert level of 59.85m results in some localised areas of increased flood

risk downstream of the FSA, offsite, a maximum of 10mm for both the 1 in 1000-year +41%CC and the 1 in 1000-year event.

Due to this minor increase, additional scenarios D7 and D8 were tested. The results from Scenarios D7 and D8 demonstrate that reducing the invert level by up to 500mm would create either a negligible impact, or a reduction in flood depths offsite for the 1 in 1000-year event. Further investigation into the detailed profiling of the basin to determine the optimum depth and slopes will need to be carried out at the next design stage.

Table 4-2 Maximum increases/ decreases in flood depth from the baseline observed for the different FSA options for both the 1:100-year + 41% CC scenario and the 1:1000-year

FSA Options	Impact in 1 in 100-year + 41% CC	Impact in 1 in 1000- year
D6	<9mm increases	10mm increases
D7	42mm decreases	33mm decreases
D8	46mm decreases	39mm decreases

Figures 4-2 to 4-9 present flood extent difference maps and flood level difference maps for both the 1 in 100-year + 41%CC allowance and the 1:1000-year events for FSA Option D6 and D8.

Figure 4-2 Change in Flood Extents for FSA D6 1 in 100 year + 41% CC

Figure 4-3 Change in Flood Levels for FSA D6 1 in 100 year + 41% CC

Figure 4-4 Change in Flood Extents for FSA D6 1 in 1000 year

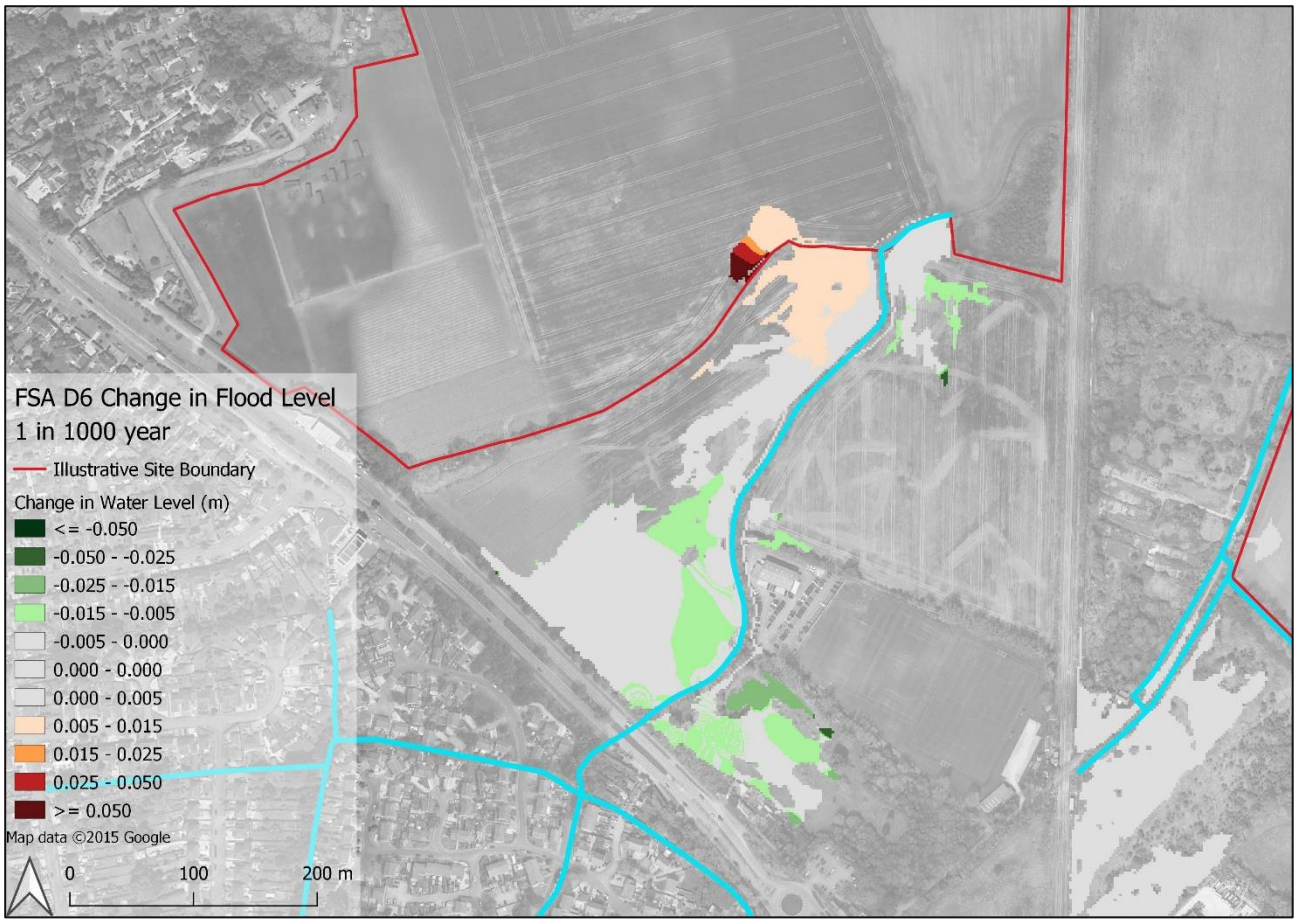

Figure 4-5 Change in Flood Levels for FSA D6 1 in 1000 year

Figure 4-6 Change in Flood Extents for FSA D8 1 in 100 year + 41% CC

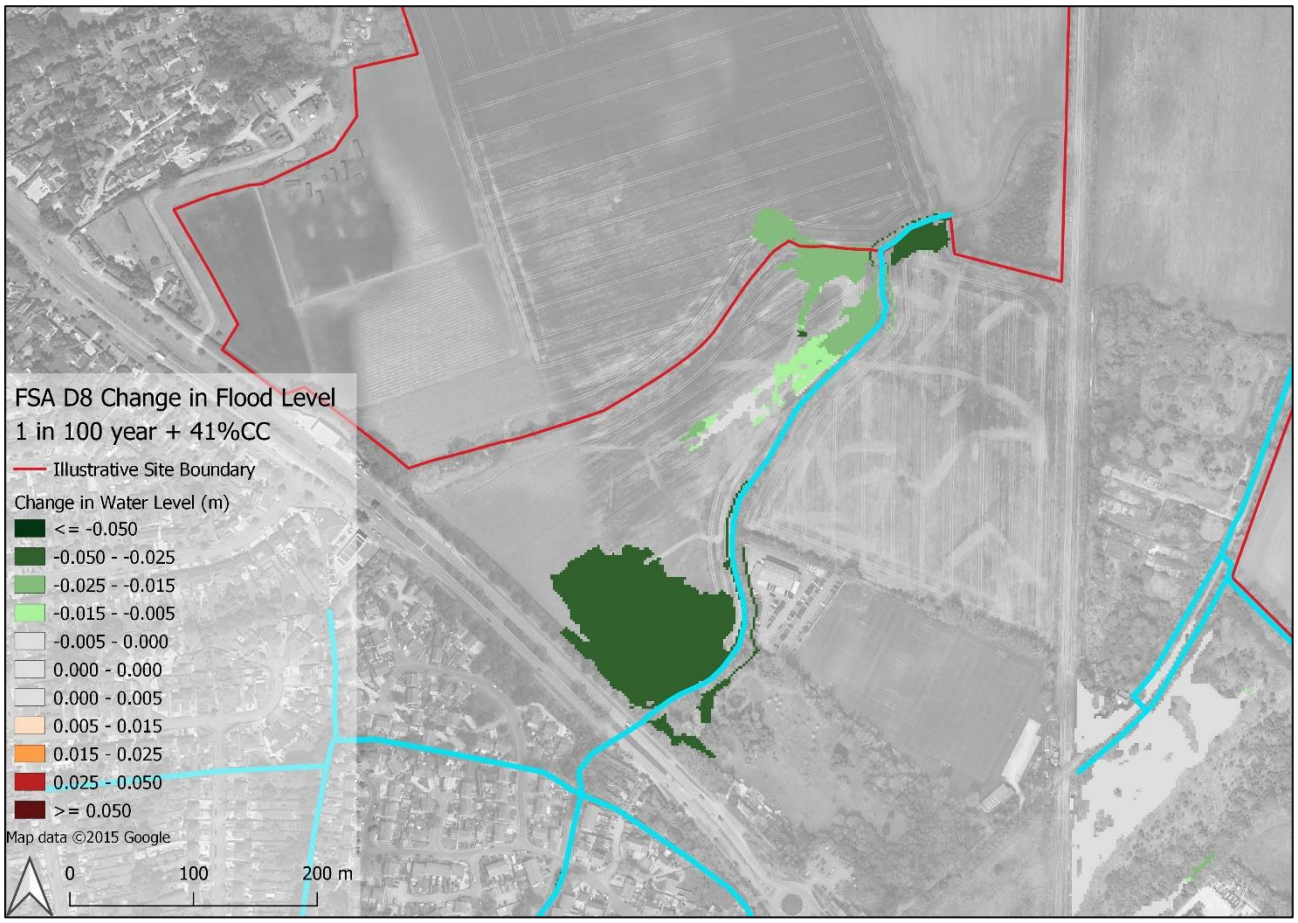

Figure 4-7 Change in Flood Levels for FSA D8 1 in 100 year + 41% CC

Figure 4-8 Change in Flood Extents for FSA D6 1 in 1000 year

Figure 4-9 Change in Flood Levels for FSA D8 1 in 1000 year

4.3.2 Assessment of 1 in 30-year flood extents

Figures 4-10 to 4-13 present flood extent difference maps and flood level difference maps for the 1 in 30-year event for FSA Option D6 and D8. These figures demonstrate that the introduction of the FSA results in a reduction in the 1 in 30-year flood extents offsite offset by the increase in floodplain on site within the FSA.

Figure 4-10 Change in Flood Extents for FSA D6 1 in 30 year

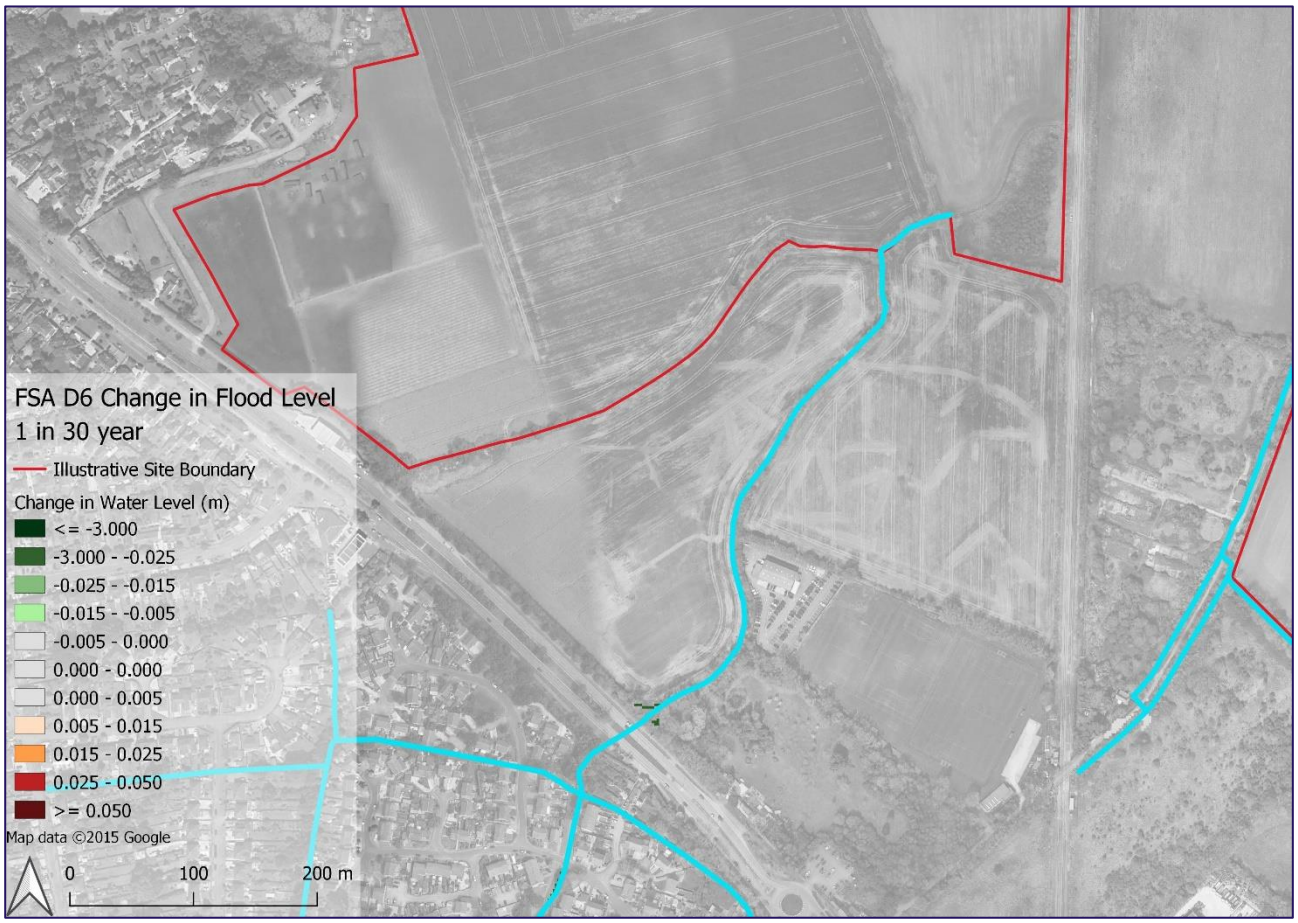

Figure 4-11 Change in Flood Levels for FSA D6 1 in 30 year

Figure 4-12 Change in Flood Extents for FSA D8 1 in 30 year

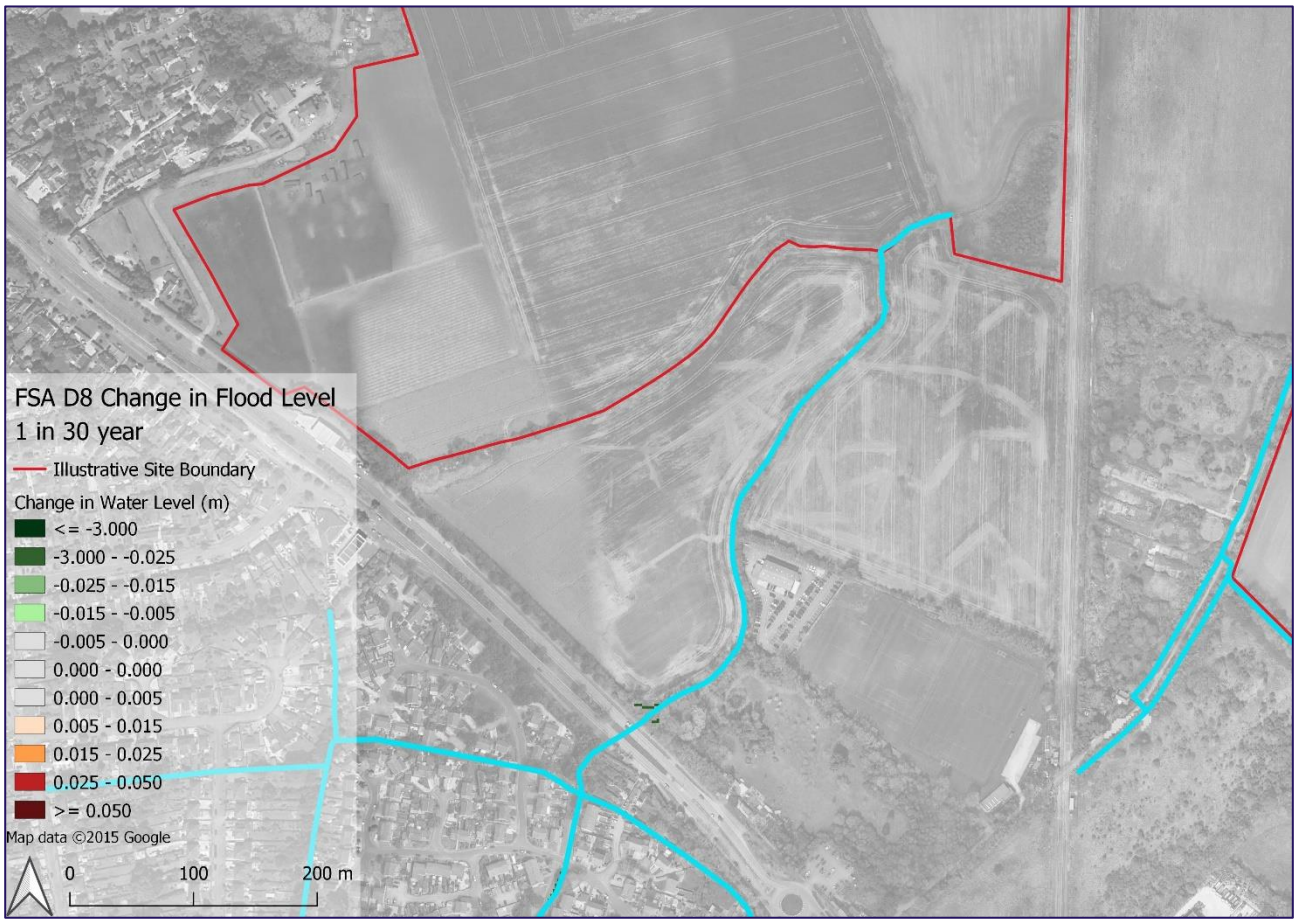

Figure 4-13 Change in Flood Levels for FSA D8 1 in 30 year

The EA initially raised a concern that the removal of a small stretch of Ordinary Watercourse needed for the southern area of the Secondary School site would constitute the removal of Flood Zone 3b extent which would then have detrimental impacts on wider flood risk.

The flood risk mapping for the project does not show any out of bank flooding from the Ordinary Watercourse in the 1 in 30-year event, hence why it is not shown on Figure 4-10 to Figure 4-13.

Figure 4-14 shows an amended version of Figure 4-10 in which the section of the Ordinary Watercourse within the school site has been artificially added to the mapping to illustrate the extent of floodplain removed in the 1 in 30-year event. Given that the 1 in 30-year event does not come out of bank, the bank full volume estimate of 100m^3 from this area would provide a conservative estimate of the potential flood plain lost.

The reduction in flood extent off-site illustrates that the introduction of the FSA provides significant reduction in flooding. Off-site a total volume of flooding alongside the Main River of 120m^3 is removed.

Given that the FSA provides ~3,000m^3 of storage it is considered that there is no overall loss of floodplain storage and the modelling clearly illustrates that there is no adverse impact on any on-site or off-site receptors.

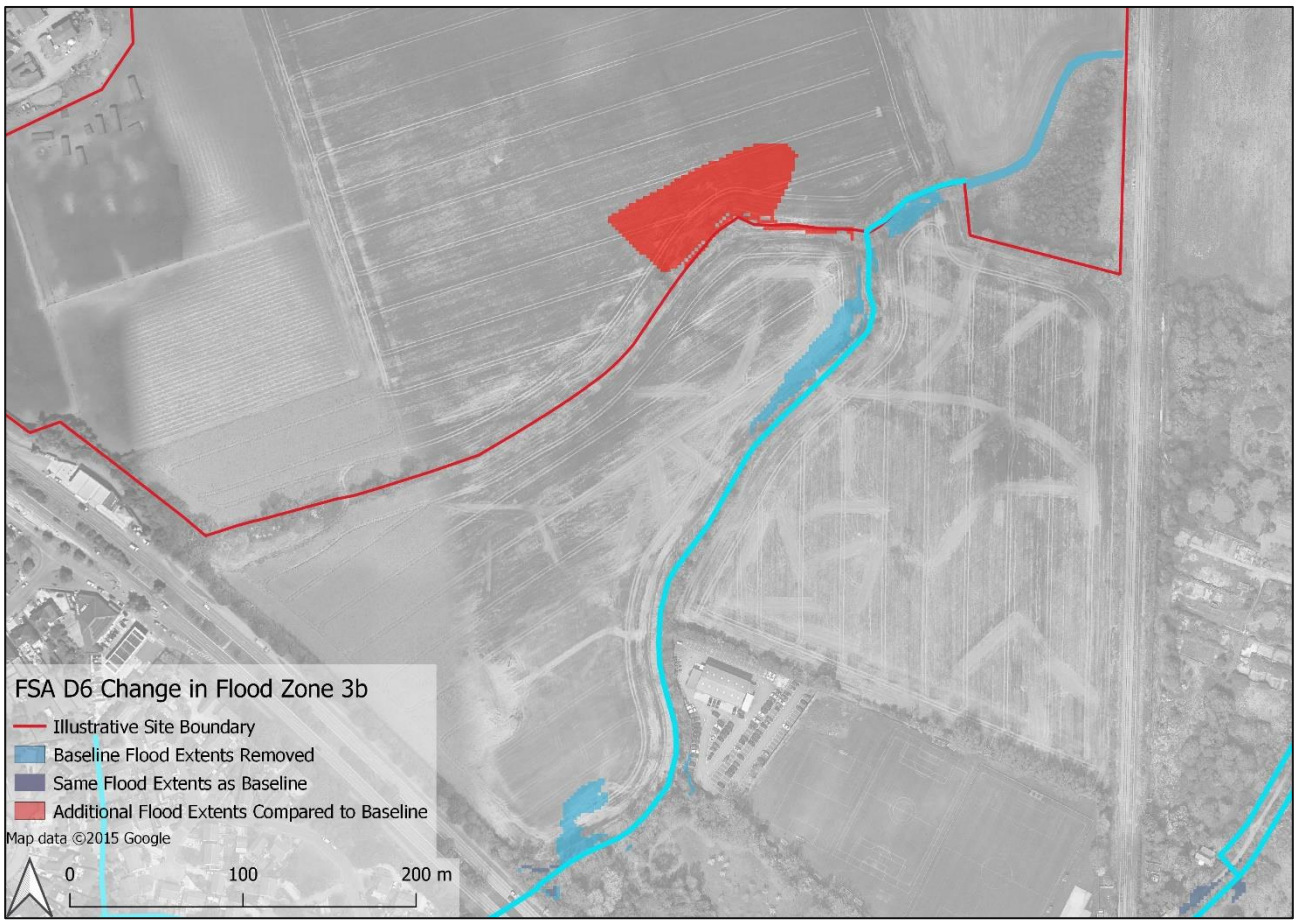

Figure 4-14 Change in Flood Extents for FSA D6 1 in 30 year, with the extent of the Ordinary Watercourse removed from the flood extents manually added to the model outputs.

5 Summary

The hydraulic modelling undertaken and presented within this Technical Note demonstrates that an appropriate solution is possible to remove flood extents from the Secondary School site, through the use of a FSA, without causing any negative impact offsite. The options tested also demonstrate that an offsite betterment is also possible depending on the chosen invert and side slopes. This will need to be developed further in the next stage of design.