HIF Banwell Bypass and Highways Improvements Project

ES Appendix 13.B - Flood Risk Assessment

BNWLBP-WHS-GEN-X_BB_Z-RP-CD-000003

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1 The Project

1.1 Scheme Overview

1.1.1 The following section provides a brief description and overview of the Banwell Bypass and Highways Improvements Project. Reference should be made to Environmental Statement (ES) Chapter 1 - Introduction for the Scheme objectives, and Environmental Statement Chapter 2 - Scheme Description for the full description.

1.1.2 The Scheme comprises the following distinct elements:

a) a bypass of the village of Banwell (referred to as the "Banwell Bypass");

b) a route connecting the A371 at Castle Hill and the A368 at East Street (referred to as the "Southern Link"); and

c) Mitigation and enhancement measures, which broadly consist of the following:

- Environmental mitigation and enhancement measures in connection with the Banwell Bypass and the Southern Link, examples of which include (but are not limited to) flood compensation areas, planting and habitat creation, attenuation basins etc.
- Placemaking improvements within Banwell, comprising mitigation and enhancement measures to the public realm; and
- Traffic mitigation in connection with the Banwell Bypass and the Southern Link, including Improvements to the wider local road network.

1.1.3 Together, these elements comprise the "Scheme". Each element as listed is described in more detail below.

Banwell Bypass

1.1.4 The Banwell Bypass would be located within the administrative area of North Somerset. The village of Banwell is located approximately 8km east of Weston-super-Mare. The Bypass would primarily consist of:

a) Signalisation and capacity improvements to the Summer Lane/Wells Lane junctions on the A371;

b) A 40mph single carriageway bypass, connecting the existing A371 (Knightcott Road, east of Summer Lane) to A368 (east of Towerhead Farm);

c) A 3 metre wide walking and cycling route provided along the majority of the Banwell Bypass providing a link from Weston-Super-Mare and to Sandford;

d) Banwell Bypass West Junction - a three arm roundabout located east of Knightcott Industrial Estate at the western end of Banwell;

e) Wolvershill Road Junction – a traffic signalised junction, providing access for all users to the west, east, and north. Access to the south would be restricted to public transport and walking, cycling and horse-riders, and limited agricultural access only;

f) Riverside Crossing – an overbridge across Riverside and the River Banwell. There would not be a direct connection between Riverside and the Bypass;

g) A side road connection between Riverside and Moor Road; and

h) Banwell Bypass East Junction - A three-arm traffic signalised junction, with dedicated turning lanes from the bypass towards the Southern Link.

Southern Link Road

1.1.5 The Southern Link would be located within the administrative area of North Somerset and within the Mendip Hills Area of Outstanding Natural Beauty (AONB). The Southern Link would be a 30mph single carriageway, connecting the A368 (East Street) to the A371 at Castle Hill. The Southern Link would link into the Bypass at the Banwell Bypass East Junction. A T-junction located along the Southern Link would provide access into the east of Banwell (at East Street).

Mitigation Measures

1.1.6 The Scheme would include mitigation measures which are provided to offset the impact of the Banwell Bypass proposal. These include (but are not limited to):

a) flood mitigation to ensure that the Banwell Bypass does not increase flood risk for third-party properties;
b) land for essential mitigation, such as ecology and landscape mitigation; and
c) sustainable urban drainage systems (e.g. attenuation basins and swales), and additional groundwater mitigation, to prevent adverse water quality impacts (including the Source Protection Zone (SPZ)).

Placemaking improvements within Banwell

1.1.7 As a result of the Banwell Bypass, there would be a reduction in traffic through Banwell. The reduction in traffic (and resulting reduction in congestion) through the village could result in higher traffic speeds without mitigation.

1.1.8 A reduced 20mph speed limit through Banwell would discourage vehicles from travelling at higher speeds, whilst also discouraging the use of the road as a through route (instead of the Banwell Bypass).

1.1.9 The reduction of traffic through Banwell due to the provision of the Banwell Bypass provides the opportunity to make improvements to the existing road and public spaces within Banwell to enhance the historic and urban setting of the village. These improvements would include, but are not limited to:

a) Alteration to the road and footways including resurfacing, widening, and narrowing (which would encourage drivers to comply with the posted 20mph speed limit);
b) Incorporation of active travel measures;
c) Soft landscaping and ecological improvements; and
d) Street signage improvements.

Improvements to the wider local road network

1.1.10 Improvements to the local road network and junctions including the surrounding villages of Churchill, Sandford and Winscombe are proposed to mitigate increases in traffic as a result of the Banwell Bypass and Southern Link. These mitigation measures would consist of:

a) Lowered speed limits:

- 20mph: A368 through Churchill, A368 through Sandford, A371 through Winscombe.
- 30mph: A368 between Churchill and Sandford Villages.

b) Gateway Features when entering and exiting the villages of Sandford, Churchill and Winscombe;

c) Non-physical traffic calming measures through and between villages (e.g. road markings and speed signage);

d) Capacity improvements to the Churchill Junction (A38/A371);

e) Provision of new / improvements to existing pedestrian and cycling crossings;

f) Active travel measures along the A368, with improved footway/cycleway access from Churchill and Langford to Churchill Academy;

g) Improvements to footways, shared pedestrian, and cycleway; and

h) Soft landscaping, native planting, rewilding, and ecological enhancements.

1.2 Context

1.2.1 North Somerset Council's (NSC) Housing Infrastructure Fund (HIF) proposal supports potential housing sites (subject to the emerging Local Plan 2038).

1.2.2 A business case was submitted to Homes England to secure funding for a package of infrastructure improvements in February 2019 and a successful funding announcement was made at the end of October 2019.

1.2.3 A number of infrastructure improvements have been proposed including: a bypass of Banwell village; a package of online improvements to the existing surrounding road network; mitigation for impacts on the nearby flood plain; and improvements to the utility supply networks in the area.

1.2.4 The bypass would provide a highway connection to enable potential housing sites that may be allocated in the emerging Local Plan and alleviate the anticipated impact of further traffic growth upon the already congested Banwell village.

1.2.5 The bypass will include wider mitigation measures and could include other enhancements subject to further appraisal, design and consultation work.

1.2.6 NSC appointed Alun Griffiths (Contractors) Ltd, with Arup and TACP (the 'AGC Team') as their technical and environmental advisors, to develop a solution including optioneering, design and planning support of the proposed HIF Banwell Bypass and Highways Improvements Project Stage 1 (the "Scheme"). Stage 1 of the project includes: optioneering; preliminary design; Environmental Impact Assessment (EIA); planning permission; Statutory Processes. Stage 2 of the project is the detailed design and construction phase, following planning determination and land acquisition.

1.3 Scheme objectives

1.3.1 NSC's overall objectives for the Scheme are to deliver, within cost, quality, and programme targets:

a) Improve the local road network to deal with existing congestion issues.
b) Improve and enhance Banwell's public spaces by reducing traffic severance and improving the public realm.
c) Provide the opportunity to increase active and sustainable travel between local villages and Weston-super-Mare.
d) Deliver infrastructure that enables housing development (subject to Local Plan).
e) Ensure the development respects the local area and minimises visual impact upon the surrounding countryside and Mendip Hills Area of Outstanding Natural Beauty (AONB).
f) Innovative and efficient in reducing and offsetting carbon from the design and construction of the infrastructure.
g) Ensure the development provides the opportunity to increase Biodiversity Net Gain by at least 10%.
h) Proactively engage with stakeholders in a way that is both clear and transparent.

1.4 Purpose of this Report

1.4.1 The purpose of this report is to demonstrate that the development will be safe for its lifetime with respect to flooding, and that the proposed works will not lead to unacceptable impacts on third party land.

1.4.2 This report discusses the flood risk for the Banwell Bypass and Southern Link Road only as described in sections 1.1.4 and 1.1.5. The Placemaking improvements within Banwell and the Improvements to the wider local road network, as described in sections 1.1.7 to 1.1.9, and section 1.1.10 respectively, are not considered within this Flood Risk Assessment as those improvements do not lie within any flood zones.

1.4.3 Surface water drainage considerations associated with the placemaking and wider mitigations are covered in the Surface Water Drainage Strategy[1].

[1] Surface Water Drainage Strategy, Report number: BNWLBP-ARP-HDG-XXXX-RP-CD-000001.

2 Introduction

2.1 Scope of Study

2.1.1 Wallingford HydroSolutions Ltd (WHS) has been commissioned to undertake a Flood Risk Assessment (FRA) for the Banwell Bypass located north of Banwell village in North Somerset (Village NGR: 339560, 159232). The River Banwell and its tributaries flow through the site of interest.

2.1.2 This FRA is supported by detailed fluvial hydraulic modelling of the River Banwell and its tributaries, to improve the understanding of flood risk in the area and quantify any impacts of the proposed bypass. The existing hydraulic modelling completed by Royal HaskoningDHV has been updated by WHS. Further details on the modelling can be found in the supplementary hydraulic modelling report[2].

2.1.3 Part of the proposed bypass is within the floodplain and shown to be partially in Flood Zone 3 following an initial review of the EA Flood Map for Planning[3]. The Flood Map for Planning shows that the site is at risk from tidal flooding which does not include the influence of tidal flood defences. The fluvial hydraulic modelling undertaken as a part of this study has indicated that the proposed bypass is also in an area at risk of fluvial flooding. This risk is from the River Banwell (which flows south to north) and its tributaries the Old Yeo Rhyne (which flows south to north) and Wallymead Rhyne (which flows west to east). The mapping indicates that the area has an annual probability of flooding of more than 1%.

2.1.4 The proposed development is categorised as “essential infrastructure” according to the technical guidance to the National Planning Policy Framework (NPPF), hence this FRA must demonstrate that the development will be safe for its lifetime, and that the proposed works do not unacceptably

[2] Banwell Bypass Hydraulic Modelling Report (BNWLBP-WHS-GEN-X_BB_Z-RP-CD-000001). Wallingford HydroSolutions Ltd, January 2022.
[3] Environment Agency (2022). *Flood Map for Planning*. https://flood-map-for-planning.service.gov.uk/ (Accessed 5th January 2022).

worsen flood risk on third party land.

2.1.5 Due to the nature of the proposed development i.e. an elevated road above the floodplain, the critical factor in terms of flood risk is to analyse the impacts of the loss of storage and conveyance in the floodplain due to the proposed embankment.

2.1.6 This document should be read alongside the Flood Evacuation Plan[4] which has identified the measures required to allow suitable escape for the relevant parts of the scheme.

2.1.7 In summary this FRA will:

a) Analyse the fluvial flood risk using detailed hydraulic modelling
b) Summarise any impacts of the proposed development on flood risk elsewhere
c) Assess the potential for mitigation
d) Draw together the key findings of the report in a conclusions and recommendations sections.

2.2 Data Sources

2.2.1 The data sources used to inform this FRA include:

a) EA online flood maps and flood map for planning
b) Historic flood data
c) River Banwell Model updated by WHS (2021/22) and the associated Hydraulic Modelling Report
d) Woodspring Bay and Severn House Farm Coastal Flood Modelling (JBA 2020) and Modelling Report
e) Details of the proposed development (obtained from the Arup team)
f) National Planning Policy Framework (NPPF)
g) Technical Guidance to the NPPF
h) Department for Communities and Local Government Planning Practice Guidance.

[4] Banwell Bypass Flood Evacuation Plan. Report number: BNWLBP-WHS-GEN-X_BB_Z-RP-CD-000004.

3 Site Description

3.1 Site Location

3.1.1 The proposed bypass will be located just north of Banwell, North Somerset (NGR: 339891, 159838). The site location along with the proposed bypass is shown in Figure 1. The bypass will cross over the River Banwell which flows south to north. It will also cross two tributaries of the River Banwell, the Old Yeo Rhyne, which flows south to north and the Wallymead Rhyne, which flows west to east, along with other minor rhynes and ditches.

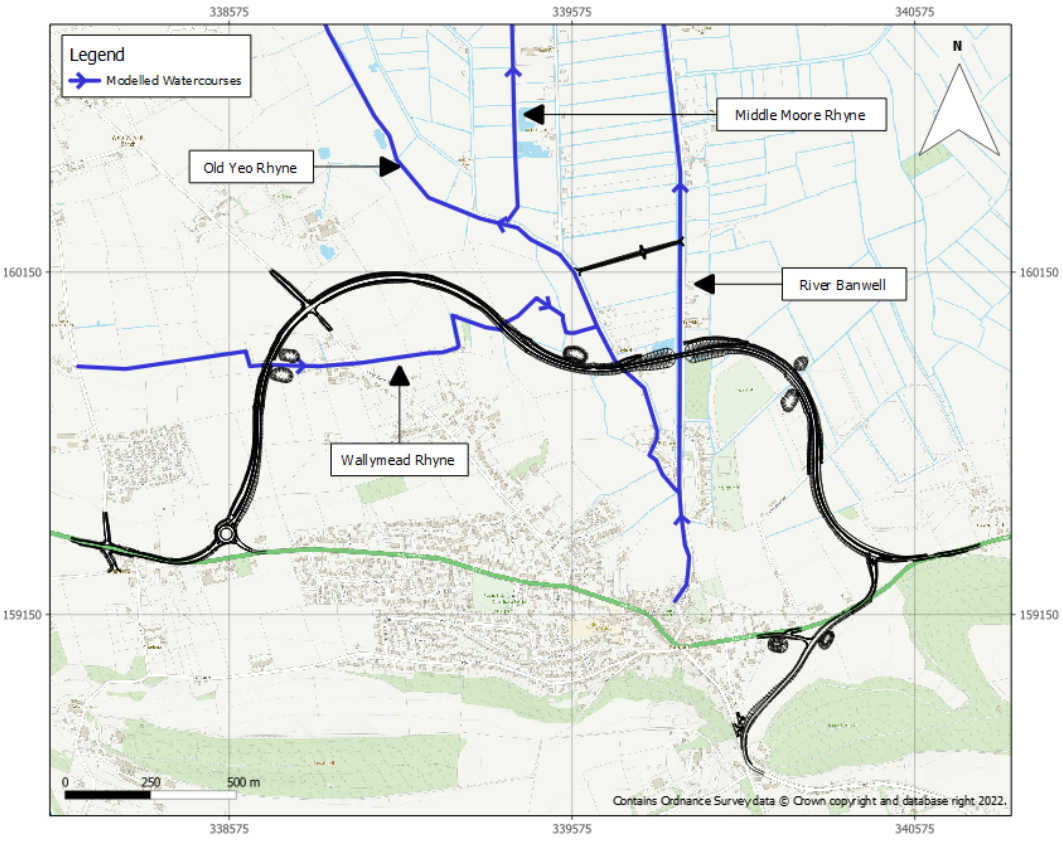

Figure 1 Proposed Bypass Location

3.2 Topography

3.2.1 The topography of the site is shown below in Figure 2. The topography of the floodplain is relatively flat with ground levels in the region of 4-6mAOD between the bypass and the estuary. Ground levels along the Wallymead Rhyne upstream (west) of the confluence with the Old Yeo Rhyne are higher, in the region of 7-10mAOD.

3.2.2 To the south of the bypass higher elevations can be found reaching approximately 120mAOD. A small hill can be seen to the northwest of the bypass reaching approximately 30mAOD, with levels remaining relatively flat and in the region of 4-6mAOD to the north and north east.

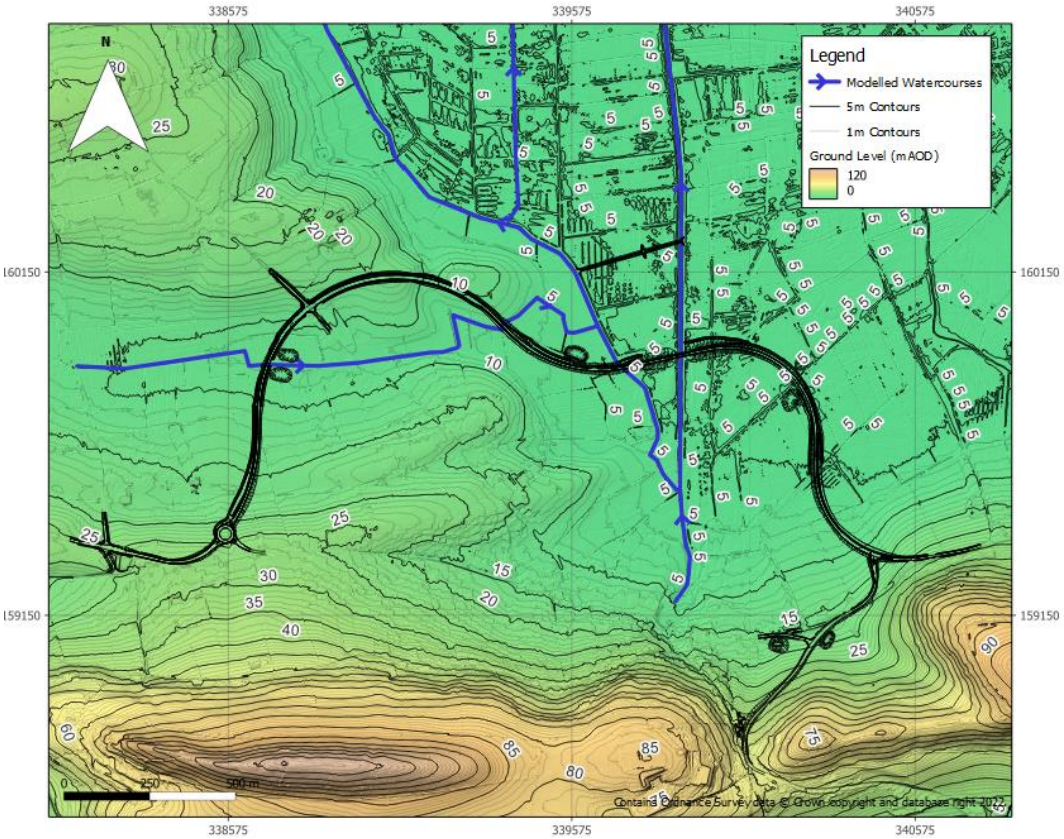

Figure 2 Topography

3.3 Proposed Development

3.3.1 The proposed works include the construction of a single carriageway bypass around Banwell village that connects the A371 (Knightcott Road) and the A368 (Towerhead Road). The bypass will include a junction onto both sides of Wolvershill Road in addition to a separate single carriageway road linking Moor Road and Riverside. This link road will be sat on an embankment above the floodplain level.

3.3.2 The development also includes the Southern Link Road (as described in section 1.1.5) which as shown in section 4 of this report is located in Flood Zone 1 and has therefore not been included in this assessment.

3.3.3 Also a part of the scheme, a 3m wide shared use path is proposed which will largely run alongside the Towerhead Brook east of the bypass. This is in part located in Flood Zone 3 but as it will be at grade and with only one additional minor ditch crossing, its impact on flood risk is not considered to be significant. Evacuation of this path has been addressed in the Flood Evacuation Plan[4]

3.3.4 In addition to the bypass itself, the planning application includes wider environmental mitigations for the purpose of landscape integration and biodiversity net gain. Placemaking in Banwell Village is also proposed which will consider opportunities for green infrastructure and improved travel systems.

3.3.5 The bypass itself will largely sit on an embankment with a small area of cutting specified between the two aforementioned junctions. At this location the bypass passes over the small hill to the northwest where the land is well above the floodplain level.

3.3.6 The proposed road will cross several watercourses including the River Banwell where an open span bridge will be constructed. For the remaining rhynes, culverts have been proposed to convey water underneath the embankments. A typical cross section of the embankment proposed in the floodplain between the River Banwell and the Old Yeo Rhyne is shown below in Figure 3.

3.3.7 The Moor Road Riverside link road will cross the River Banwell and two minor rhynes. The former will be spanned by a bridge and the latter will be culverted. As agreed in principle with the EA[5], the bridge soffit level will be at the maximum design water level (100yr plus climate change) but for design feasibility a 600mm freeboard has not been specified.

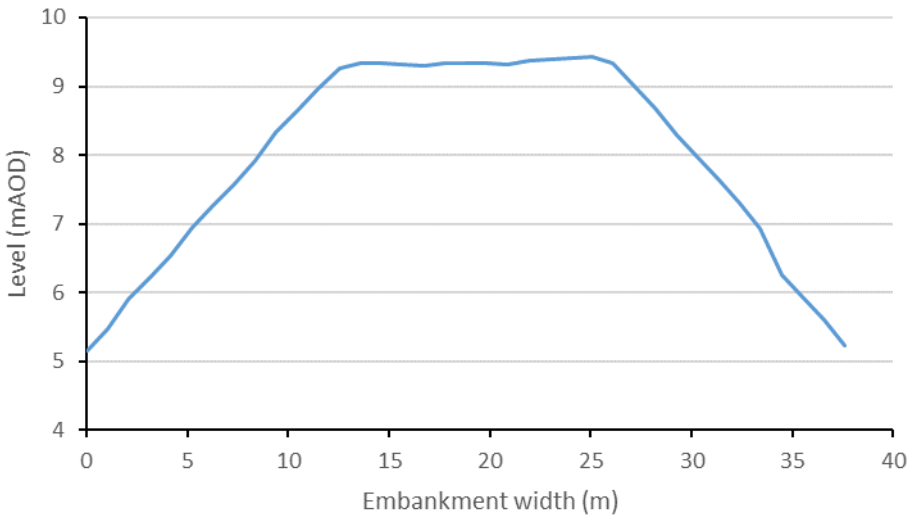

Figure 3 Typical cross section of the proposed bypass between the River Banwell and Old Yeo Rhyne

[5] Banwell Flood Modelling Results Meeting with the EA, 17/02/22. Meeting minute reference: BNWLBP-WHS-GEN-X_BB_Z-MI-CD-000004.

4 Flood Risk

4.1 Historic Flooding

4.1.1 The EA's historic flood map indicates historic flooding in the vicinity of the Old Yeo Rhyne at NGR: 339673, 159801. The Lead Local Flood Authority (LLFA), North Somerset Council, has also identified multiple locations in Banwell that have historically flooded. Both datasets are shown below in Figure 4.

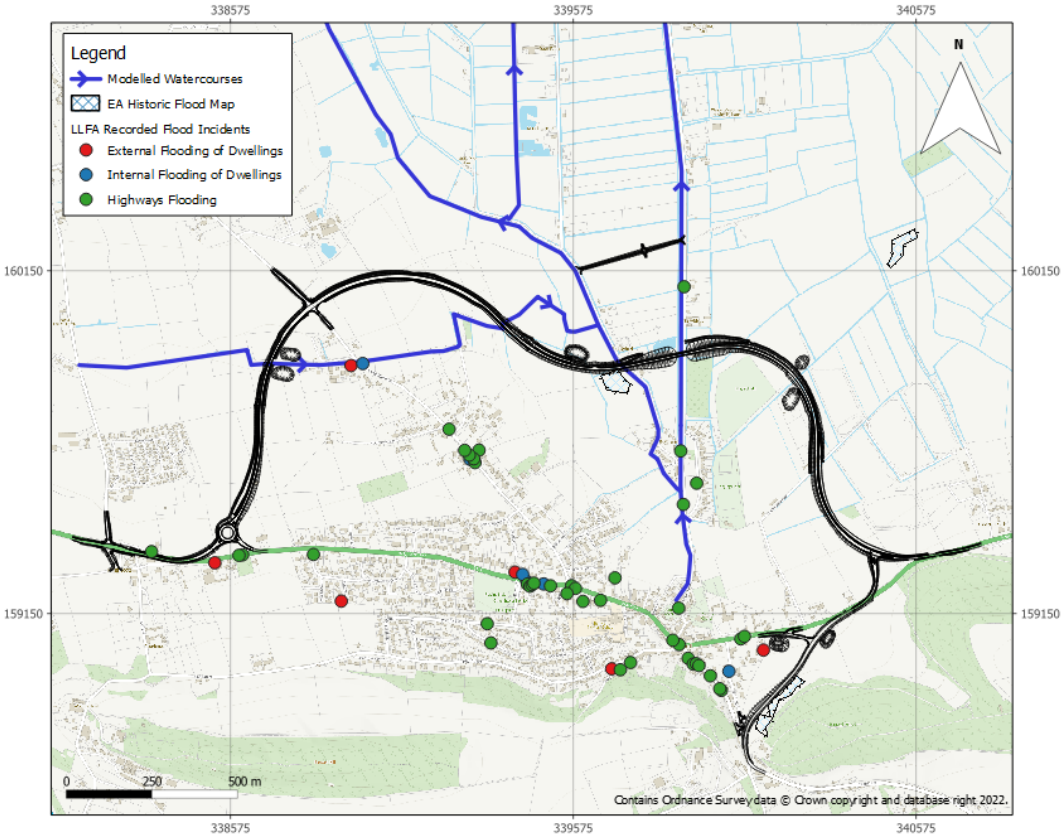

Figure 4 Historic Flooding

4.1.2 The LLFA pointed out four areas of historic flood risk of concern in the Banwell area. These were discussed and an appropriate action agreed in a meeting held on 21/10/21[6] attended by NSC, Arup and WHS. The areas discussed are shown in Table 1.

[6] LLFA Surface Water Flood Risk Meeting, 21/10/21. Minutes document reference: BNWLBP-WHS-GEN-X_BB_Z-MI-CD-000003

Table 1 Recorded Flood Incidents

Area	Issue	Agreed Action
Stonebridge Farm	Known area where water pools and causes property flooding.	The fluvial model is sufficient to pick up flooding here due to the inclusion of the Wallymead Rhyne.
Goding Lane	Property and road flooding.	Highlighted as an area to consider when looking at the design and placement of SuDS features.
Castle Hill Road	Known flow route which causes property flooding.	Given proximity to the proposed southern link a solution could be considered in the detailed drainage design that reduces current risk.
Wolvershill Road	Recorded flooding including external flooding.	Agreed that flooding here is unlikely to be affected by the scheme given its distance.

4.2 Flood Map for Planning

4.2.1 The River Banwell and part of the proposed development is located within Flood Zone 3. The EA's Flood Map for Planning indicates that the bypass is at risk from tidal flooding. The annual probability of flooding is more than 0.5% ignoring the presence of defences. The area is shown to benefit from coastal defences to the north which mitigate the tidal flood risk. Figure 5 shows the bypass in relation to the EA's flood zones and areas benefitting from defences.

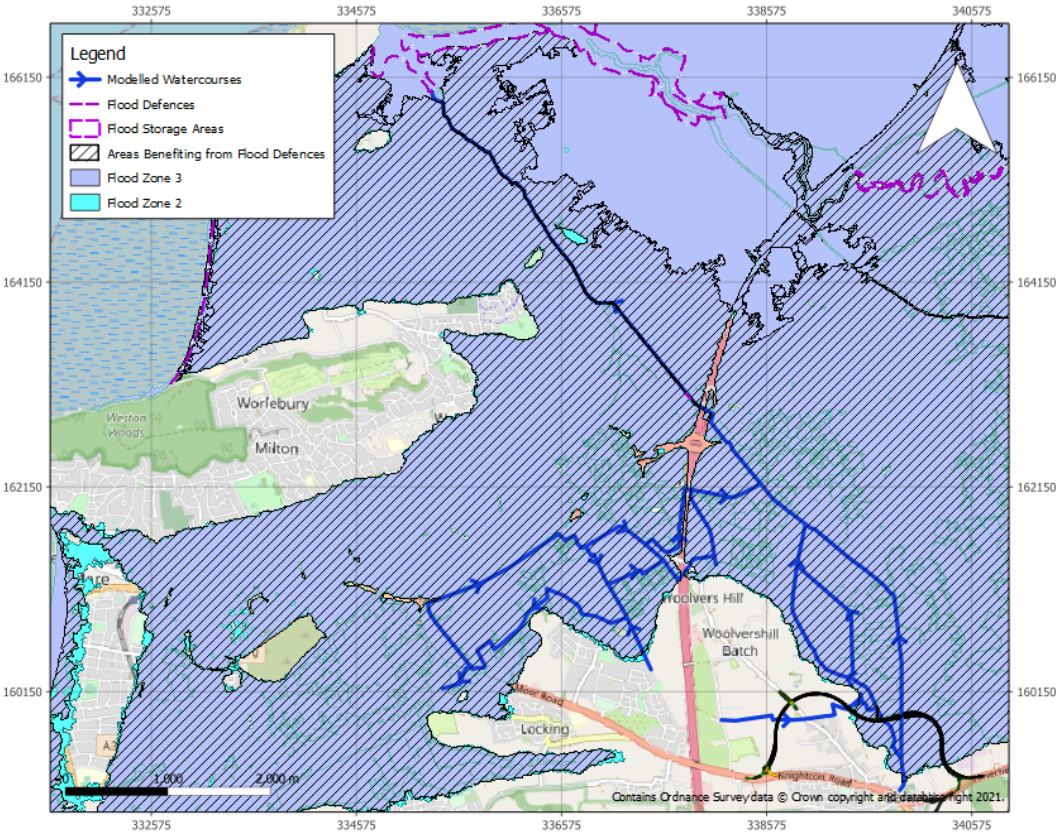

Figure 5 Flood Zones and Defended Zones

4.3 Fluvial Flooding

4.3.1 The fluvial flood risk has been assessed by reviewing the updated River Banwell hydraulic model. The model assumes that the tidal flood defences are in place and does not account for defence overtopping and the associated tidal flood risk. However, the influence of the tide on the fluvial flood levels has been represented using a Mean High Water Spring (MHWS) tidal curve at the downstream boundary.

4.3.2 For more information on the development of the fluvial flood model, please see the supplementary hydraulic modelling report[2]. The detailed modelling allows flood levels, depths and velocities to be analysed for the purpose of a relative impact assessment of the proposed scheme. However, the purpose of the model is not to update the EA's Flood Maps. Figure 6 below shows the baseline model maximum flood depth plot for the design event. For essential infrastructure this is the 1 in 100 year plus higher central climate change allowance (CC) event (39% increase in peak flow).

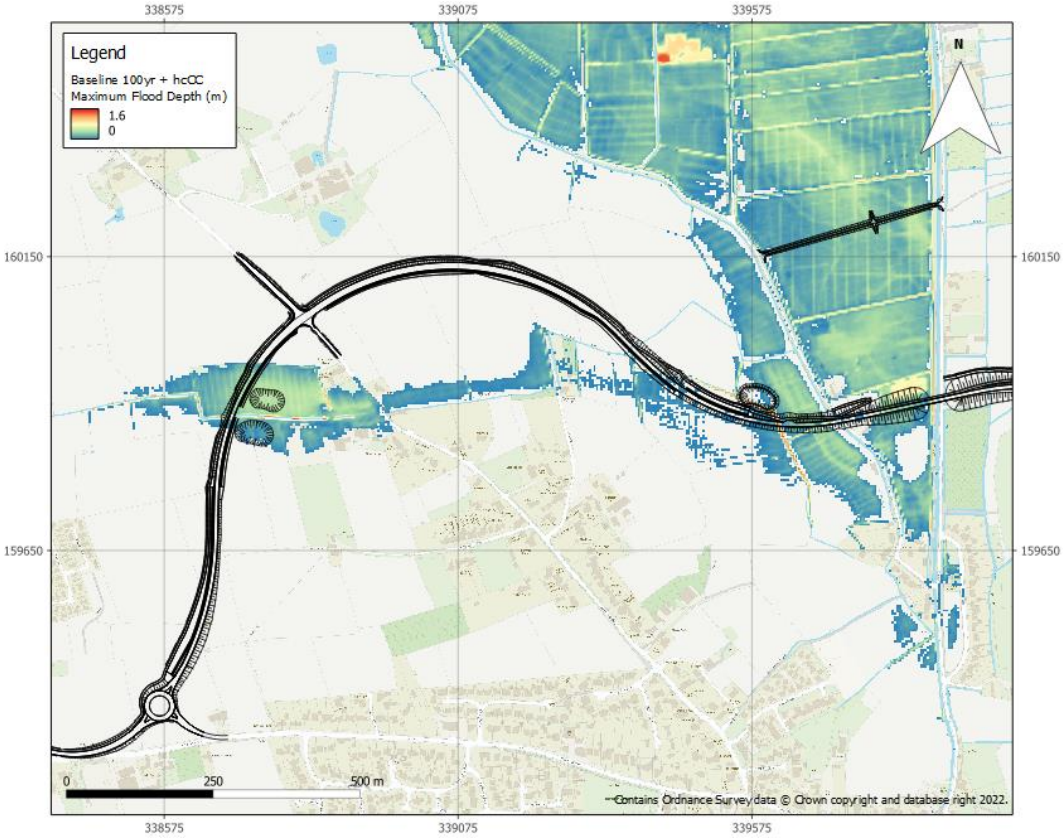

Figure 6 100 year + 39% CC Flood Depths

4.3.3 The floodplain in the vicinity of the proposed bypass is flooded in the design event by depths up to 0.50m. The floodplain bounded by the River Banwell and the Old Yeo Rhyne is largely inundated as are the fields where the Wallymead Rhyne meets the Old Yeo Rhyne. A south-easterly flow route occurs between these two rhynes due to a restriction caused by a culvert. Further upstream on the Wallymead Rhyne, Stonebridge Farm is shown to flood where the proposed bypass crosses.

4.3.4 Where flooding is predicted in the vicinity of the proposed bypass, this is significantly lower than the level of the proposed road. As it is sat on an embankment the design level is well above the flood level including a 600mm freeboard.

4.4 Coastal Flooding

4.4.1 The Woodspring Bay and Severn House Farm Coastal Flood Model informs the Flood Map for Planning. It was commissioned by the EA and developed by JBA Consulting in 2020. The results have been acquired to inform this assessment. The results did not include breach scenarios, as indicated by the EA[7] in preliminary discussions. It was agreed that breach analysis is unlikely to be required given that the bypass is on the fringe of the flood extents in the Flood Map for Planning.

4.4.2 Maximum flood level plots were provided for both the defended and undefended scenarios for a range of return periods. A review of the defended scenarios shows that the model does not predict flooding in the vicinity of the proposed bypass for any modelled return period (including the 200yr plus climate change and 1000yr events). Figure 7 shows the flood extent for the 200yr plus climate change scenario.

4.4.3 Figure 8 shows the maximum flood levels produced during the undefended 200yr plus climate change event (NPPF factors and 100yr lifespan). The figure indicates that the level is fairly constant across the floodplain at approximately 7.20m AOD. This is significantly higher than the fluvial flood level and indicative of the severity of the scenario. Because the flood

[7] Banwell Flood Risk Meeting with the EA, 28/07/2021. Minutes document reference: BNWLBP-WHS-GEN-X_BB_Z-MI-CD-000001

defences are in place and as the bypass is located on the fringe of the undefended zone this has not been considered as an appropriate design standard.

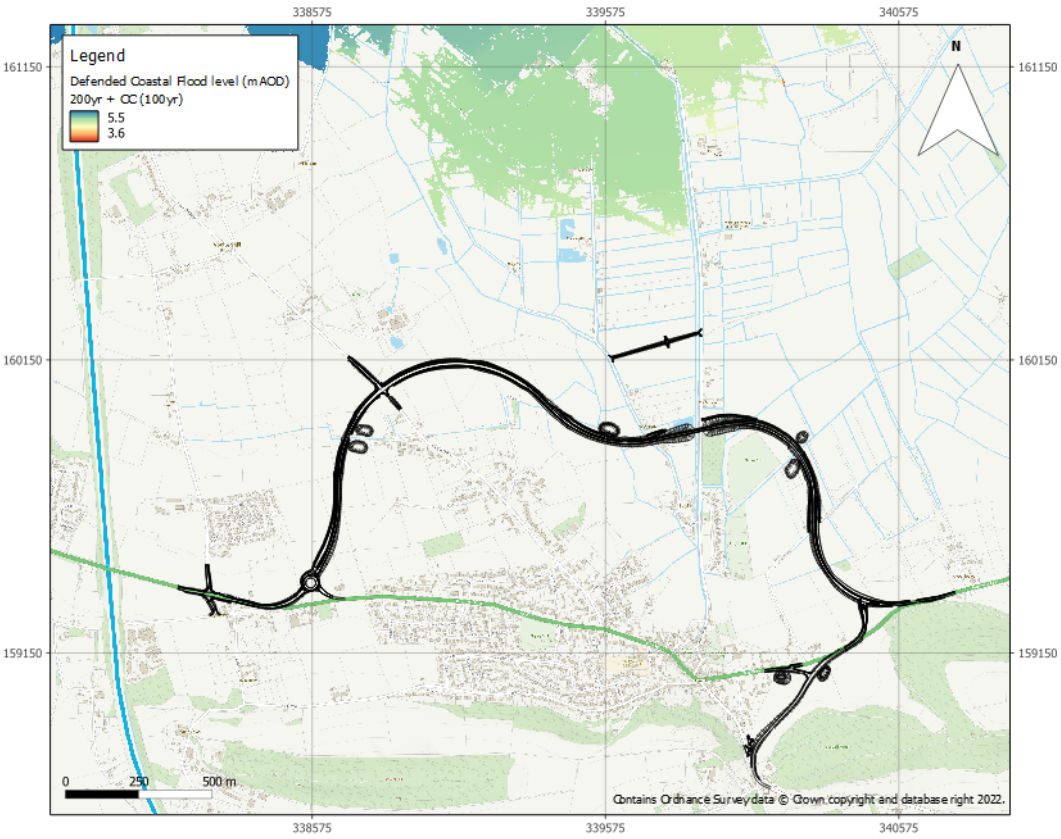

Figure 7 Defended Coastal 200yr + CC Max Flood Levels

4.4.4 A review of the undefended flood levels against the highest level of the embankment shows that on the western side it sits above the undefended coastal flood level. On the eastern side, where the road curves to the south, the road level is 0.5-1.0m below the undefended coastal flood level. However, as described earlier this is not a realistic scenario for design purposes as coastal defences will be maintained. The Shoreline Management Plan (SMP)[8] supports this by indicating that the policy for the coastline (KIN 1) is Managed Realignment. In the 20 to 50 years epoch the existing defences will come to the end of their serviceable life where new, realigned defences will be created. Managed Realignment is currently focused around Congresbury Yeo. In future this will be directed to the areas south of here and along the shoreline north of Commissioner's bank. To the east of the River Banwell the policy for the

[8] SMP 19 Anchor Head to Lavernock Point (Severn Estuary), February 2017.

coastline (KIN 2) is No Active Intervention due to the natural high ground and hard geology.

4.4.5 The model data included information on the overall condition of the flood defences. A bridge abutment and maintained channel with retaining wall were categorised as being in poor condition. The remaining defences were categorised as being in fair condition with a few being in good condition.

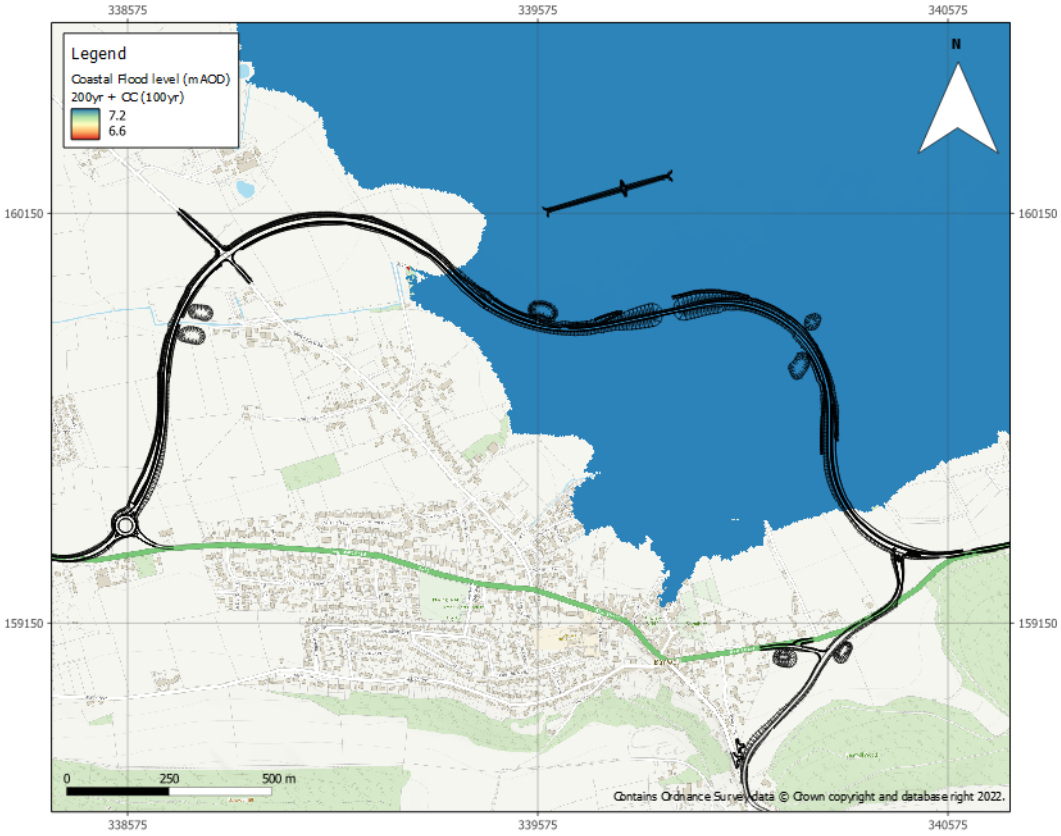

Figure 8 Undefended Coastal 200yr + CC Max Flood Levels

4.5 Pluvial Flooding

4.5.1 The surface water flood risk has been assessed by reviewing the EA's surface water flood map shown in Figure 9. Along the Wallymead Rhyne and to the west of the Old Yeo Rhyne, the surface water flood extent is shown to closely match the fluvial flooding in the updated River Banwell model. This flooding originates from these small watercourses and will be addressed by the fluvial flooding mitigation measures.

4.5.2 To the east of the River Banwell surface water flooding up to and including the 1 in 100 year event is shown to be contained within the drainage ditches and rhynes. The 1 in 1000 year extent is shown to inundate the fields around these drainage ditches and will be addressed in the drainage design. The ditches and rhynes to the east of the River Banwell are not within the River Banwell catchment but are within the Towerhead Brook catchment which was agreed with the EA not to be included in the updated River Banwell model.

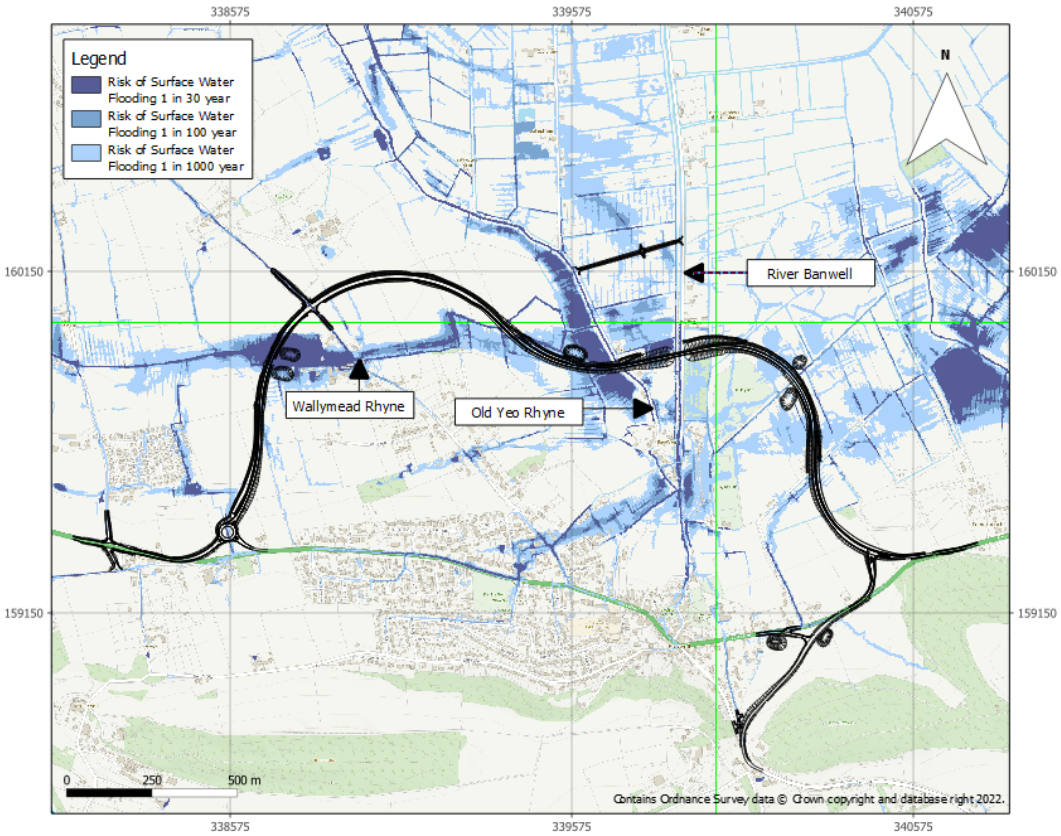

Figure 9 Surface Water Flood Risk

5 Flood Risk Assessment

5.1 Planning Policy

5.1.1 The NPPF and guidance set out for Communities and Local Government states that the development of essential infrastructure in Flood Zone 3 is only permitted if the exception test is passed. The exception test is required to demonstrate that:

a) The development provides wider benefits for the sustainability of the community.

b) The development will be safe for its lifetime and will not have any adverse effects on third party flood risk, reducing overall flood risk wherever possible.

5.2 Consultation with the Environment Agency

5.2.1 Liaison with the EA was undertaken throughout the development of the fluvial hydraulic model and this FRA to ensure compliance with their requirements. This liaison took the form of contact via email and an online meeting held on 28th July 2021[9]. In the meeting the approach to the hydraulic modelling and the FRA was agreed. The EA expect the model to show no unacceptable third party impacts unless agreed with landowners, where 10mm is considered the maximum acceptable flood depth increase. The need for provision of compensatory storage to compensate for any loss of flood volume in fluvial flood areas was also confirmed.

5.2.2 The principles and mitigation measures described in this FRA have been discussed and agreed in principle with the EA in an online meeting held on 17th February 2022[10].

[9] Banwell Flood Risk Meeting with the EA, 28/07/21. Meeting minutes reference: BNWLBP-WHS-GEN-X_BB_Z-MI-CD-000001
[10] Banwell Flood Modelling Results Meeting with the EA, 17/02/22. Meeting minute reference: BNWLBP-WHS-GEN-X_BB_Z-MI-CD-000004.

5.3 Flood Risk Impacts on Third Party Land without Mitigation Strategy

5.3.1 In order to quantify any impacts of the proposed works, the hydraulic model was run for flood events ranging from the 1 in 20 year to the 1 in 1000 year , incorporating the proposed levels and extent of the proposed embankment including the culverts running under it. The raised drainage attenuation basins proposed as part of the drainage strategy were also included. These details were supplied by the Arup team. It has been agreed with the EA that 10mm of impact is the trigger for significance. The 3m wide shared cycle and footpath is not considered to have a significant impact on flood risk because it is at grade with only one crossing proposed over a minor ditch. Therefore, it has not been included in the hydraulic model.

5.3.2 There are a small number of proposed diversions of rhynes in the area bounded by the bypass around the Old Yeo Rhyne and Wallymead Rhyne. The proposed bypass and drainage attenuation basins cut across the rhyne network here therefore diversions are required This can be viewed in more detail in the Surface Water Drainage Assessment[11]. Figure 10 shows the location of the proposed rhyne diversion, culverts and channels being decommissioned, which have all been incorporated into the post-development flood model.

5.3.3 Figure 11 shows the change in maximum flood depth between the baseline and post-development scenarios for the design event (100 year plus 39% CC) and relevant critical duration (15 hours). This plot does not account for any proposed mitigations.

[11] Surface Water Drainage Strategy, May 2022, Report number: BNWLBP-ARP-HDG-XXXX-RP-CD-000001.

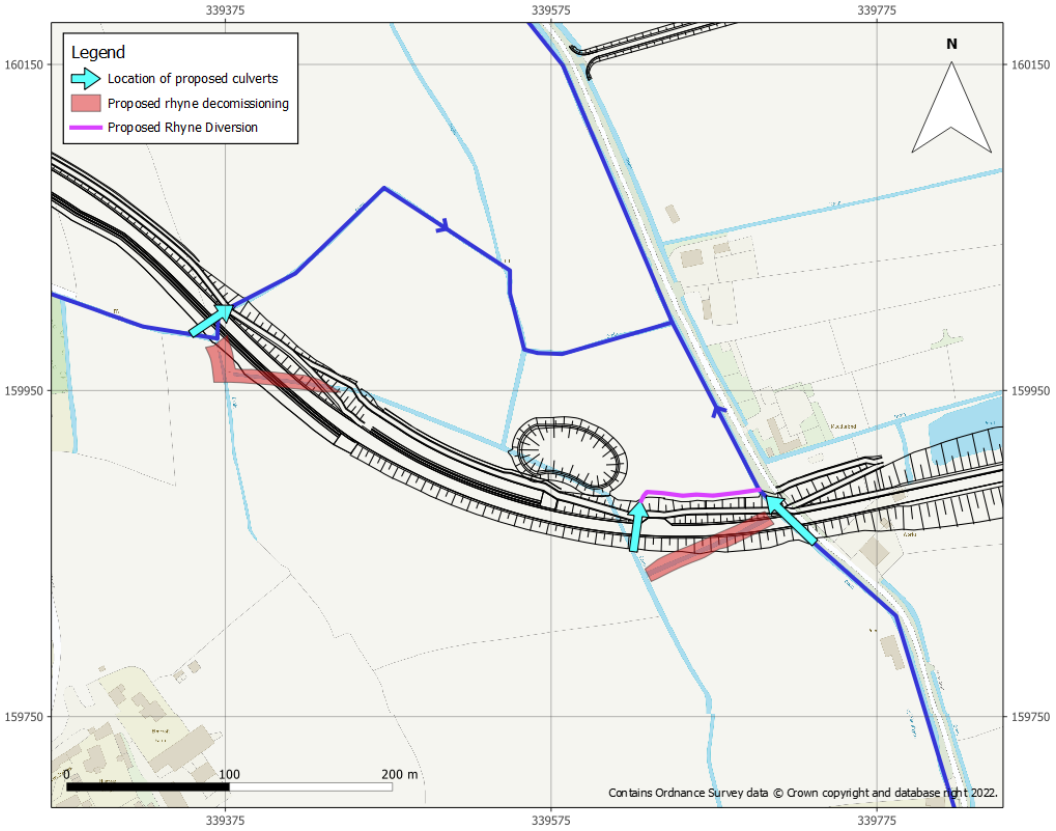

Figure 10 Overview of proposed rhyne diversion

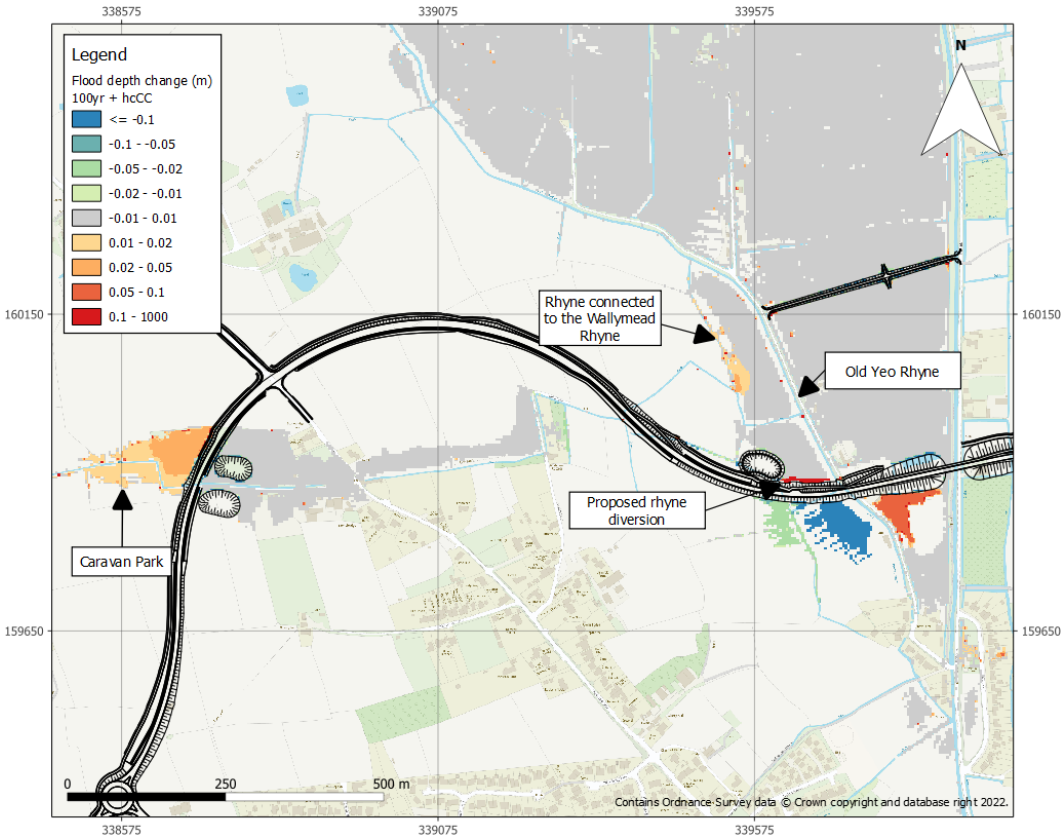

Figure 11 100 year + 39% CC No Mitigation Strategy Impacts

5.3.4 The impact map in Figure 11 shows that there are four areas where impacts are not negligible (>10mm). Firstly, at the caravan park at Stonebridge. Upstream of the proposed bypass there is detriment in the region of 10mm – 50mm, with the greatest detriment in the 20mm – 50mm band shown predominantly in the field north of the Wallymead Rhyne immediately west of the bypass. The bypass cutting through the floodplain at this location has redistributed the flood water when compared to the baseline.

5.3.5 Secondly, impacts can be seen between Moor Road and the Rhyne connected to the Wallymead Rhyne. The detriment is predominantly in the region of 10mm – 20mm with a small area in the region of 20mm – 50mm just north of the confluence of this unnamed Rhyne and Wallymead Rhyne. This is a result of the increased conveyance in the Wallymead Rhyne caused by the new enlarged culvert under the bypass.

5.3.6 Thirdly, impacts can be seen west of Moor Road between the Old Yeo Rhyne and the River Banwell, just south of the bypass. The detriment here is in the region of 50mm – 100mm. The Old Yeo Rhyne is predicted to overtop in the baseline model so by increasing the conveyance through to this rhyne the overtopping has increased.

5.3.7 Fourthly, there is detriment visible where the proposed rhyne diversion is located. This is to be expected from introducing a new watercourse.

5.3.8 To the south of the bypass just west of the Old Yeo Rhyne some improvements in flood depths can be seen. Between the Old Yeo Rhyne and the next Rhyne due west a reduction of over 100mm can be seen. West of this unnamed Rhyne a reduction in the region of 20mm – 50mm can be seen. This is also a result of the increased conveyance through the Wallymead Rhyne due to the increased culvert size, removing the overland flow route observed in the baseline results.

5.4 Mitigation Assessment

5.4.1 Culverts passing underneath the bypass on the main watercourses have been designed as agreed with the EA to have a soffit level set to the 1 in 100 year plus higher central climate change allowance including a 600mm freeboard. This will improve conveyance in the Wallymead Rhyne, where there is currently a relatively small culvert, preventing the development of the overland flow route.

5.4.2 Compensatory storage is required to account for the loss in floodplain storage where the bypass crosses areas predicted to flood in the baseline scenario. Therefore, the volume of flood water displaced has been calculated to determine practical measures for the provision of compensatory storage.

5.4.3 There are two main types of compensatory storage. Level for level is generally the preferred option as it can provide the specific volumes lost at particular levels, meaning the compensation is provided to specific flood events. Volume for volume storage on the other hand provides compensation toward the overall volume of floodplain storage lost, but not necessarily at the same level. To inform the mitigation assessment, the volume of flood water lost at 250mm increments was calculated. The ground levels along the floodplain were reviewed at 250mm bandings to identify any suitable areas that could provide level for level compensation where possible. The volume assessment is provided in Appendix A. Table 3 and Table 4 below summarise the change in flood storage at each proposed flood compensatory storage (FCA) area.

5.4.4 An additional flood compensation area has been included as a mitigation, south of the bypass, to address predicted impacts in the Old Yeo Rhyne. This will involve lowering of the left bank of the Old Yeo Rhyne and provision of a culvert with a diameter of 1.2m connected to the Wallymead Rhyne under the bypass. By including this culvert, flood water is transferred from the northern side of the bypass and provides some minor betterment. Most noticeably, overtopping of the Old Yeo Rhyne predicted in the baseline scenario is reduced and some betterment also achieved.

5.4.5 The three flood compensation areas are shown in Figure 12, with FCA 1 covering an area of approximately 6,550m^2 and FCA 2 covering an area of approximately 5,050m^2 providing compensatory storage, and FCA 3 coving an area of approximately 19,160m^2 being the additional flood compensation area included as mitigation. The areas where the bypass passes through the flood extent as listed in section A.2.1.2 are covered by FCA 1 (Stonebridge Farm) and FCA 2 (Old Yeo Rhyne East and West).

5.4.6 The locations of the FCAs were determined by assessing the DTM to identify areas adjacent to the flooding which were above the flood and could be lowered for the purposes of storage. FCA 1 and FCA 2 are located on raised ground adjacent to the Wallymead Rhyne in the vicinity of the flooding. FCA 1 has been sized to compensate for the loss of floodplain at Stonebridge Farm whilst FCA 2 compensates for the losses by the Old Yeo Rhyne (both east and west sides). FCA 3 provides additional storage purely to provide flood risk betterment, therefore there are no losses associated with it.

5.4.7 Small losses in overall floodplain volume can be seen at lower levels, due to the drainage ditches being filled by the proposed bypass. However, these volumes are very small and are dealt with through overcompensation at higher levels. Therefore, strictly speaking, level for level compensation has only been achieved for the higher depth bands. Therefore, volume for volume requirements have been met overall.

5.4.8 Whilst this FRA sets out the principles of storage provision, it is anticipated that during detailed design the precise areas, levels and volumes will vary in line with design development and other factors relating to the use of the storage areas to create biodiversity net gain.

Table 2 FCA 1 Changes in Flood Storage Volume

Banding Level (mAOD)	Floodplain Volume Lost (m^3)	Volume Gained by FCA (m^3)	Overall Change in Volume (m^3)
7.25 – 7.50	0.05	0.00	-0.05
7.50 – 7.75	1.26	0.00	-1.20
7.75 – 8.00	2.60	0.00	-2.60
8.00 – 8.25	3.70	0.00	-3.70
8.25 – 8.50	17.63	0.00	-17.63
8.50 – 8.75	671.28	728.14	+56.86
8.75 – 9.00	1154.25	1393.68	+239.43
Total	**1850.78**	**2121.82**	**+271.04**

Table 3 FCA 2 Changes in Flood Storage Volume

Banding Level (mAOD)	Floodplain Volume Lost (m^3)	Volume Gained by FCA (m^3)	Overall Change in Volume (m^3)
3.75 – 4.00	-0.31	0.00	+0.31
4.00 – 4.25	2.83	0.00	-2.83
4.25 – 4.50	102.08	0.00	-102.08
4.50 – 4.75	212.67	0.00	-212.67
4.75 – 5.00	723.42	0.09	-723.33
5.00 – 5.25	1455.39	1252.34	-203.05
5.25 – 5.50	817.17	1229.91	+412.74
5.50 – 5.75	48.84	988.76	+939.92
5.75 – 6.00	17.57	0.00	-17.57
6.00 – 6.25	19.64	0.00	-19.64
6.25 – 6.50	14.35	0.00	-14.35
6.50 – 6.75	9.34	0.00	-9.34
6.75 – 7.00	2.42	0.00	-2.42
Total	**3425.42**	**3471.09**	**+45.67**

Table 4 FCA 3 Storage Volume

Banding Level (mAOD)	Volume Gained by FCA (m^3)
4.50 – 4.75	0.21
4.75 – 5.00	0.73
5.00 – 5.25	4367.27
5.25 – 5.50	2643.20
5.50 – 5.75	1304.34
Total	**8315.74**

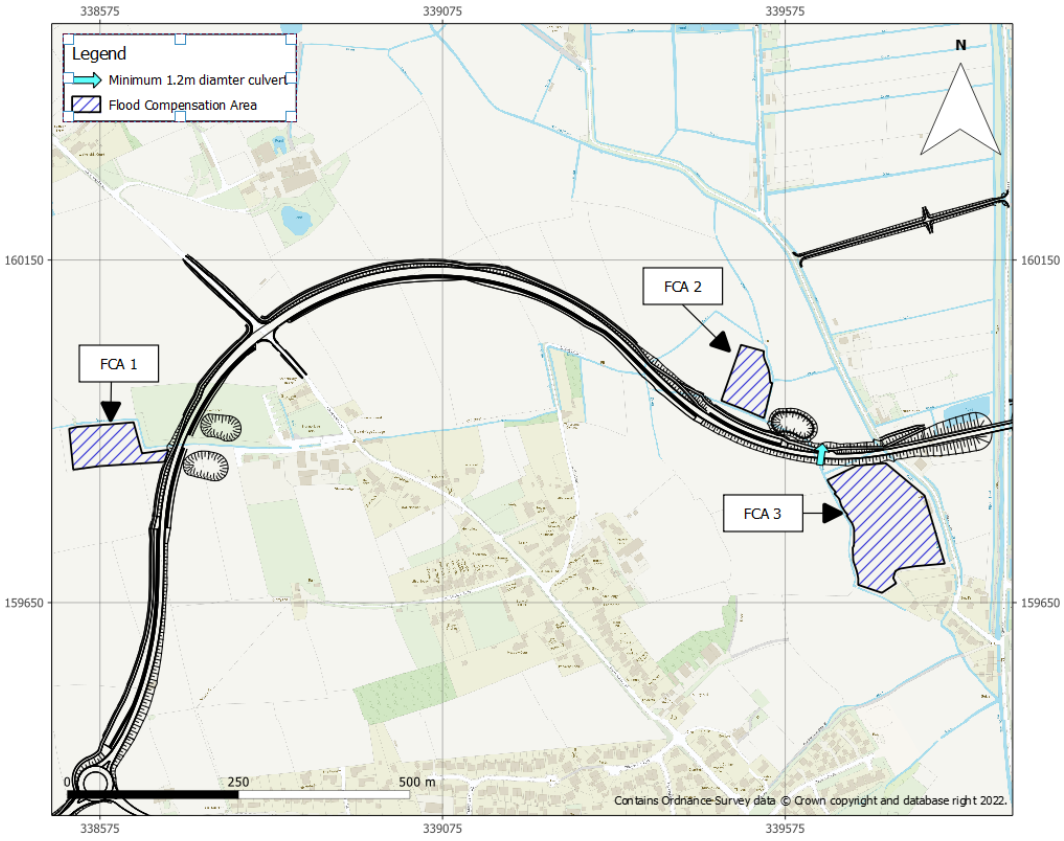

Figure 12 Proposed Flood Mitigation Areas

6 Sequential and Exception Tests

6.1 Sequential Test

6.1.1 The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding). Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses.

6.1.2 A Banwell Transport Area Study commissioned in 2000 concluded with the recommendation of a bypass north of Banwell. This formed the basis of a route that is currently safeguarded within the NSC Local Plan[12] for planning purposes.

6.1.3 In 2021, an Options Appraisal Report[13] was prepared for the Banwell Bypass. This reviewed the need for intervention and identified and appraised the need for transport infrastructure improvements.

6.1.4 In summary, the Options Appraisal Report shortlisted three route alignments to determine which was the best to take forward. For all three alignments, the road was proposed to be elevated above design flood levels. These route options are described below:

a) Route 1 – Northern Alignment. This route has the greatest length (approx. 1.7km) of highway within the Flood Zone,

[12] Policies Map (n-somerset.gov.uk). Accessed 15th February 2022.
[13] Options Appraisal Report, September 2021. Report Number: BNWLBP-ARP-GEN-X_BB_Z-RP-CH-000001

and as such had the greatest potential adverse impact on flood risk;

b) Route 2 – Middle Alignment. This route has a 1km length of highway within the Flood Zone, and as such was judged to have a moderate potential adverse effect on flood risk; and

c) Route 3 – Southern Alignment. This route has the least length of highway (0.5km) within the Flood Zone, and as such had a slight potential adverse effect on flood risk.

6.1.5 The outcome of the appraisal, together with the outcome of Public Consultation and consultation with the Environment Agency and Lead Local Flood Authority determined the preferred route to form the basis of a Planning Application. The preferred route was judged to be the route referred to as Option 2, which is largely the same route alignment as that which is protected for planning purposes within the Local Plan. The route minimises the footprint within the floodplain as denoted by the Flood Map for Planning, has the least impact on land take and severance and has the greatest opportunity for providing a balance of impacts and habitat enhancements.

6.1.6 The route alignment is considered to satisfy the requirements of the Sequential Test approach as the route is protected for planning purposes within the NSC Local Plan, the precise alignment has been the subject of a route Options Assessment and will be elevated above the design flood level, as described within this section.

6.2 Exception Test: Sustainable Benefits to the Wider Community

6.2.1 The benefits and wider mitigations outside of the proposed bypass are described in section 1.1 of this report and should be read in aid of this exception test.

6.3 Exception Test: Flood Risk Impacts on Third Party Land

6.3.1 In order to quantify any impacts of the proposed works, the hydraulic model was run for flood events ranging from the 1 in 20 year to the 1 in 1000 year, incorporating the proposed levels and extent of the proposed embankment including the proposed compensatory storage areas as mitigation. Further details on how the proposed development has been incorporated into the hydraulic model can be viewed in the hydraulic modelling report[2]. Figure 13 displays the difference in flood level between the baseline and proposed scenarios (with mitigation) for the 1 in 100 year plus higher central climate change event for the relevant critical duration.

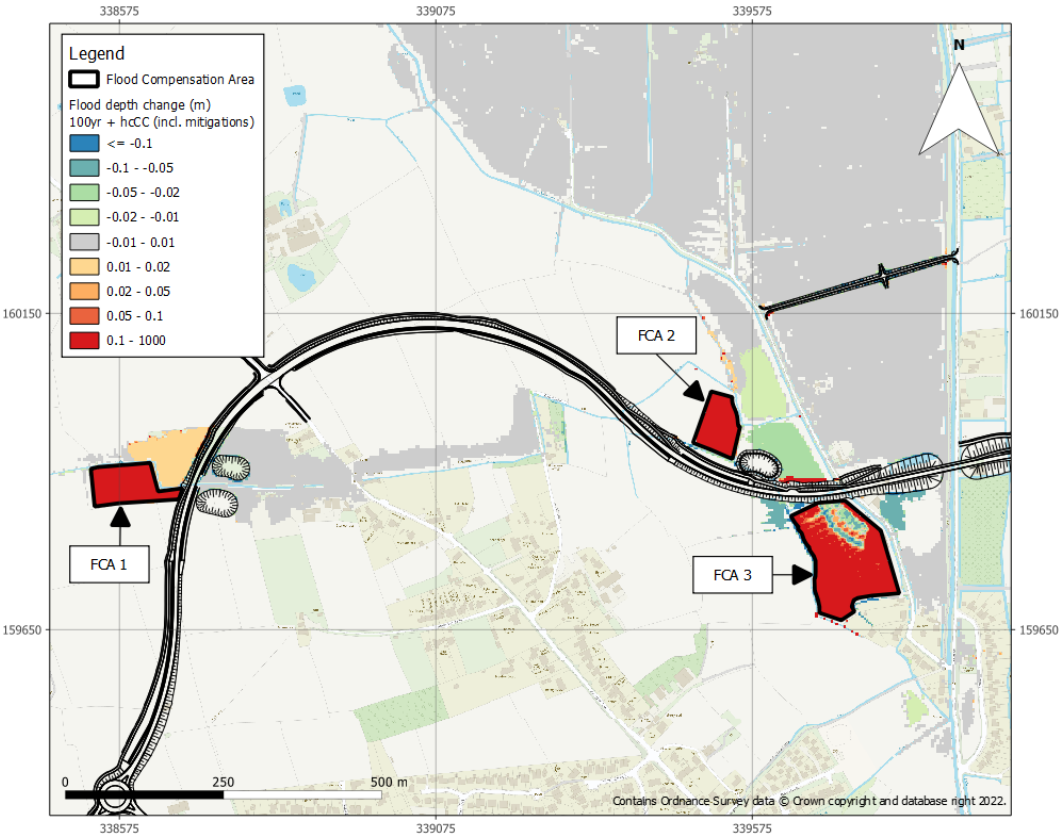

Figure 13 100 year + 39% CC Impacts

6.3.2 The impacts map shows that, excluding the flood levels in the three storage areas, there are two areas where the impacts are not negligible (>10mm). Firstly, the rhyne connected to the Wallymead Rhyne just above the northern most flood compensation area is 10-20mm higher. This increase is contained within the rhyne with the impact to the east of the rhyne seen without the mitigation strategy no longer present. This is as a result of the increased conveyance in the Wallymead Rhyne caused by the new culvert under the bypass. Secondly, there is detriment in the region of 10-20mm in the caravan park near Stonebridge Farm. This impact is reduced in extent compared to the impact without the mitigation strategy and a reduction from the 20 – 50mm region of impact seen without mitigation. The bypass cutting through this floodplain has redistributed the flood water in comparison to the baseline.

6.3.3 There are three areas where improvements in flood level are seen. Firstly, the field west of the bifurcation of the River Banwell and Old Yeo Rhyne south of Bow Farm with a reduction in the region of 10-20mm. This is an improvement on the detriment that was shown in Figure 11. without mitigations present. Secondly, to the immediate east and west of the southern flood compensation area with a reduction in the region of 50-100mm. Thirdly, east of the northern flood compensation area, with a reduction of 20-50mm between the Wallymead Rhyne and bypass and 10-20mm between the Old Yeo Rhyne and the Rhyne connected to the Wallymead Rhyne just above the northern most flood compensation area.

6.3.4 A review of the lower return period events (20yr, 50yr and 100yr) was undertaken to determine whether the detriment was consistent. Detriment on the west side of Stonebridge farm generally occurs in the region of 10-20mm in line with the design event. As the flood events are less severe, they do not show overtopping of the Old Yeo Rhyne and FCA 3 is not used for return periods below the 50yr scenario. As a result of this there is detriment shown in the field between the attenuation basin and diverted rhyne for the 50yr and 100yr scenarios. This was in region of >100mm and 20-50mm respectively. Figure 14 shows the shows the flood depth change from the baseline to proposed scenario for the 50yr return period (2.0% AEP).

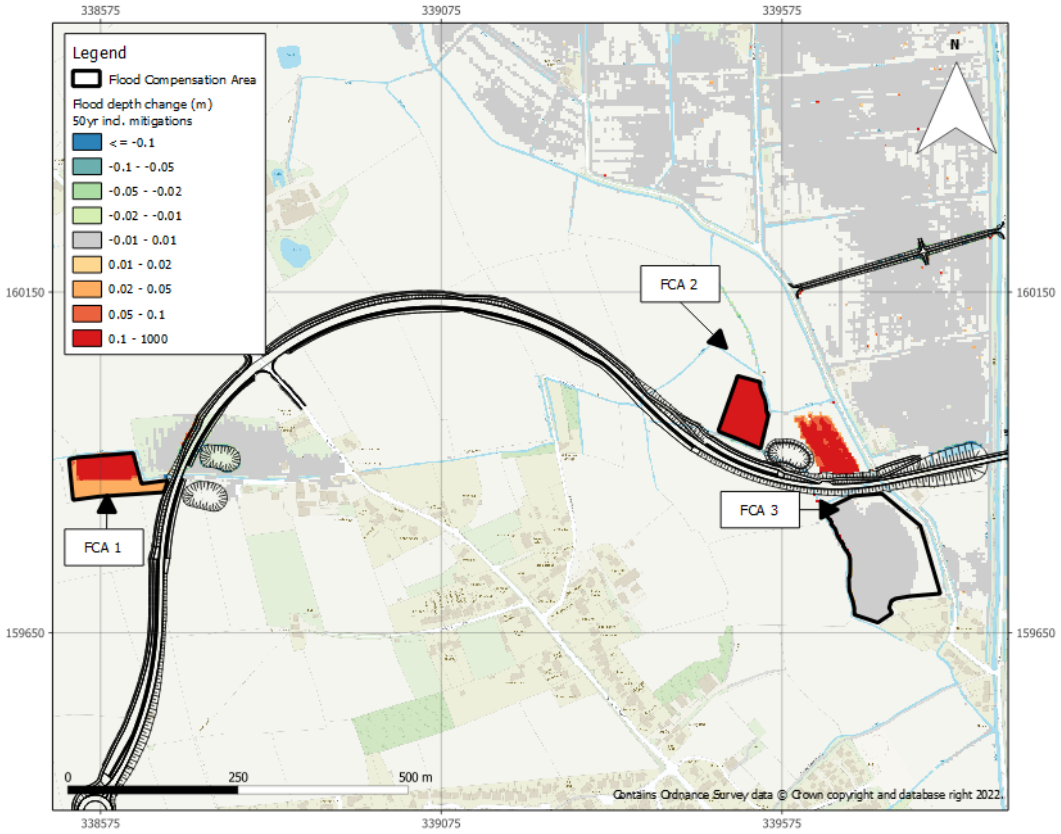

Figure 14 50 year Impacts

6.4 Residual Impacts

6.4.1 As described in section 6.3there are three areas with residual impact. Firstly, within the Rhyne connected to the Wallymead Rhyne, caused by the increased conveyance of the culverted section of the Wallymead Rhyne under the proposed bypass. As the increase in flood depths are contained within the watercourse and the increased size of the culvert provides other flood risk and ecological benefits, this impact has not been mitigated.

6.4.2 In the case of the second area in the caravan park near Stonebridge farm, further mitigation of this impact would require an increase in conveyance through the bypass where it crosses the Wallymead Rhyne at this location. This would direct more flood water towards the properties at Stonebridge, which are more vulnerable to the impacts of increased flood risk and as such this impact has not been mitigated. For these areas of residual impact, it is proposed to enter into agreements with the landowners.

6.4.3 The final area is in the field where the attenuation basin is located between the bypass, Wallymead Rhyne and the Old Yeo Rhyne. Detriment was shown here for the 50yr and 100yr return periods.. As this field contains the attenuation basin and diverted rhyne and will become part of the scheme, this is considered to be acceptable.

7 Management of Surface Water

7.1.1 A surface water drainage assessment for the proposed works has been completed by Arup[1] and is available as a separate document. In summary, the proposed strategy is to discharge surface water to watercourses. Surface water is to be attenuated and discharged at the greenfield runoff rate.

7.1.2 The outline drainage proposals have been designed to attenuate the critical rainfall event for the 1 in 100 year return period plus a 40% allowance for climate change event through six proposed attenuation ponds. The drainage system will be designed in accordance with the requirements of DMRB where possible. Flow control devices will be used to restrict flows from the attenuation basins. Please refer to the drainage strategy completed by Arup for more detail.

7.1.3 Please note that the surface water drainage strategy has also considered the impacts of wider mitigations and placemaking where these impact upon drainage.

8 Conclusion

8.1.1 This FRA has drawn together the findings of the detailed hydraulic modelling of the River Banwell and its tributaries to assess the impacts of the Banwell Bypass scheme. The baseline flood risk has been established by modelling return periods ranging from the 1 in 20 year to 1 in 1000 year events . Floodplain depths adjacent to the road range from 0 to 500mm in the 1 in 100 year plus 39% allowance for climate change event. Where flooding is predicted, the bypass is above the maximum fluvial flood level including a 600mm freeboard.

8.1.2 The development has been justified as providing sustainable benefits to the wider community in Section 6, therefore adhering to the requirements of the exception test as set out in the NPPF. These benefits include less congestion in the village of Banwell. This in turn provides local and wider benefits to the social and economic environment.

8.1.3 The impacts of the development have been quantified, informed by hydraulic modelling of the proposed scheme. The modelling has shown benefits as well as detriment in two areas, namely at the caravan site at Stonebridge Farm. Without mitigation there would also be detriment in and around the Old Yeo Rhyne.

8.1.4 The provision of compensatory storage and culverts is proposed as a scheme mitigation to make up for the loss in floodplain storage caused by the presence of the bypass. This will provide other biodiversity and amenity benefits by the provision of a combined storage/wetland feature. Viable locations for the storage locations have been identified that will provide all of the required storage on a volume for volume basis. However, the final form of the storage/wetland feature and the total volume provided will be confirmed during the detailed design stage of the scheme and agreed with the EA.

8.1.5 Surface water run-off from the increased paved area will be managed and attenuated according to the surface water drainage strategy completed by the Arup team. This is available as a separate document submitted as a part of the planning process.

9 Appendices

Appendix A Floodplain Compensation Volume Calculations

A.1 Introduction

A.1.1.1 The proposed Banwell Bypass will cross over the River Banwell and two of its tributaries, the Old Yeo Rhyne and the Wallymead Rhyne. The proposed bypass runs through the fluvial floodplains of the River Banwell and its tributaries. This report details the calculations for the volume of floodplain lost in the proposed bypass.

A.2 Methodology

A.2.1.1 WHS have developed an updated FMP/TUFLOW fluvial hydraulic model for the River Banwell for the Banwell Bypass. The models Digital Terrain Models (DTMs) for the baseline and post development scenarios have been analysed against the baseline model 100 year higher central climate change merged duration flood levels.

A.2.1.2 The areas where the proposed bypass runs through modelled flood extent have been broken into three areas referred to as, Old Yeo Rhyne East, Old Yeo Rhyne West and Stonebridge Farm in this report. These can be seen in Figure A-1.

A.2.1.3 At the areas identified a 0.5m grid of points was created in GIS software. At these sample points the baseline and post development DTM elevations were sampled along with the baseline model flood level. Each point represents the centroid of a 0.25m^2 cell, with the volume of floodplain loss calculated for each cell using a spreadsheet. Where the flood level was below the proposed bypass elevation the depth change between the flood level and the baseline model elevation was calculated and multiplied by the cell area to derive the volume loss for the cell. Where the flood level was above the proposed bypass elevation the depth change between the post development model and baseline model was used to calculate the volume loss.

A.2.1.4 The volume of floodplain lost was additionally broken down into banding levels of 250mm to show the volumes of compensatory storage required at between each banding level to achieve level for level compensation.

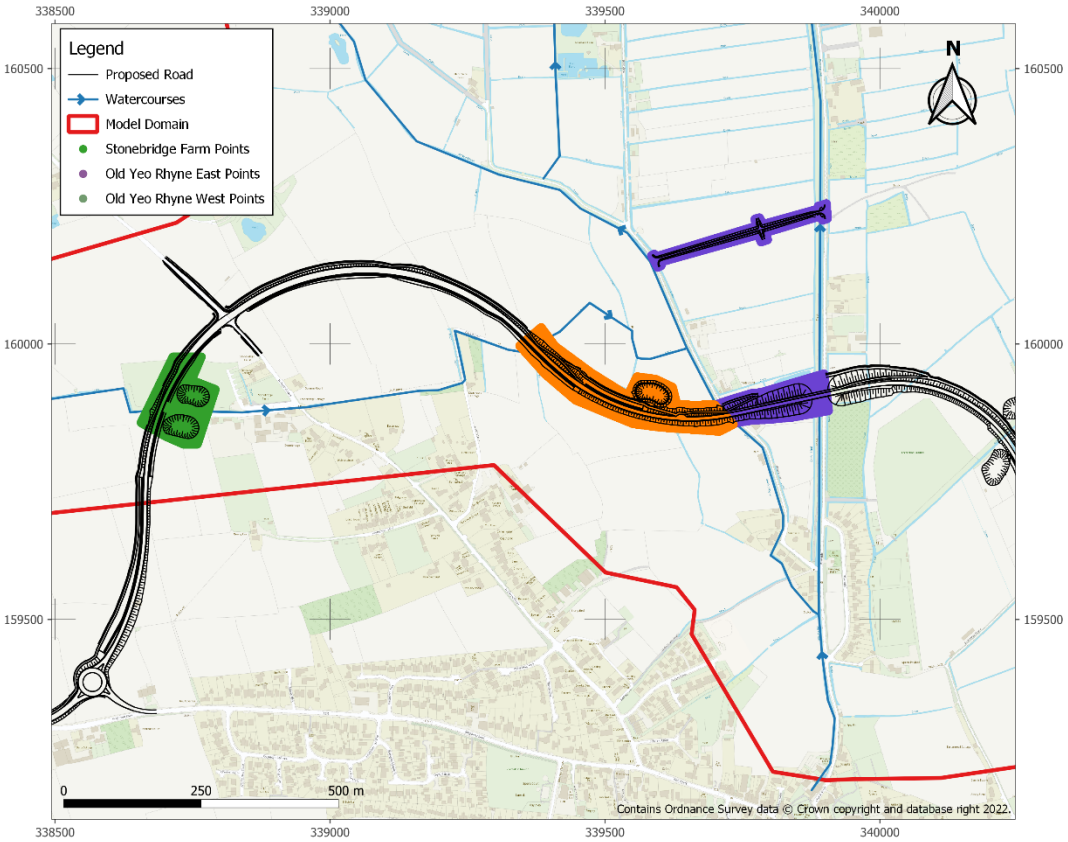

Figure A-1 Floodplain Volume Calculation Areas

A.3 Results

A.3.1.1 The following section details the results of the floodplain volume loss calculations.

A.3.2 Stonebridge Farm

A.3.2.1 Table A-1 below shows the volume of flood plain loss by banding level for the Stonebridge Farm area, with the total loss for the area being approximately 1850m^3.

Table A-1 Stonebridge Farm Floodplain Volume Loss

Banding Level (mAOD)	Floodplain Volume Loss (m^3)
7.25 - 7.50	0.05
7.50 – 7.75	1.26
7.75 – 8.00	2.60
8.00 – 8.25	3.70
8.25 – 8.50	17.63
8.50 – 8.75	671.28
8.75 – 9.00	1154.25
Total	**1850.78**

A.3.3 Old Yeo Rhyne West

A.3.3.1 Table A-2 below shows the volume of flood plain loss by banding level for the Old Yea Rhyne West area, with the total loss for the area being approximately 1220m^3.

Table A-2 Old Yeo Rhyne West Floodplain Volume Loss

Banding Level (mAOD)	Floodplain Volume Loss (m^3)
3.75 – 4.00	-0.31
4.00 – 4.25	-1.70
4.25 – 4.50	-2.48
4.50 – 4.75	7.83
4.75 – 5.00	64.76
5.00 – 5.25	234.13
5.25 – 5.50	808.36
5.50 – 5.75	48.84
5.75 – 6.00	17.57
6.00 – 6.25	19.64
6.25 – 6.50	14.35
6.50 – 6.75	9.34
6.75 – 7.00	2.42
Total	**1222.74**

A.3.4 Old Yeo Rhyne East

A.3.4.1 Table A-3 below shows the volume of floodplain lost by banding level for the Old Yeo Rhyne East area, with the total loss for the area being approximately 2200m^3.

Table A-3 Old Yeo Rhyne East Floodplain Volume Loss

Banding Level (mAOD)	Floodplain Volume Loss (m^3)
4.00 - 4.25	4.54
4.25 – 4.50	104.57
4.50 – 4.75	204.85
4.75 – 5.00	658.66
5.00 – 5.25	1221.27
5.25 – 5.50	8.81
Total	**2202.68**

A.4 Limitations

A.4.1.1 The main limitation of the analysis as described above is that it is based on the DTM from the updated Banwell hydraulic model, which has a 4m resolution. An assessment of the volume lost using a higher resolution DTM would provide improved estimates of the volume lost.

A.4.1.2 Additionally, the flood levels from the baseline model have been used. An assessment of volume lost using post development flood levels would also improve the estimate of the volume lost.