MetroWest

Portishead Branch Line (MetroWest Phase 1)

TR040011
Applicant: North Somerset District Council
Flood Risk Assessment Addendum to documents 5.6 Flood Risk Assessment and 6.25 Environmental Statement Volume 4 - Appendix 17.1 Flood Risk Assessment
The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009, regulation 5(2) (a) and (e)
Planning Act 2008

Author: CH2M
Date: March 2021

Notice

Document history

Project	Portishead Branch Line (MetroWest Phase 1) Development Consent Order Scheme
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Document title	Flood Risk Assessment (FRA) Addendum
Regulation Number	Regulation 5(2) (a) and (e)
Applicant	North Somerset District Council
Lead Author	RB at CH2M

Version	**Date**	**Status of Version**
01	12/03/21	Addendum to FRA Application document

Table of Contents

Acronyms and Abbreviations

BAFS	Bristol Avon Flood Strategy
BCC	Bristol City Council
CFB2018	[Environment Agency's] Coastal Flood Boundary dataset, 2018
DCO	Development Consent Order
EA	Environment Agency
EWL	Extreme Water Level
FRA	Flood Risk Assessment
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment

SECTION 1
Introduction

1.1 Introduction

1.1.1 Since the DCO application Flood Risk Assessment (FRA) (main document found in duplicate at APP-076 and APP-173[1]) was submitted in November 2019, there have been a number of non-material changes to the draft DCO, the Applicant has responded to the Examining Authority's s51 advice letter (PD-006) and further information and studies have been undertaken requiring an update to the FRA (which is presented in this Addendum) as follows:

- Works numbers 10C, 12B, 16B, 16D and 27 have been removed from the DCO application (REP5-020).
- In response to the Examining Authority's s51 advice letter, dated 24 January 2020, (PD-006), requesting that the Applicant accounts for current guidance[2] climate change allowances, the Applicant prepared a written response (AS-007). The response was informed by further hydraulic modelling. Subsequent to the Applicant's written response, further modelling was undertaken to assess sensitivity to higher climate change allowances in Longmoor and Colliter's Brooks (applying river flow allowances rather than rainfall allowances).
- Further hydraulic modelling was undertaken to assess the requirement for floodplain compensation in the Easton-in-Gordano Stream floodplain.
- More FRA detail is provided for the Associated Development works, as requested by the Environment Agency.
- The draft operational flood plan and Clanage Road construction compound flood plan included in Appendix T of the FRA (APP-092) have been updated to include document REP3-015 to inform the discharge of relevant DCO requirements. Also, the temporary welfare facilities referred to in paragraph 2.3 of Appendix T should refer to being raised 1m above the finished compound ground level of 7.4 mAOD (i.e. raised above a level of 8.4mAOD).
- Additional information that has become available since November 2019. This includes:
    - i. Observed River Avon extreme tidal event in March 2020 (Appendix A).
    - ii. Bristol City Council Bristol Avon Flood Strategy (BAFS), Strategic Outline Case Technical Document, DRAFT for consultation,

[1] All document references submitted to the examination in this Addendum are contained in the latest DCO Examination Library dated 5 March 2021

[2] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances – the climate change allowances applied were from the December 2019 version, and are the same as in the latest July 2020 version

October 2020, https://www.bristol.gov.uk/policies-plans-strategies/flood-risk-strategy and

iii. Bristol City Council Level 1 Strategic Flood Risk Assessment (SFRA), December 2020 https://www.bristol.gov.uk/documents/20182/4913559/Bristol_Level_1_SFRA_VF.pdf/6358cc8e-9ce3-e11f-83fd-bbb8674e3026

1.1.2 This Addendum is a stand-alone document which provides an update to the FRA and must be read alongside the FRA which has not been amended.

SECTION 2

Flood Risk Assessment Updates

2.1 Examining Authority's s51 advice

Examining Authority's s51 advice letter and the Applicant's response

2.1.1 The Examining Authority's s51 advice letter identifies that climate change allowances applied in the FRA were not in accordance with current guidance. The s51 advice letter refers to three key areas of concern to the Examining Authority; (i) frequency of flooding of the proposed railway at Bower Ashton, (ii) floodplain compensation requirements, and (iii) agreement with the Environment Agency regarding the scope and robustness of the assessment. The Examining Authority's s51 advice letter states *"the Inspectorate is keen to understand the extent to which the application of revised climate change allowances may influence the findings of the assessment and/or the design of the Proposed Development, including any potential consequential needs for lands, rights or powers to deliver mitigation."*

2.1.2 The Applicant's detailed response (AS-007) assesses the proposed DCO scheme against current guidance climate change allowances and, informed by further hydraulic modelling, concluded that the FRA accurately depicts both the frequency of future flooding of the proposed railway at Bower Ashton and floodplain compensation requirements..

Further hydraulic modelling undertaken to inform Applicant response

2.1.3 The further hydraulic modelling undertaken to inform the Applicant's response to the Examining Authority's s51 advice letter is summarised below and in REP2-022. The further hydraulic modelling includes updated future event simulations (2075 design life and 2115 upper sensitivity test), applying current guidance climate change allowances. This further modelling was reviewed and considered suitable for use in the DCO application FRA by the Environment Agency (communicated to the Applicant by email on 17 December 2020 copy attached at Appendix B). The Environment Agency therefore agreed the scope and robustness of the assessment.

River Avon tidal events

Floodplain compensation

2.1.4 Further modelling has been undertaken dated 4 August 2020 to demonstrate that the preferred Clanage Road permanent maintenance compound compensation option (denoted Ramps version 2 in REP2-022) still provides mitigation for the impacts of the access ramps when the current guidance climate change allowances and CFB2018 Extreme Water Levels (EWL) are applied.

2.1.5 The revised simulations included the 200 year return period River Avon tidal flood event in 2075 and 2115 applying current guidance sea level rise allowances and river flow allowances (upper end +70%). For the Longmoor and Colliter's Brooks catchments (small catchments) rainfall allowances (upper end +40%) are applied rather than river flow allowances, as the guidance specifies that rainfall allowances should be applied for catchments less than 5km^2. As the Longmoor and Colliter's Brooks catchments are only slightly larger (catchment areas 8.6km^2 and 5.4km^2 respectively) the rainfall allowances are considered more representative than the river flow allowances.

2.1.6 The results presented in REP2-022 show that the proposed floodplain compensation within the Clanage Road compound site fully mitigates for the proposed access ramps with no offsite impacts when current guidance climate change allowances are applied at a ground level of 7.4 mAOD.

Frequency of flooding of the DCO scheme railway at Bower Ashton

2.1.7 Present day (2015) simulations (which are used to define the Environment Agency's Flood Zones) were not undertaken as part of the further modelling. However, the Applicant's response (AS-007) reports that the present day (2015) tidal simulations are likely to overstate flood risk at Bower Ashton as the present day tidal boundary conditions applied in the FRA modelling assume higher EWLs than those of the current EA CFB2018 dataset. The higher EWLs together with the observed data and additional information presented in paragraph 2.4 below results in the Applicant's assessment that no part of the DCO Scheme falls within Flood Zone 3b and all references in the FRA to any part of the DCO Scheme being within Flood Zone 3b (functional flood plain) should be deleted.

2.1.8 The DCO application FRA (APP-076) estimates the future frequency of flooding of the DCO Scheme railway at Bower Ashton in 2075 (design life) and 2115 (sensitivity test) as more than once every year on average. The Applicant's response (AS-007) refines this estimate as approximately 2 to 3 times per year on average in 2075 and approximately 8 times per year on average in 2115, applying the Upper end projected future sea level rise allowances at Avonmouth.

Longmoor and Colliter's Brooks fluvial events

2.1.9 Simulations were undertaken with current climate change allowances applied to assess the future frequency of inundation of the DCO Scheme where it crosses Longmoor and Colliter's Brooks, and to confirm that the floodplain compensation at the Clanage Road site fully mitigates for the proposed access ramps with no offsite impacts when current guidance climate change allowances are applied.

2.1.10 Simulations included the 25, 50 and 75 year return period fluvial events in Longmoor and Colliter's Brooks in 2075 and 2115, applying revised rainfall uplifts in the Longmoor and Colliter's Brooks catchment (upper end +40% allowance applied).

2.1.11 In addition, simulations were undertaken for the Longmoor and Colliter's Brooks fluvial events in 2075 and 2115 applying +70% climate change peak river flow allowances, as an upper sensitivity test, rather than +40% rainfall allowances. These simulations included the 50, 75 and 100-year return period fluvial events in Longmoor and Colliter's Brooks in 2075 and the 25, 50, 75 and 100-year return period fluvial events in 2115.

2.1.12 The simulations undertaken applying +40% rainfall allowances indicate that the frequency of inundation of the railway in 2075 and 2115 will be approximately once every 50 to 75 years on average (i.e. unchanged compared to the FRA conclusion).

2.1.13 The fluvial simulations undertaken applying +70% (i.e. upper sensitivity test) climate change peak river flow allowances in Longmoor and Colliter's Brooks provide an upper estimate of the frequency of flooding of the DCO Scheme at the crossing of Longmoor and Colliter's Brooks of approximately once every 50 to 75 years on average in 2075 and once every 25 to 50 years on average in 2115, and do not change the FRA conclusion that the Clanage Road compound site fully mitigates for the proposed access ramp with no offsite impacts at a 7.4 mAOD ground level.

Easton-in-Gordano Stream fluvial events

2.1.14 Simulations were undertaken with current guidance climate change allowances applied to review the adequacy of the proposed (but since removed from the DCO application, work 16D) Easton-in-Gordano Stream floodplain compensation area. Events simulated were the 100 year and 200 year return period fluvial events in 2075 and 2115, applying updated peak rainfall allowances (+40% in 2075 and 2115), and updated sea level rise allowances in the downstream tidal boundaries. The simulation results demonstrated that, with current guidance climate change allowances, the proposed (but since removed from the DCO application, work 16D) compensation area still provided mitigation for displaced fluvial floodplain storage by the DCO application proposed works.

2.1.15 Simulated peak flood levels in the Easton-in-Gordano Stream floodplain south of the DCO Scheme railway are compared in Table 1 for the original DCO application modelling and for the updated modelling, applying current guidance climate change allowances.

	Simulated peak flood level adjacent to southern edge of DCO Scheme railway (mAOD)	
Simulation	**100 year return period**	**200 year return period**
DCO application FRA modelling – 2075	8.245	8.297
DCO application FRA modelling - 2115	8.263	8.312
Current guidance climate change allowances – 2075	8.283	8.332
Current guidance climate change allowances – 2115	8.290	8.332

Table 1: Simulated peak flood levels for the original DCO application modelling and for the updated modelling

2.2 Easton-in-Gordano Stream floodplain compensation

Further hydraulic modelling to assess the requirement for floodplain compensation in the Easton-in-Gordano Stream floodplain

2.2.1 Further hydraulic modelling was undertaken, initially to assess an option to relocate floodplain compensation in the Easton-in-Gordano Stream floodplain from fluvial floodplain west of the stream to fluvial floodplain east of the stream, directly south of the DCO Scheme.

2.2.2 For this assessment, a higher resolution model grid was required (2m grid size compared to FRA model 4m grid size) to represent the proposed local shift in railway alignment by approximately 2m southwards. As well as enabling an assessment of the alternative floodplain compensation works this more detailed resolution modelling also enabled an assessment of the impact of the DCO Scheme in Easton-in-Gordano Stream fluvial floodplain (minor displacement of fluvial floodplain storage) without any mitigation. Previously as floodplain compensation was to be provided on a level-for-level hydraulically connected basis, modelling was not required to validate the proposed compensation.

2.2.3 The higher resolution modelling demonstrates that the impact of the DCO Scheme on Easton-in-Gordano Stream floodplain levels is negligible (differences in simulated peak flood levels are within +/- 1mm) and it was therefore agreed with the Environment Agency and Bristol Port Company (as the principal affected party) that floodplain compensation is not required in this area, and work number 16D (floodplain compensation) could be removed from the DCO application.

2.2.4 Full details of the modelling undertaken are in Appendix C. The further modelling was reviewed and considered suitable for use in the DCO application FRA by the Environment Agency (communicated to the Applicant by email on 17 December 2020 Appendix B).

2.3 More FRA detail for the Associated Development works

2.3.1 For completeness and to respond to the Environment Agency's request for more details of the FRA for all Associated Development in Flood Zone 2 and Flood Zone 3, the FRA requirements and how these are addressed are in Appendix D.

2.4 Additional information available since November 2019

Observed River Avon extreme tidal event in March 2020

2.4.1 An extreme tide level was recorded at Avonmouth with a peak level of 8.626m AOD at 9.00pm on 11th March 2020 (https://www.gaugemap.co.uk/#!Map/Summary/8241/3586/2020-03-11/2020-03-12). This peak tide level is above the Environment Agency’s Coastal Flood Boundary dataset 2018 (CFB2018) 20 year return period design extreme tide level at Avonmouth of 8.61 mAOD. The rarity of the March 2020 tidal event is noted in the BAFS report which states: *"In March 2020, Bristol experienced the highest tidal event (of 8.81m AOD) since records began."* However, the BAFS report does not state where in Bristol this was measured, or when records began.

2.4.2 The Applicant visited Bower Ashton area on the morning of 12 March 2020, during the subsequent high tide recorded at Avonmouth (8.442 mAOD at 9.00am on 12 March 2020) and took photographs of the proposed Clanage Road compound site, the railway at Bower Ashton and nearby areas. These photographs, included in Appendix A, indicate there had been no flooding to the proposed Clanage Road compound or railway during the March 11 2020 extreme tidal event. (There was no flooding at the time of the photographs on 12 March 2020 and no debris to suggest flooding from the River Avon had occurred on 11 March 2020. The surface water shown in the photographs is from rainfall rather than tidal flood water). Bristol City Council also did not identify any flooding of the proposed Clanage Road compound during the March 2020 event (REP5-038): *"BCC's Flood Risk Manager has advised that BCC does not hold any records of this site flooding in the last ten years and our investigation into the March 2020 flood event did not identify any flooding during that event at this site."*. The Applicant can find no records of the Clanage Road Compound experiencing a flooding event due to tidal or fluvial flooding in the past 50 years.

2.4.3 As the proposed Clanage Road compound did not experience tidal flooding as a result of the March 2020 extreme tidal event, which had a peak level exceeding the CFB2018 20 year return period design tide level, the compound is considered more likely to be outside of tidal River Avon Flood Zone 3b (defined by the 20 year return period flood extent) than inside. This is in accordance with the FRA discussion regarding historic flood information and hydraulic modelling uncertainty (Sections 4.2.12 to 4.2.24 in APP-076).

Bristol City Council Bristol Avon Flood Strategy, Strategic Outline Case Technical Document, DRAFT for consultation, October 2020

2.4.4 Bristol City Council (BCC) Bristol Avon Flood Strategy (BAFS) draft for consultation (https://bristol.citizenspace.com/bristol-city-council/bristol-avon-flood-strategy/user_uploads/2020-bristol-avon-flood-strategy---strategic-outline-case-draft-for-consultation-1.pdf) *"sets out the Strategic Outline Case (SOC) to deliver a strategic flood risk management approach to the single benefit area of central Bristol".*

2.4.5 The BAFS preferred choice for flood defence improvements in Bristol includes providing a *"National Planning Policy Framework (NPPF) standard of protection"* (i.e. 100 year return period fluvial event and 200 year return period tidal event) in the River Avon floodplain at Bower Ashton to be implemented in the 2020s. This would place the DCO Scheme railway at Bower Ashton and the Clanage Road compound in defended Flood Zone 3. Whilst the FRA reporting and modelling assumes that no strategic flood defences are built throughout the whole study area, it is considered likely that the DCO Scheme will be defended by 2030.

Bristol City Council Level 1 Strategic Flood Risk Assessment, December 2020

2.4.6 BCC Level 1 Strategic Flood Risk Assessment (SFRA) was published in December 2020 (https://www.bristol.gov.uk/planning-and-building-regulations/planning-policy/planning-evidence).

2.4.7 The NPPF definition of the functional floodplain (Flood Zone 3b) is in terms of flooding from rivers and sea, and so accounts for tidal flood risk (https://www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables).. The BCC Level 1 SFRA provides additional information and mapping with respect to tidal Flood Zone 3b e.g. at the proposed Clanage Road compound (see REP4-026 for Flood Zone 3b map).

SECTION 3

Summary

3.1 Updated hydraulic modelling

3.1.1 Whilst the DCO application FRA (APP-076) continues to provide the qualitative assessment, and much of the quantitative assessment of flood risk to the DCO Scheme and its impact on flood risk elsewhere, further hydraulic modelling was undertaken to update key elements of the assessment applying current guidance climate change allowances.

3.1.2 To achieve this updated assessment, only the simulations required to provide specific updates to the assessment were undertaken i.e. update estimated frequency of future flooding of the DCO Scheme railway at Bower Ashton and at its crossing of Longmoor and Colliter's Brooks, update assessment of the adequacy of proposed floodplain compensation at the Clanage Road compound in Bower Ashton and in the Easton-in-Gordano Stream floodplain.

3.1.3 The updated simulations comprise:

- River Avon tidal flood events: 200 year return period flood in 2075 and 2115
- Longmoor and Colliter's Brooks fluvial flood events: 25, 50 and 75 year return period flood in 2075 and 2115 with +40% rainfall climate change allowance applied (also simulated the 50, 75 and 100 year return period flood in 2075 and the 25, 50, 75 and 100 year return period flood in 2115 with +70% river flow climate change allowance applied as an upper sensitivity test).
- Easton-in-Gordano Stream fluvial events: 100 and 200 year return period flood in 2075 and 2115 with +40% rainfall climate change allowance applied.

3.1.4 The updated simulations and their results presented in Appendix C, and REP2-022, replace the equivalent simulations and their results presented in the DCO application FRA (i.e. tabulated model results and flood maps), and so this addendum should be read alongside the FRA to enable reference to the updated results where relevant.

3.1.5 The complete set of hydraulic model simulations and associated results tables and flood maps have not been updated to apply current guidance climate change allowances. Instead, specific simulated flood events have been updated for specific FRA requirements (e.g. to demonstrate the DCO Scheme will not increase flood risk elsewhere up to the design return period, to assess future frequency of flooding to the DCO Scheme). The modelling presented in the DCO application FRA, that has not been updated, provides a comparative assessment for the wider range of flood return periods.

3.2 Other FRA updates

3.2.1 In addition to the further hydraulic modelling undertaken, this FRA addendum provides further assessment of the proposed Associated Development works in Flood Zones 2 and 3.

3.2.2 Works numbers 10C, 12B, 16B, 16D and 27 have been removed from the DCO application. Therefore the assessment of these works should be discounted when reading the FRA.

3.2.3 The operational flood plan and Clanage Road construction compound flood plan included in Appendix T of the FRA (APP-092) have been updated to include document REP3-015 to inform the discharge of relevant requirements in the DCO. Also, the temporary welfare facilities referred to in paragraph 2.3 of Appendix T should refer to being raised 1m above the finished compound ground level of 7.4 mAOD (i.e. raised above a level of 8.4mAOD).

3.2.4 An interpretation of the March 2020 extreme River Avon tidal event supports this FRA Addendum conclusion that the Clanage Road compound is more likely to be in Flood Zone 3a than 3b.

3.2.5 The BCC SFRA mapping denotes that the Clanage Road compound falls outside Flood Zone 3b.

3.2.6 Whilst the FRA reporting and modelling assumes that no strategic flood defences are built throughout the whole study area, based on the BAFS preferred choice for flood defence improvements in Bristol, it is considered likely that the DCO Scheme will be defended by 2030.

Appendix A
Observed River Avon extreme tidal event, March 2020

APPENDIX A

Photographs taken from and around Rownham Bridge at 09:00 on 12 March 2020 when the recorded peak tide level at Avonmouth was 8.44mAOD, with a preceding peak tide level at 18:00 on 11 March of 8.63mAOD (source: https://www.gaugemap.co.uk/#!Detail/8241/3586/2020-03-11/2020-03-12) and with heavy rain the night before.


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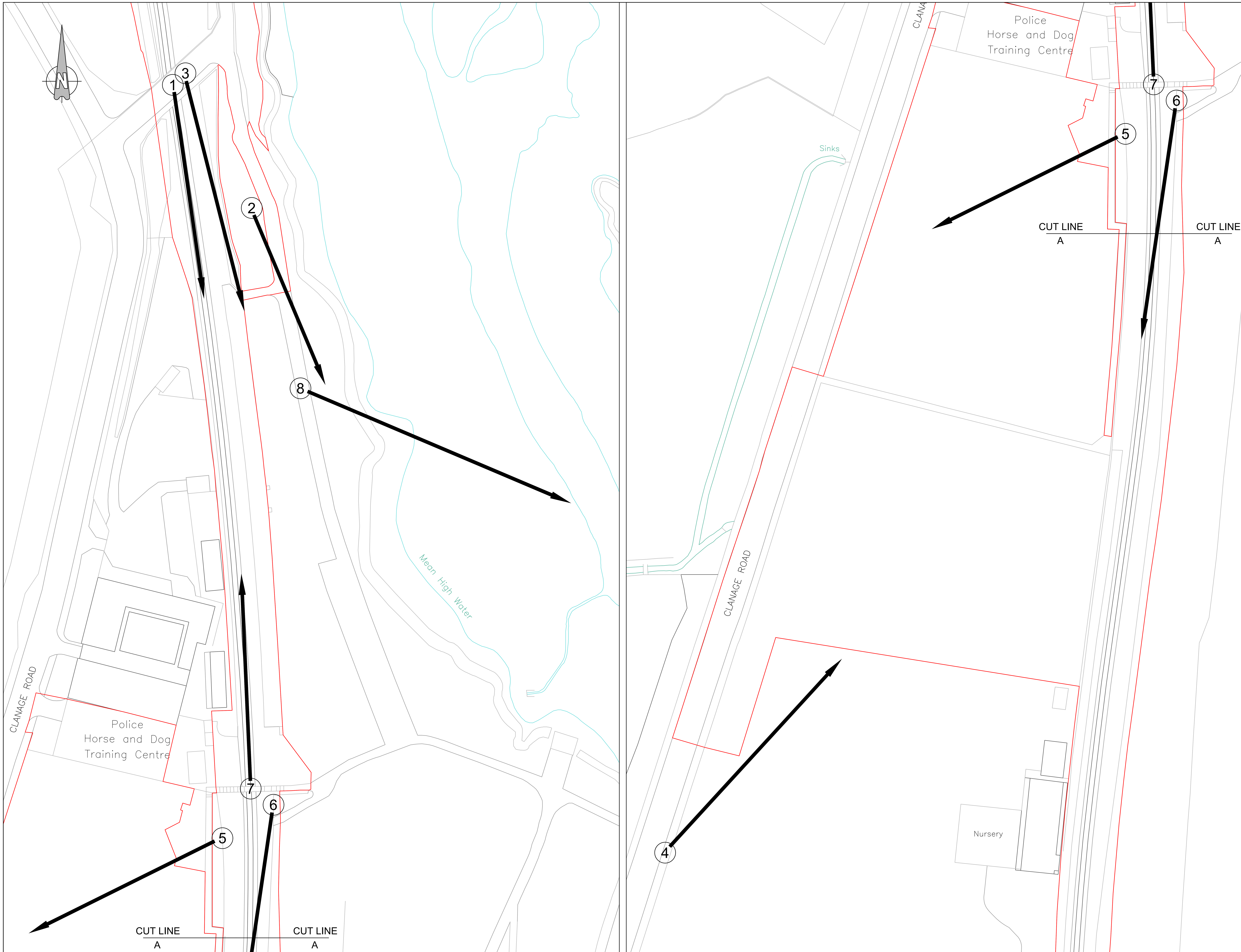

LEGEND:

Order Limits

PHOTO REFERENCES:

1	JPG1154
2	JPG1155
3	JPG1157
4	JPG0384
5	JPG0388
6	JPG0403
7	JPG0396
8	JPG1166

DO NOT SCALE. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialist Manufacturer's drawings and specifications. If in doubt please consult the Engineer.

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SCALE 1:500 (A1)
SCALE 1:1000 (A3)
METRES

Rev	By	Chkd	Apprvd	Date	Description

travelwest
Bath & North East Somerset, Bristol, North Somerset and South Gloucestershire Councils working together to improve your local transport

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Project

PORTISHEAD BRANCH LINE
(METROWEST PHASE 1)

Drawing

LOCATIONS OF PHOTOGRAPHS TAKEN IN THE BOWER ASHTON AREA DURING RIVER AVON HIGH TIDAL EVENT ON 12 MARCH 2020

Drawn by: OHP Date: 08/12/2020
Checked by: CF Date: 08/12/2020
Approved by: CF Date: 08/12/2020

Drawing No. 467470.BJ.35.01-SK01
Revision 0

Drawing Scale: 1:500 @ A1 or 1:1000 @ A3

Drawing file path & name : \\brsfpp01\Proj\Consulting\Projects\674946 NSC - 2016 Bristol Framework\674946.BJ.35.01 MW Ph1 Landscape and Arb\90 AutoCAD\90 AutoCAD\ 674946.BJ.35.01-SK01 Rev 0.dwg

Appendix B
Copy of correspondence from the Environment Agency to the Applicant

Subject: RE: MetroWest Flood Risk Modelling

From: [redacted]
Sent: 17 December 2020 19:22
To: [redacted]
Cc: [redacted]
Subject: [EXTERNAL] RE: MetroWest Flood Risk Modelling

Hi [redacted]

Please find attached the latest review spreadsheets for the Metrowest models. In summary, the additional information supplied has addressed our previous concerns and the models can now be considered suitable for their purpose.

Kind regards

[redacted]

[redacted]

[redacted]
Email: nwx.sp@environment-agency.gov.uk

Environment Agency, Rivers House, East Quay, Bridgwater, Somerset, TA6 4YS

Creating a better place for people and wildlife

Please note Environment Agency staff are working remotely as part of a continuity management plan in relation to Coronavirus (COVID-19). All staff can be contacted via e-mail or telephone, although our ability to access emails and the EA network may be limited. Please accept our apologies in advance for any delays in our service during this difficult time, which we are working hard to minimise as much as possible. Meetings will be held remotely and any non-urgent meetings may be rearranged.

From: [redacted]
Sent: 08 December 2020 17:06
To: [redacted]
Cc: [redacted]
Subject: RE: MetroWest Flood Risk Modelling

Hi [redacted]

Further to our model dataset submission below, please find attached our responses to the Environment Agency's model review comments spreadsheets, which you provided on 27 October 2020 (for the MetroWest CAFRA modelling and Easton-in-Gordano Stream modelling).

Regards

[redacted]

www.jacobs.com

From: [redacted]
Sent: 04 December 2020 09:38
To: [redacted]
Cc: [redacted]
Subject: [EXTERNAL] RE: MetroWest Flood Risk Modelling

Hi [redacted]

I can confirm receipt of the hard drive.

Kind regards

[redacted]

[redacted]

[redacted]
Email: nwx.sp@environment-agency.gov.uk

Environment Agency, Rivers House, East Quay, Bridgwater, Somerset, TA6 4YS

From: [redacted]
Sent: 03 December 2020 10:17
To: [redacted]
Cc: [redacted]
Subject: RE: MetroWest Flood Risk Modelling

Hi [redacted]

The MetroWest modelling hard drive was collected by courier yesterday at 9am.
Please can you confirm it has arrived at the EA Leeds office?

Thanks

[redacted]

Appendix C Easton-in-Gordano Stream floodplain compensation modelling technical note

Technical note

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Project Name	**Metro West Flood Risk Assessment - Easton-in-Gordano - Mitigation**
Prepared for	North Somerset Council and EA
Prepared by	NT/IG
Reviewed by	RB
Approved by	
Date	15/07/2020
Project Number	674946CH
Revision No	0

Contents

1. Introduction

The proposed MetroWest Phase 1 scheme, as presented in the MetroWest Development Consent Order (DCO) application Flood Risk Assessment (FRA), includes a local shift in railway alignment by approximately 2m southwards in the Easton-in-Gordano Stream floodplain. This shift results in a slight reduction in fluvial floodplain storage south of the railway.

The DCO application proposes fluvial floodplain compensation south of the railway, and west of Easton-in-Gordano Stream, with the proposed floodplain compensation specified to replace displaced floodplain volumes on a level-for-level hydraulically linked basis. Hydraulic modelling was therefore not required to demonstrate the proposed floodplain compensation was adequate.

Since submitting the DCO application, the preferred location of floodplain compensation is east of Easton-in-Gordano Stream, where floodplain compensation is hydraulically linked to the displaced floodplain, but it is not possible to specify floodplain compensation on a level-for-level basis.

This technical note details further hydraulic modelling undertaken to assess;

- the impact of the proposed shift in railway alignment on flood risk and
- the benefit of providing floodplain compensation east of Easton-in-Gordano Stream.

This technical note does not report development of the Easton-in-Gordano Stream hydraulic modelling undertaken for the DCO application. This is reported in Appendix K of the DCO application Flood Risk Assessment.

This technical note is structured as follows:

Section 2: Development of a revised pre-development model with a 2m grid resolution (the modelling undertaken for the DCO application applied a 4m grid resolution). A 2m grid resolution is required to represent the proposed shift in railway alignment (Section 3). Comparison of results of 4m and 2m grid resolution pre-development models. The 2m grid size was applied to improve model resolution and so enable representation of the post development embankment shift. There was no need to simulate a post development case when the compensation was proposed west of the railway – as this could be provided on a hydraulically linked level-for-level basis. Hence there was no need to refine the model grid size.

Section 3: Development of post-development model (2m grid resolution) to represent the proposed shift in railway alignment. This model does not include floodplain compensation. Assessment of impacts of the proposed shift in railway alignment on flood risk.

Section 4: Development of post development model (2m grid resolution) including floodplain compensation east of Easton-in-Gordano Stream. Assessment of the impacts of simulated floodplain compensation on flood risk.

Section 5: Conclusions

2. Revised pre-development model with 2m grid resolution

2.1 Model updates

The 4m grid resolution pre-development model was amended to apply a 2m grid resolution.

2.2 Model simulations

The pre-development (2m grid) model was run for the following events:

- Fluvial events: 30 year and 100 year return period fluvial floods for the present day (2015) and future (2075 and 2115) years.

The model was run using a timestep of 0.5s and 1s for the 1D and 2D domains for a duration of 29 hours. The model run-time is approximately 40 hours.

2.3 Model results

Table 1 lists simulated peak flood levels upstream and downstream of the railway in the 1D and 2D domains, at locations presented in Figures 1 and 2, for the pre-development models applying a 4m grid and 2m grid, and the differences between peak flood levels simulated with the 4m grid and 2m grid pre-development models.

Figures 5 to10 in Appendix A show the difference in maximum depth between pre-development model (4m grid) and pre-development model (2m grid).

Table 1 indicates that simulated peak flood levels are generally slightly lower for the 2m grid model upstream (south) of the railway, by up to approximately 20mm, and generally slightly higher downstream (north) of the railway by up to approximately 20mm. These differences between pre-development peak flood levels simulated by the 2m and 4m grid resolution models are considered minor and within model uncertainty/accuracy. The 2m grid resolution model results will be used to compare relative differences between pre- and post-development (also 2m grid) peak flood levels.

Table 1: Simulated peak flood levels upstream and downstream of the railway (1D and 2D domain)

Location	Peak flood level (mAOD) upstream and downstream of the railway								
	30 year flood in 2015			30 year flood in 2075			30 year flood in 2115		
	Pre-dev. (4m grid)	Pre-dev. (2m grid)	Diff. (m)	Pre-dev. (4m grid)	Pre-dev. (2m grid)	Diff. (m)	Pre-dev. (4m grid)	Pre-dev. (2m grid)	Diff. (m)
13 (1D)	8.091	8.090	-0.001	8.156	8.143	-0.014	8.171	8.165	-0.006
2 (1D)	8.091	8.090	-0.001	8.156	8.142	-0.014	8.171	8.165	-0.006
34 (1D)	6.894	6.889	-0.005	6.957	6.966	0.008	6.990	6.998	0.008
64 (1D)	6.618	6.613	-0.006	6.713	6.718	0.005	6.781	6.792	0.012
1 (2D)	8.091	8.090	-0.001	8.157	8.143	-0.014	8.171	8.165	-0.006
2 (2D)	8.091	8.090	-0.001	8.157	8.143	-0.014	8.171	8.165	-0.006
3 (2D)	8.091	8.090	-0.001	8.157	8.143	-0.014	8.171	8.165	-0.006
4 (2D)	8.091	8.090	-0.001	8.157	8.143	-0.014	8.171	8.165	-0.006
5 (2D)	8.592	8.593	0.001	8.592	8.594	0.002	8.592	8.594	0.002
6 (2D)	8.325	8.322	-0.003	8.325	8.322	-0.003	8.325	8.322	-0.003
7 (2D)	8.091	8.090	-0.001	8.158	8.143	-0.015	8.171	8.165	-0.006
8 (2D)	8.091	8.090	-0.001	8.158	8.143	-0.015	8.171	8.165	-0.006
Location	100 year flood in 2015			100 year flood in 2075			100 year flood in 2115		
	Pre-dev. (4m grid)	Pre-dev. (2m grid)	Diff. (m)	Pre-dev. (4m grid)	Pre-dev. (2m grid)	Diff. (m)	Pre-dev. (4m grid)	Pre-dev. (2m grid)	Diff. (m)
13 (1D)	8.193	8.177	-0.016	8.290	8.269	-0.021	8.283	8.269	-0.013
2 (1D)	8.193	8.177	-0.016	8.290	8.269	-0.021	8.283	8.269	-0.013
34 (1D)	7.003	7.020	0.017	7.258	7.275	0.017	7.327	7.333	0.006
64 (1D)	6.760	6.782	0.023	7.127	7.147	0.021	7.233	7.241	0.008
1 (2D)	8.194	8.177	-0.017	8.290	8.269	-0.021	8.283	8.269	-0.014
2 (2D)	8.193	8.177	-0.016	8.290	8.269	-0.021	8.283	8.269	-0.014
3 (2D)	8.193	8.177	-0.016	8.290	8.269	-0.021	8.283	8.269	-0.014
4 (2D)	8.193	8.177	-0.016	8.290	8.269	-0.021	8.283	8.269	-0.014
5 (2D)	8.592	8.594	0.002	8.592	8.594	0.002	8.592	8.594	0.002
6 (2D)	8.325	8.322	-0.003	8.327	8.322	-0.005	8.326	8.322	-0.004
7 (2D)	8.194	8.177	-0.017	8.290	8.269	-0.021	8.283	8.269	-0.014
8 (2D)	8.194	8.177	-0.017	8.290	8.269	-0.021	8.283	8.269	-0.014

Figure 1: Peak water level locations (2D domain)

Figure 2: Peak water levels locations in 1D model domain (the grey and blue dashed lines shown are the railway and adjacent cycle path respectively)

3. Post-development model with 2m grid resolution - without floodplain compensation

This Section describes the post-development model (2m grid) without floodplain compensation, covering:

- Model changes, compared to the 2m grid pre-development model, to represent shifting the MetroWest Phase 1 railway alignment 2m southwards.
- Resulting displaced floodplain volumes.
- Model simulations and the impact of the proposed shift in railway alignment on flood risk.

3.1 Model updates

The following updates, as presented in Figure 2, have been applied in the 2m grid post-development model:

- Amend the Z-line features (line and point shapefile) representing the railway by moving them 2m southwards. Please note, the line features zigzag due to the resolution of the model, but in reality would curve smoothly.
- Add a Z-shape feature (line shapefile, based on scheme design drawings) between contour of 8.0 and 8.3mAOD to raise the ground levels by 0.27m. This was added to better represent the foot of the railway embankment.

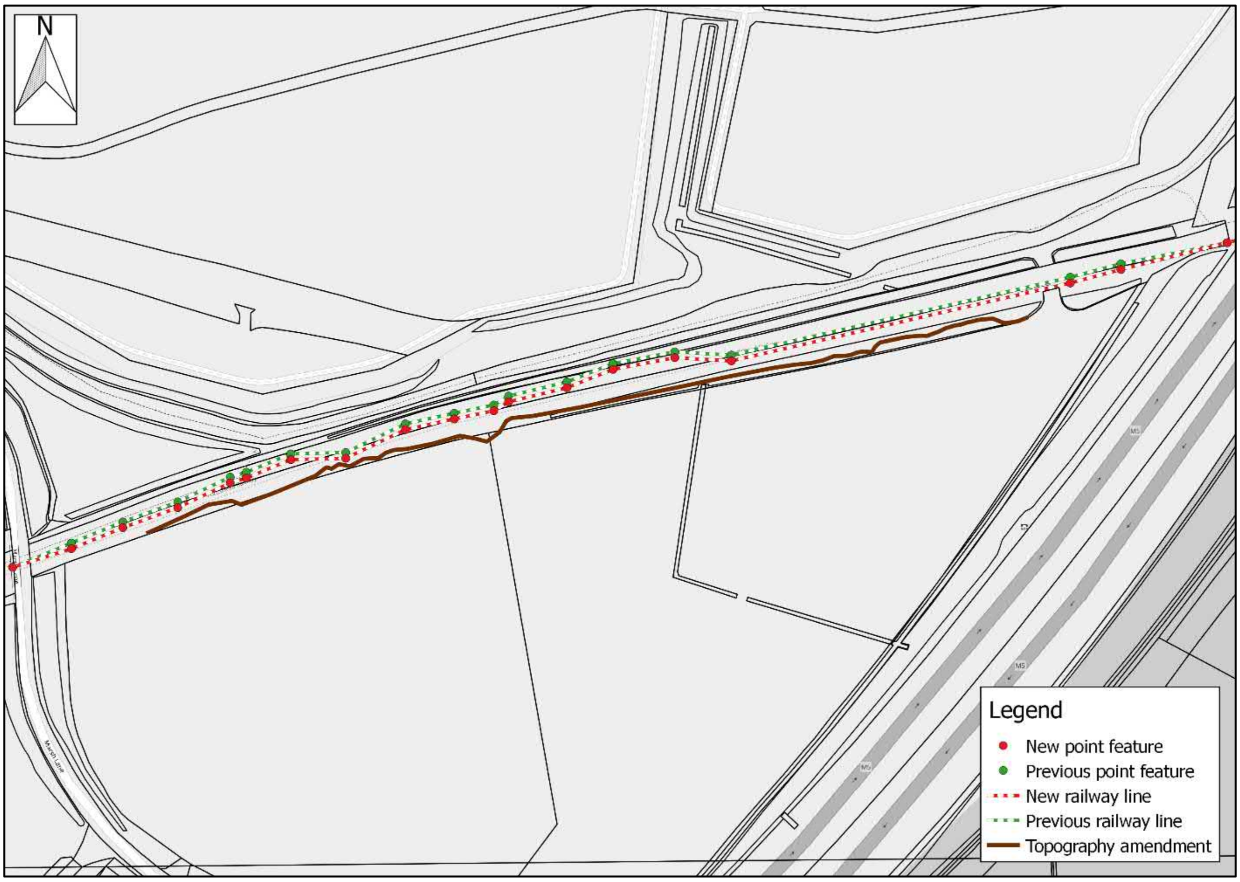


Figure 3: Model updates applied in the 2m grid post-development model

3.2 Displaced floodplain volume representation

The DCO application FRA quantifies the displaced floodplain storage in the Easton-in-Gordano Stream floodplain south of the railway, within 0.1m level ranges, resulting from the proposed shift southwards for the railway alignment. These were calculated based on the pre-development and proposed post-development cross section drawings. These displaced floodplain volumes are listed in Table 2 as well as equivalent volumes calculated based on the pre- and post-development model grids (with 2m grid resolution). Table 2 shows that that displaced floodplain storage values based on a comparison of pre- and post-development model grids are slightly higher than those based on the pre-development and proposed post-development cross section drawings, in terms of total volume displaced and for each level range i.e. the model representation slightly overstates the proposed displacement of floodplain storage south of the railway and so the modelling is slightly conservative in this respect.

Table 2: Floodplain displaced volumes

Lower level (mAOD)	Upper level (mAOD)	Calculated displaced floodplain storage (m^3) (based on the pre-development and proposed post-development cross section drawings)	Calculated displaced floodplain storage (m^3) (based on comparison of pre- and post-development model grids)
7.8	7.9	0.0	4.2
7.9	8.0	1.8	7.5
8.0	8.1	11.3	15.1
8.1	8.2	20.2	23.0
8.2	8.3	25.6	25.7
Total displaced floodplain storage (m^3)		58.9	75.5

3.3 Model simulations

The post-development (2m grid) model, without floodplain compensation, was run for the following events:

- Fluvial events: 30 year and 100 year return period fluvial floods for the present day (2015) and future (2075 and 2115) years.

The model was run using a timestep of 0.5s and 1s for the 1D and 2D domains for a duration of 29 hours. The model run-time is approximately 40 hours.

3.4 Model results and interpretation

Table 3 lists the peak water levels upstream and downstream of the railway in the 1D and 2D domain for the locations presented in Figures 1 and 2, for simulations with pre-development (2m grid) and post-development (without mitigation) models.

The results in Table 3 indicate that the impact of the proposed railway shift of 2m southwards on flood risk is negligible since there is almost no difference between pre- and post-development simulated peak water levels for all simulated events (all differences are within +/- 1mm).

Table 3: Peak water levels upstream and downstream of the railway (1D and 2D domain)

Location	Peak flood level (mAOD) upstream and downstream of the railway								
	30 year flood in 2015			30 year flood in 2075			30 year flood in 2115		
	Pre-dev. (2m grid)	Post-dev. Without floodplain comp. (2m grid)	Diff. (m)	Pre-dev. (2m grid)	Post-dev. Without floodplain comp. (2m grid)	Diff. (m)	Pre-dev. (2m grid)	Post-dev. Without floodplain comp. (2m grid)	Diff. (m)
13 (1D)	8.090	8.090	0.000	8.143	8.142	0.000	8.165	8.165	0.000
2 (1D)	8.090	8.090	0.000	8.142	8.142	0.000	8.165	8.165	0.000
34 (1D)	6.889	6.889	0.000	6.966	6.966	0.000	6.998	6.998	0.000
64 (1D)	6.613	6.613	0.000	6.718	6.719	0.001	6.792	6.792	0.000
1 (2D)	8.090	8.090	0.000	8.143	8.142	-0.001	8.165	8.165	0.000
2 (2D)	8.090	8.090	0.000	8.143	8.142	-0.001	8.165	8.165	0.000
3 (2D)	8.090	8.090	0.000	8.143	8.142	-0.001	8.165	8.165	0.000
4 (2D)	8.090	8.090	0.000	8.143	8.142	-0.001	8.165	8.165	0.000
5 (2D)	8.593	8.593	0.000	8.594	8.594	0.000	8.594	8.594	0.000
6 (2D)	8.322	8.322	0.000	8.322	8.322	0.000	8.322	8.322	0.000
7 (2D)	8.090	8.090	0.000	8.143	8.142	-0.001	8.165	8.165	0.000
8 (2D)	8.090	8.090	0.000	8.143	8.142	-0.001	8.165	8.165	0.000
	100 year flood in 2015			100 year flood in 2075			100 year flood in 2115		
Location	Pre-dev. (2m grid)	Post-dev. Without floodplain comp. (2m grid)	Diff. (m)	Pre-dev. (2m grid)	Post-dev. Without floodplain comp. (2m grid)	Diff. (m)	Pre-dev. (2m grid)	Post-dev. Without floodplain comp. (2m grid)	Diff. (m)
13 (1D)	8.177	8.177	0.000	8.269	8.269	0.000	8.269	8.269	0.000
2 (1D)	8.177	8.177	0.000	8.269	8.269	0.000	8.269	8.269	0.000
34 (1D)	7.020	7.020	0.000	7.275	7.275	0.000	7.333	7.333	0.000
64 (1D)	6.782	6.782	0.000	7.147	7.147	0.000	7.241	7.241	0.000
1 (2D)	8.177	8.177	0.000	8.269	8.269	0.000	8.269	8.269	0.000
2 (2D)	8.177	8.177	0.000	8.269	8.269	0.000	8.269	8.269	0.000
3 (2D)	8.177	8.177	0.000	8.269	8.269	0.000	8.269	8.269	0.000
4 (2D)	8.177	8.177	0.000	8.269	8.269	0.000	8.269	8.269	0.000
5 (2D)	8.594	8.594	0.000	8.594	8.594	0.000	8.594	8.594	0.000
6 (2D)	8.322	8.322	0.000	8.322	8.322	0.000	8.322	8.322	0.000
7 (2D)	8.177	8.177	0.000	8.269	8.269	0.000	8.269	8.269	0.000
8 (2D)	8.177	8.177	0.000	8.269	8.269	0.000	8.269	8.269	0.000

4. Floodplain compensation option

Section 3 concludes the impact of the proposed railway shift on flood levels is negligible. In this section the impact of floodplain compensation specified to replace displaced floodplain volume is assessed.

4.1 Simulated floodplain compensation

The simulated floodplain compensation area was schematised by using a z-shape polygon feature to set the ground levels (mostly lowering ground levels) within the polygon to a constant level of 7.3 mAOD as shown in Figure 4.

Tables 4 lists the dimension details of the z-shape polygon feature that was used to schematise the compensation area, as well as the additional floodplain volume provided by revising ground levels within the polygon.

The additional floodplain storage provided by the compensation area is calculated as 78.5m^3 (Table 4). The simulated additional floodplain storage therefore exceeds the 58.9m^3 of calculated displaced floodplain storage (Table 2) as a result of the proposed shift in railway alignment. Whilst the simulated floodplain compensation is hydraulically linked to the displaced floodplain storage, it is not specified on a level-for-level basis as this is not possible within the land available east of Easton-in-Gordano Stream.

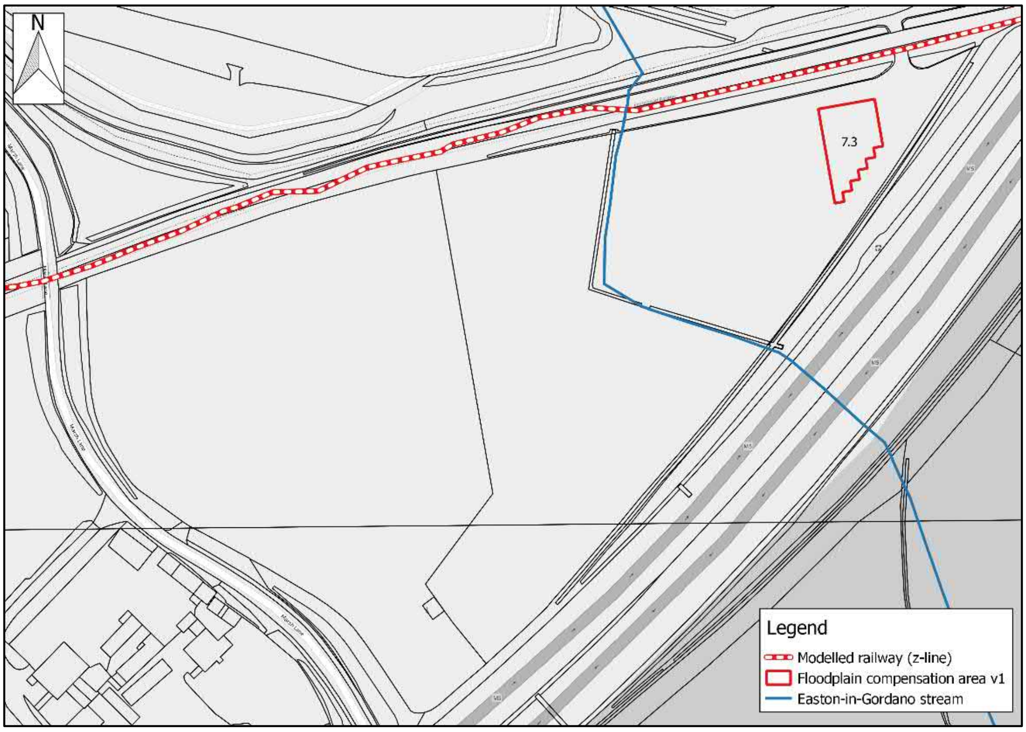


Figure 4: Simulated floodplain compensation area location

Table 4: Modelling file and dimension details for simulated floodplain compensation

TUFLOW file	Area of polygon (m^2)	Pre-development ground levels within polygon (m AOD)	Updated level (m AOD)	Additional floodplain storage provided by updating ground levels (m^3)
2d_zsh_EiG_CSA_v1_R.shp	720	7.218 – 7.622	7.3	78.5

4.2 Model simulations

The post-development (2m grid) model, with floodplain compensation, was run for the following events:

- Fluvial events: 30 year and 100 year return period fluvial floods for the present day (2015) and future (2075 and 2115) years.

The model was run using a timestep of 0.5s and 1s for the 1D and 2D domains for a duration of 29 hours. The model run-time is approximately 40 hours.

4.3 Model results and interpretation

Table 5 lists simulated peak water levels upstream and downstream of the railway in the 1D and 2D domain for the locations presented in Figures 1 and 2, for simulations with pre-development (2m grid) and post-development (with floodplain compensation) models.

Section 3 concludes that the impact of the proposed railway shift of approximately 2m southwards on flood risk is negligible. Table 5 indicates that the post-development (with floodplain compensation) peak flood levels are generally slightly lower than the pre-development case by approximately 0mm to 2mm. The simulated floodplain compensation is therefore considered adequate to mitigate the (negligible) impacts of the proposed railway shift of approximately 2m southwards.

Table 5: Peak water level (m AOD) upstream and downstream of the railway (1D and 2D domain) for compensation storage area

Location	Peak flood level (mAOD) upstream and downstream of the railway								
	30 year flood in 2015			30 year flood in 2075			30 year flood in 2115		
	Pre-dev. (2m grid)	Post-dev. With floodplain comp. (2m grid)	Diff. (m)	Pre-dev. (2m grid)	Post-dev. With floodplain comp. (2m grid)	Diff. (m)	Pre-dev. (2m grid)	Post-dev. With floodplain comp. (2m grid)	Diff. (m)
13 (1D)	8.090	8.089	-0.001	8.143	8.142	-0.001	8.165	8.164	0.000
2 (1D)	8.090	8.089	-0.001	8.142	8.142	-0.001	8.165	8.164	0.000
34 (1D)	6.889	6.888	-0.001	6.966	6.965	-0.001	6.998	6.997	-0.001
64 (1D)	6.613	6.612	-0.001	6.718	6.718	0.000	6.792	6.791	-0.002
1 (2D)	8.090	8.089	-0.001	8.143	8.142	-0.001	8.165	8.164	-0.001
2 (2D)	8.090	8.089	-0.001	8.143	8.142	-0.001	8.165	8.164	-0.001
3 (2D)	8.090	8.089	-0.001	8.143	8.142	-0.001	8.165	8.164	-0.001
4 (2D)	8.090	8.089	-0.001	8.143	8.142	-0.001	8.165	8.164	-0.001
5 (2D)	8.593	8.593	0.000	8.594	8.594	0.000	8.594	8.594	0.000
6 (2D)	8.322	8.322	0.000	8.322	8.322	0.000	8.322	8.322	0.000
7 (2D)	8.090	8.089	-0.001	8.143	8.142	-0.001	8.165	8.164	-0.001
8 (2D)	8.090	8.089	-0.001	8.143	8.142	-0.001	8.165	8.164	-0.001
Location	100 year flood in 2015			100 year flood in 2075			100 year flood in 2115		
	Pre-dev. (2m grid)	Post-dev. With floodplain comp. (2m grid)	Diff. (m)	Pre-dev. (2m grid)	Post-dev. With floodplain comp. (2m grid)	Diff. (m)	Pre-dev. (2m grid)	Post-dev. With floodplain comp. (2m grid)	Diff. (m)
13 (1D)	8.177	8.176	0.000	8.269	8.269	0.000	8.269	8.269	0.000
2 (1D)	8.177	8.176	0.000	8.269	8.269	0.000	8.269	8.269	0.000
34 (1D)	7.020	7.020	-0.001	7.275	7.274	-0.001	7.333	7.332	-0.001
64 (1D)	6.782	6.781	-0.001	7.147	7.146	-0.001	7.241	7.240	-0.001
1 (2D)	8.177	8.176	-0.001	8.269	8.269	0.000	8.269	8.269	0.000
2 (2D)	8.177	8.176	-0.001	8.269	8.269	0.000	8.269	8.269	0.000
3 (2D)	8.177	8.176	-0.001	8.269	8.269	0.000	8.269	8.269	0.000
4 (2D)	8.177	8.176	-0.001	8.269	8.269	0.000	8.269	8.269	0.000
5 (2D)	8.594	8.594	0.000	8.594	8.594	0.000	8.594	8.594	0.000
6 (2D)	8.322	8.322	0.000	8.322	8.322	0.000	8.322	8.322	0.000
7 (2D)	8.177	8.176	-0.001	8.269	8.269	0.000	8.269	8.269	0.000
8 (2D)	8.177	8.176	-0.001	8.269	8.269	0.000	8.269	8.269	0.000

5. Conclusions

The MetroWest Phase 1 DCO application proposes a shift in railway alignment in the Easton-in-Gordano Stream floodplain by approximately 2m southwards, and a corresponding displacement of Easton-in-Gordano Stream floodplain storage south of the railway.

Hydraulic modelling has been undertaken to assess:

- The impact of the MetroWest Phase 1 proposed shift southwards in railway alignment in the Easton-in-Gordano Stream floodplain on flood risk.

- The benefit of providing floodplain compensation east of Easton-in-Gordano Stream.

The hydraulic modelling undertaken indicates:

- Floodplain compensation east of Easton-in-Gordano has been specified with total compensation volume in the floodplain south of the railway exceeding the floodplain volume displaced (76 m^3 specified compared to 59 m^3 displaced). The specified floodplain compensation east of Easton-in-Gordano Stream is hydraulically linked to the displaced floodplain, but it is not possible to specify floodplain compensation on a level-for-level basis.

- Simulation results indicate the impact on flood risk of the proposed shift in railway alignment by approximately 2m southwards in the Easton-in-Gordano Stream floodplain (without providing floodplain compensation) is negligible since there is almost no difference between pre- and post-development simulated peak water levels for all simulated events (all differences are within +/- 1mm).

- With the specified floodplain compensation, post-development peak flood levels are generally slightly lower than the pre-development case by approximately 0mm to 2mm. The simulated floodplain compensation is therefore considered to mitigate the (negligible) impacts of the proposed railway shift of approximately 2m southwards.

Reprofiling of ground levels in the floodplain east of Easton-in-Gordano Stream (south of the railway) could therefore provide compensation for the displaced floodplain storage resulting from the proposed approximately 2m shift southwards of the railway. Appendix C shows the reprofiling of ground levels, with compensation volumes slightly exceeding those modelled to enable the lowered ground levels to smoothly tie in with the surrounding existing ground levels.

However, given the negligible increase in flood levels due to the proposed shift in railway alignment, and the current land use of this site as a local Wildlife Site important for the marshy habitat, we propose that no attenuation is needed. However, if the Council or the EA required attenuation, the ground levels could be reprofiled as indicated in the drawing in Appendix C. Ecological mitigation would be required for these works (e.g. digging up and replanting species).

Appendix A. Difference in maximum flood depths between FRA 4m grid pre-development model and 2m grid pre-development model

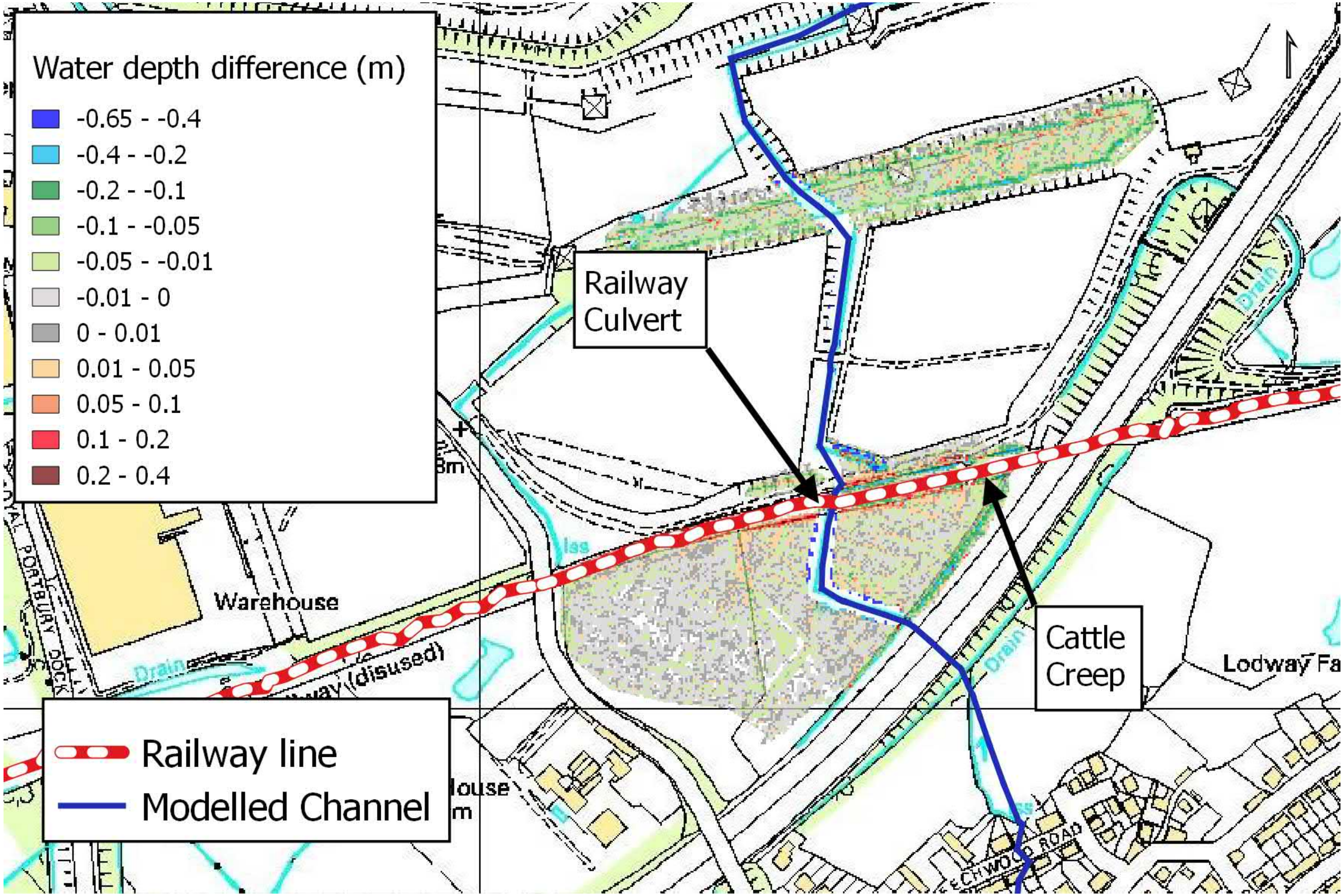


Figure 5: Easton-in-Gordano – Fluvial event – 30 year return period in 2015 – Difference in maximum depth

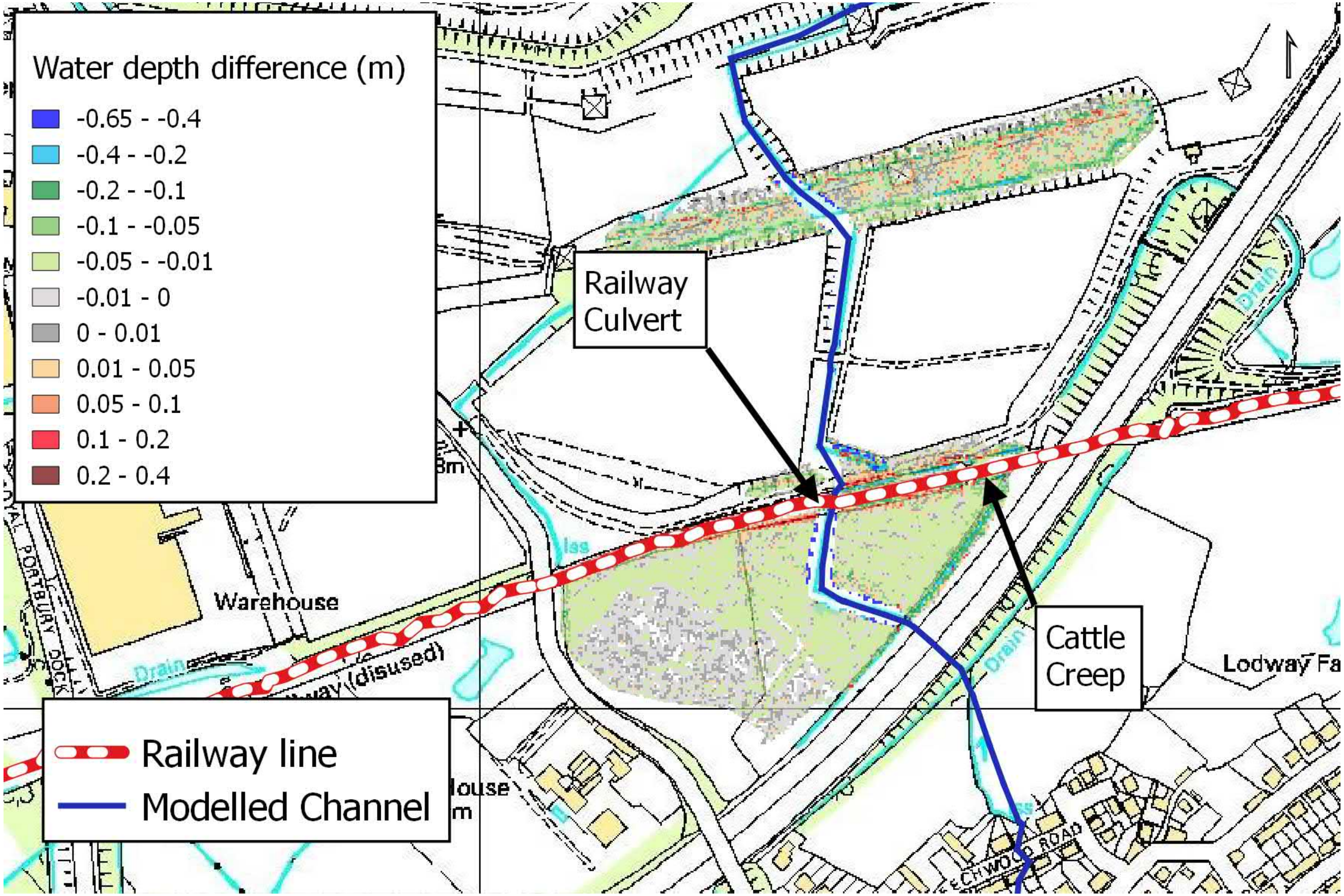


Figure 6: Easton-in-Gordano – Fluvial event – 30 year return period in 2075 – Difference in maximum depth

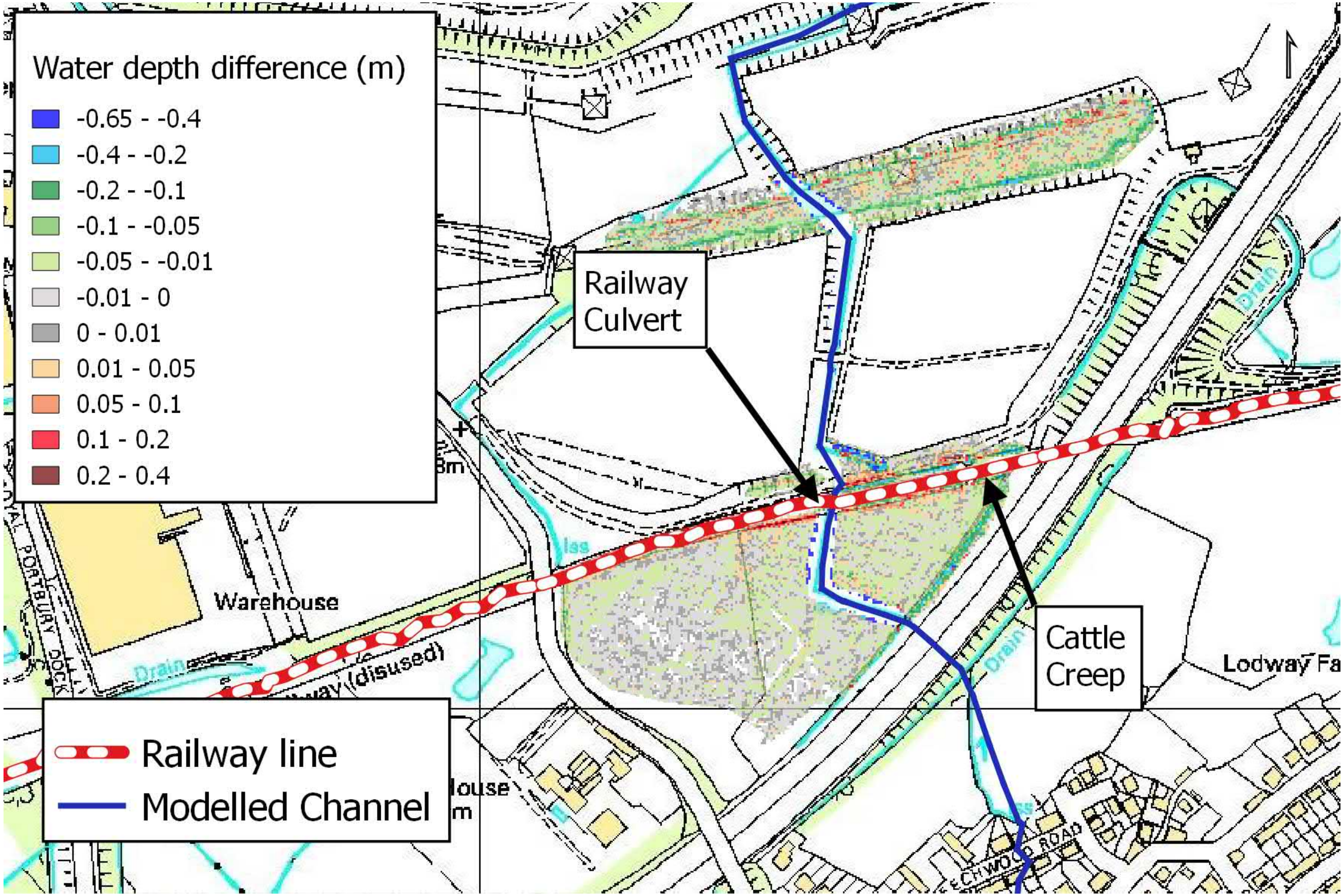


Figure 7: Easton-in-Gordano – Fluvial event – 30 year return period AEP in 2115 – Difference in maximum depth

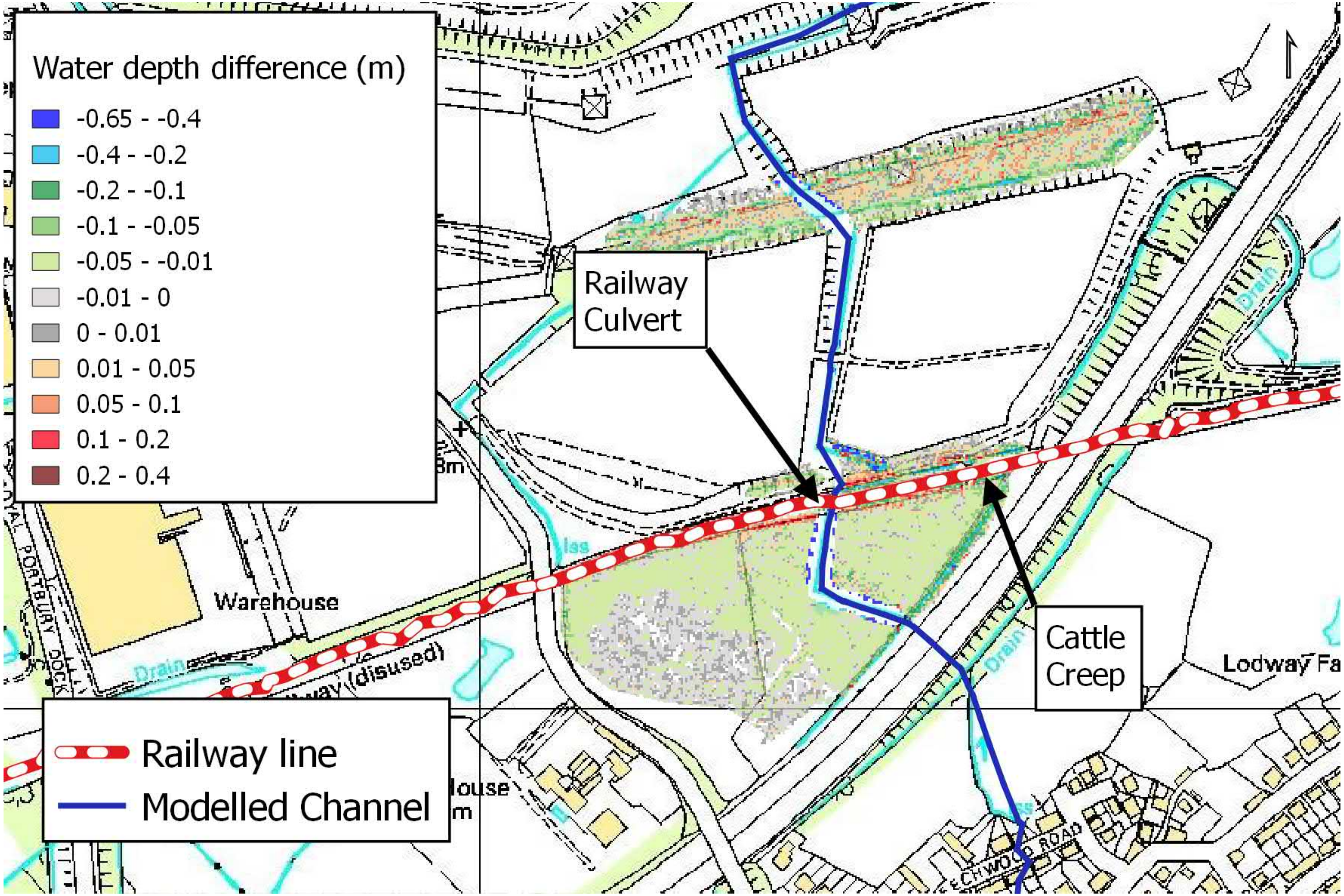


Figure 8: Easton-in-Gordano – Fluvial event – 100 year return period in 2015 – Difference in maximum depth

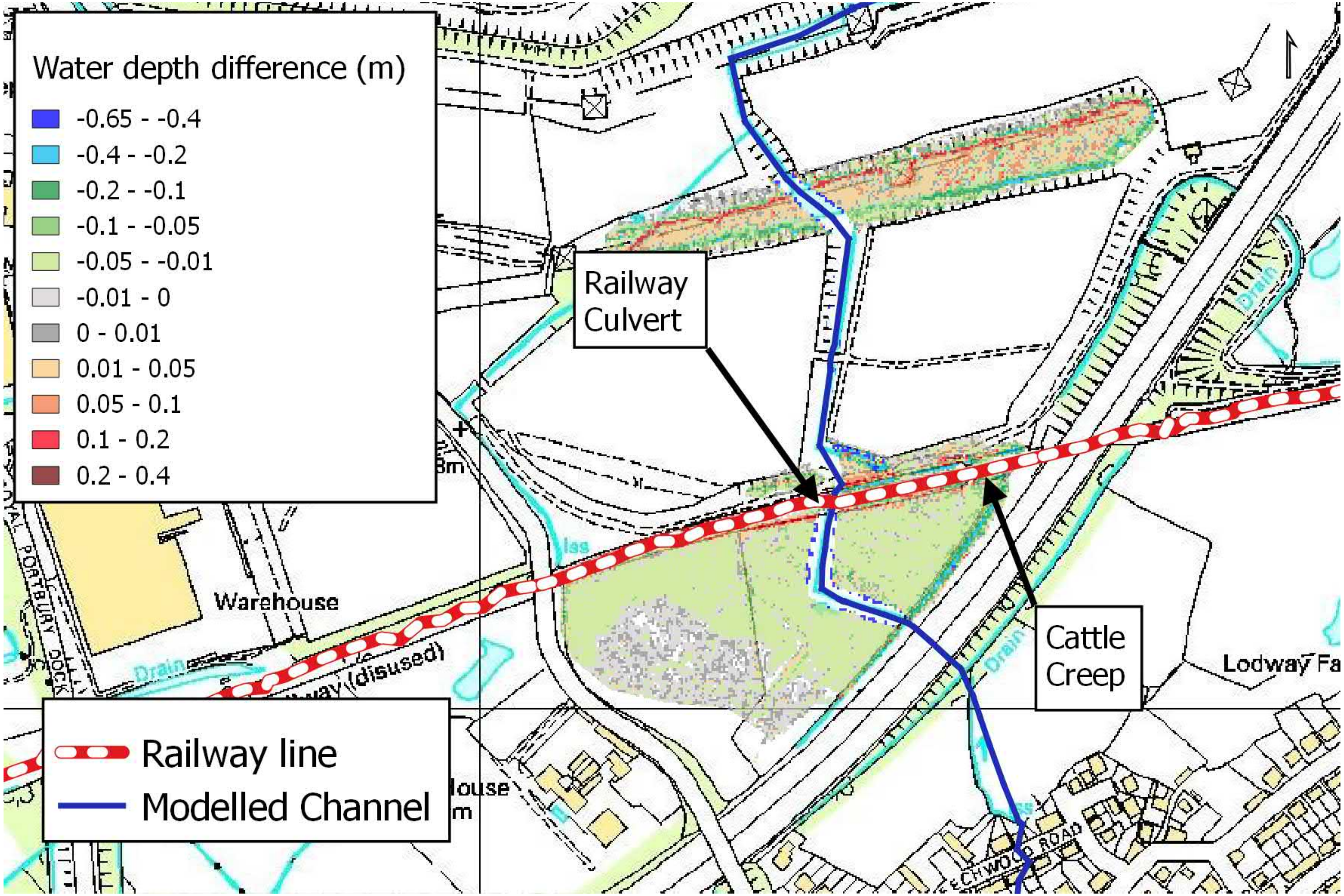


Figure 9: Easton-in-Gordano – Fluvial event – 100 year return period in 2075 – Difference in maximum depth

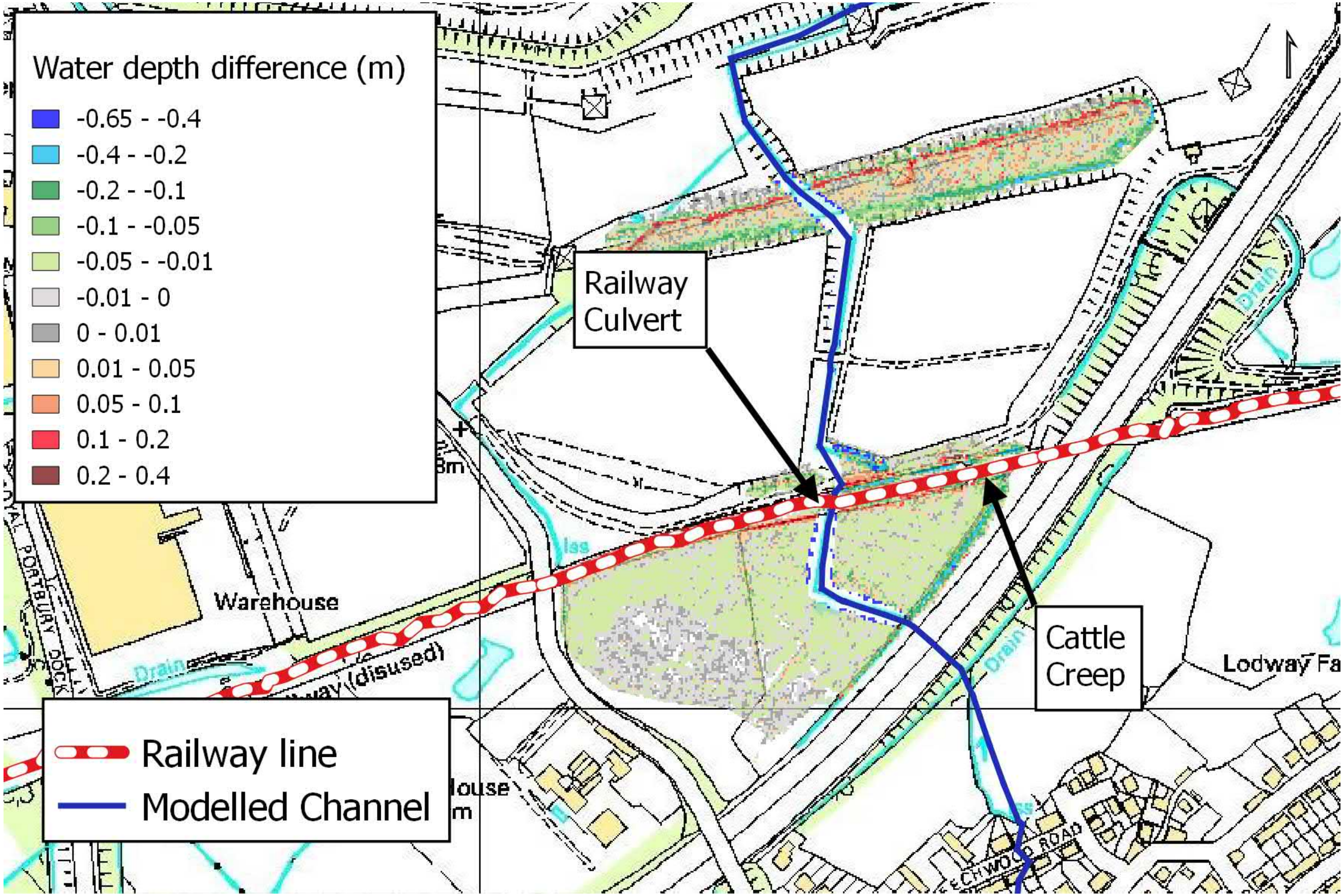


Figure 10: Easton-in-Gordano – Fluvial event – 100 year return period in 2115 – Difference in maximum depth

Appendix B. Difference in maximum flood depths between 2m grid pre-development model and post-development with mitigation

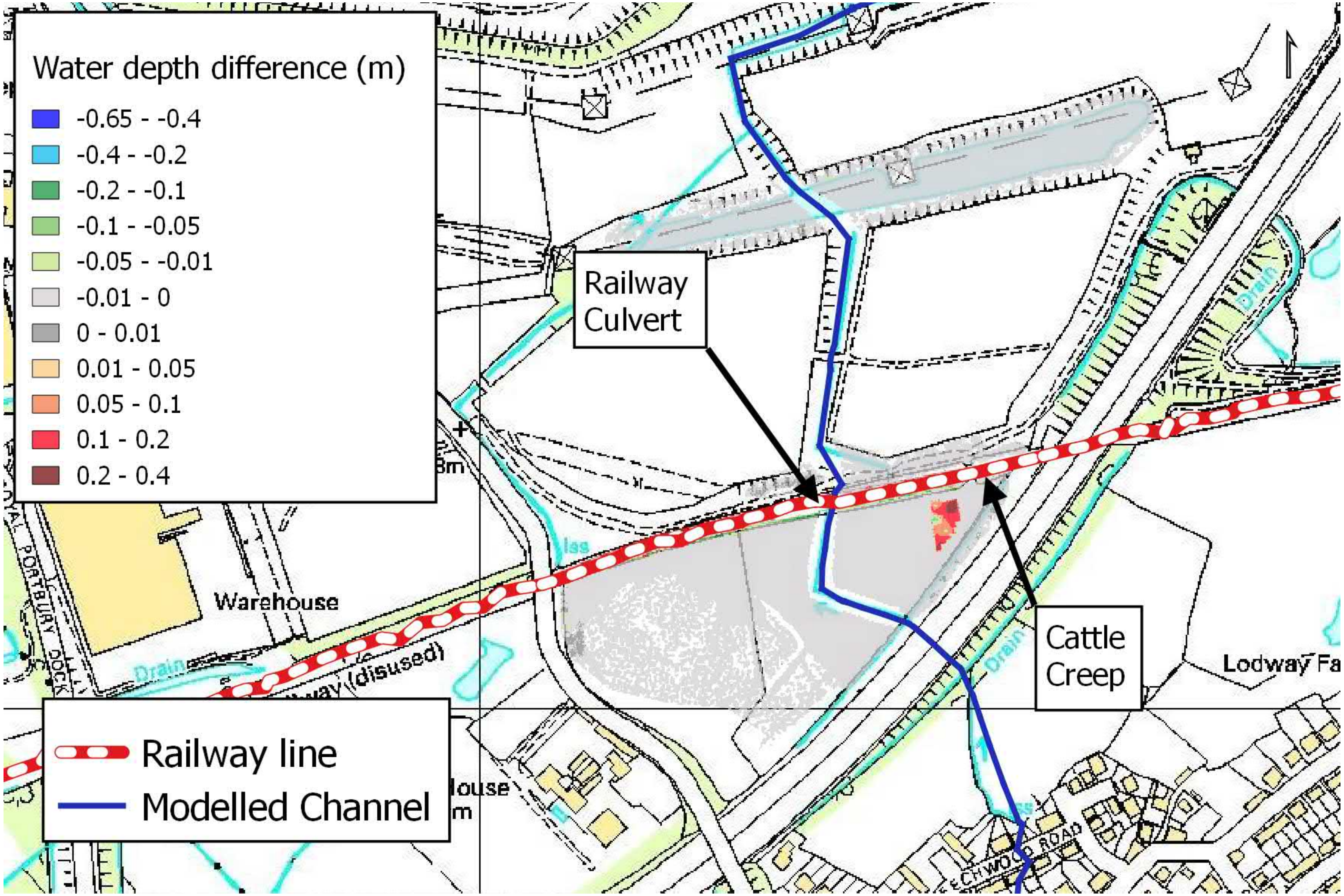


Figure 11: Easton-in-Gordano – Fluvial event – 30 year return period in 2015 – Difference in maximum depth

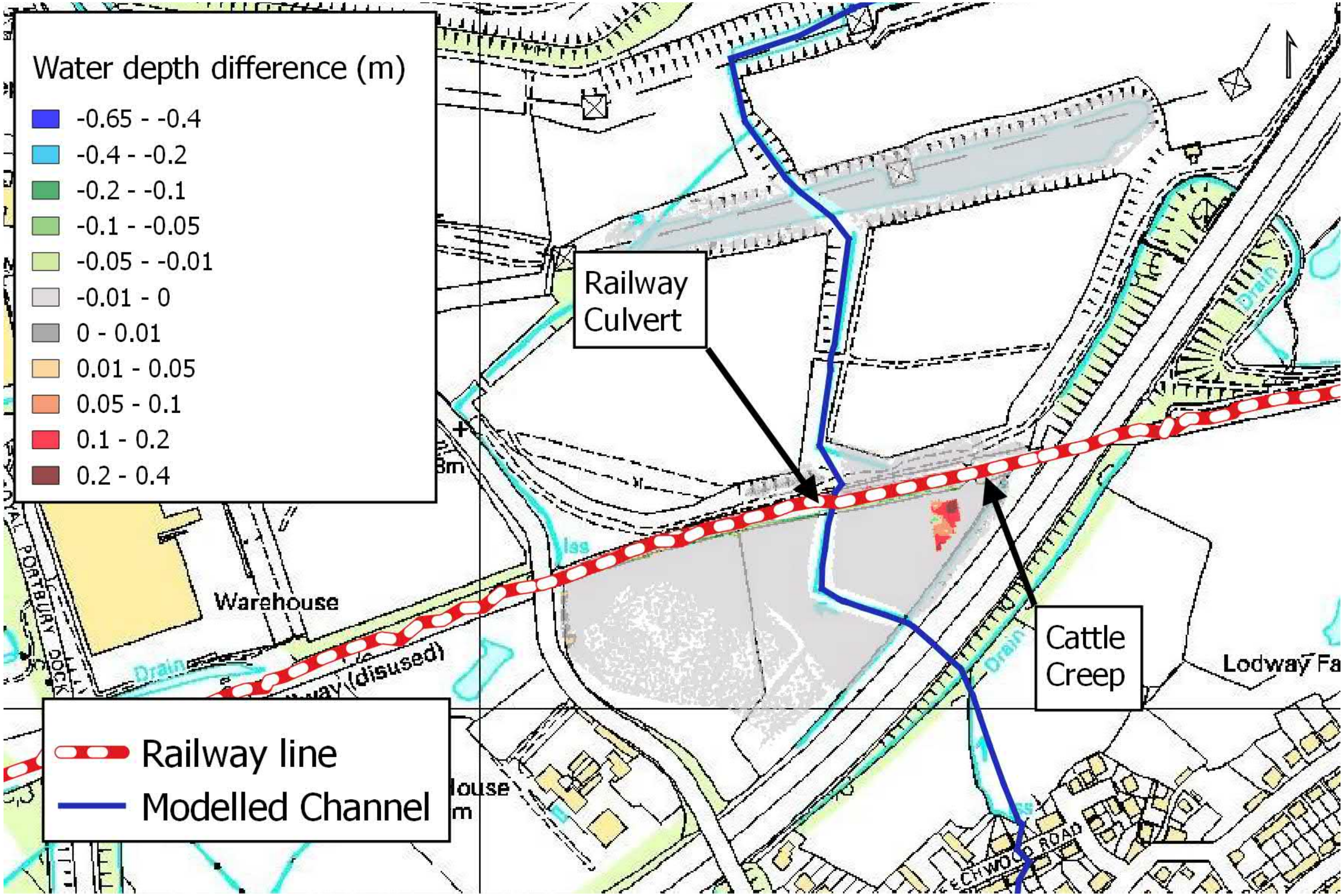


Figure 12: Easton-in-Gordano – Fluvial event – 30 year return period in 2075 – Difference in maximum depth

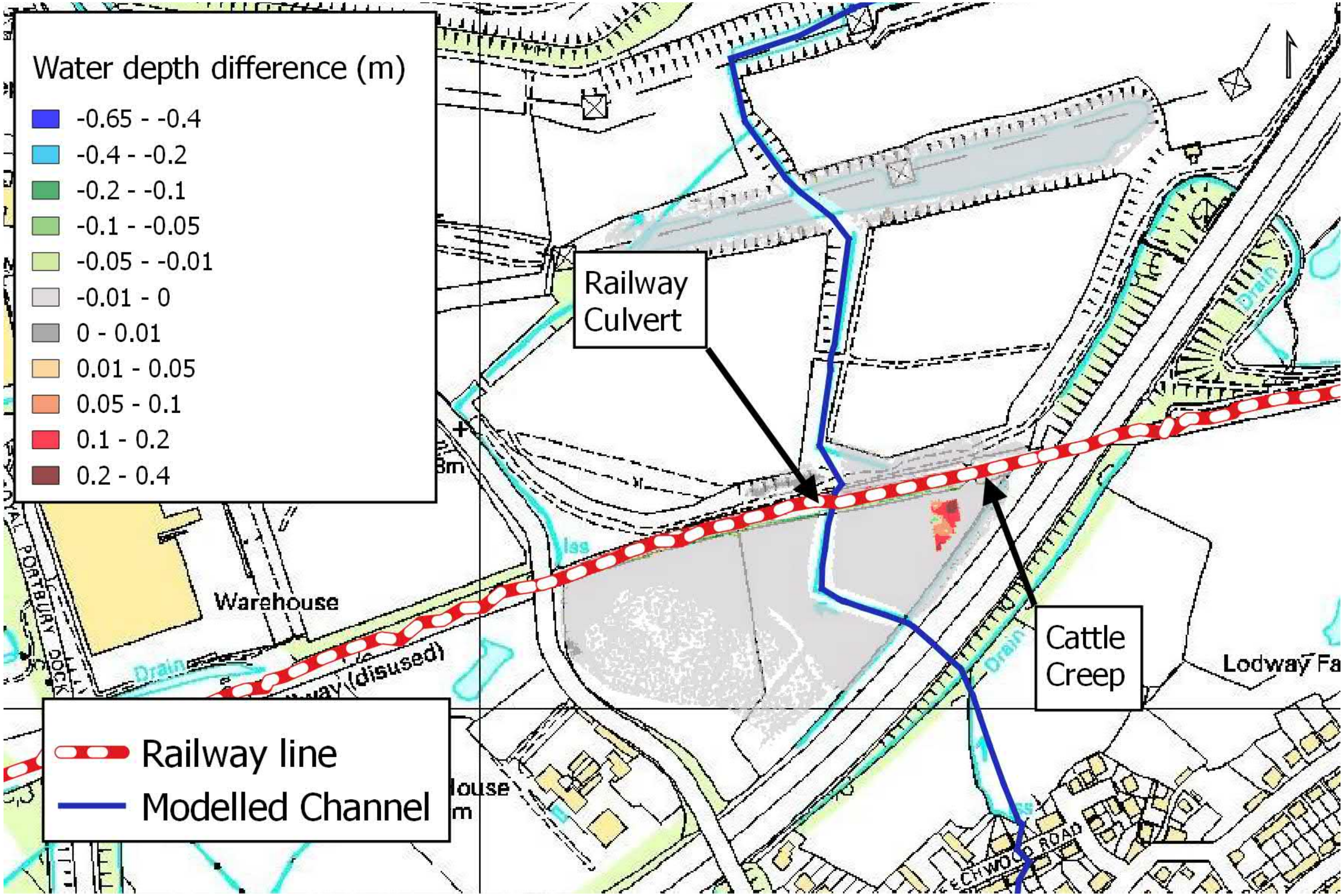


Figure 13: Easton-in-Gordano – Fluvial event – 30 year return period in 2115 – Difference in maximum depth

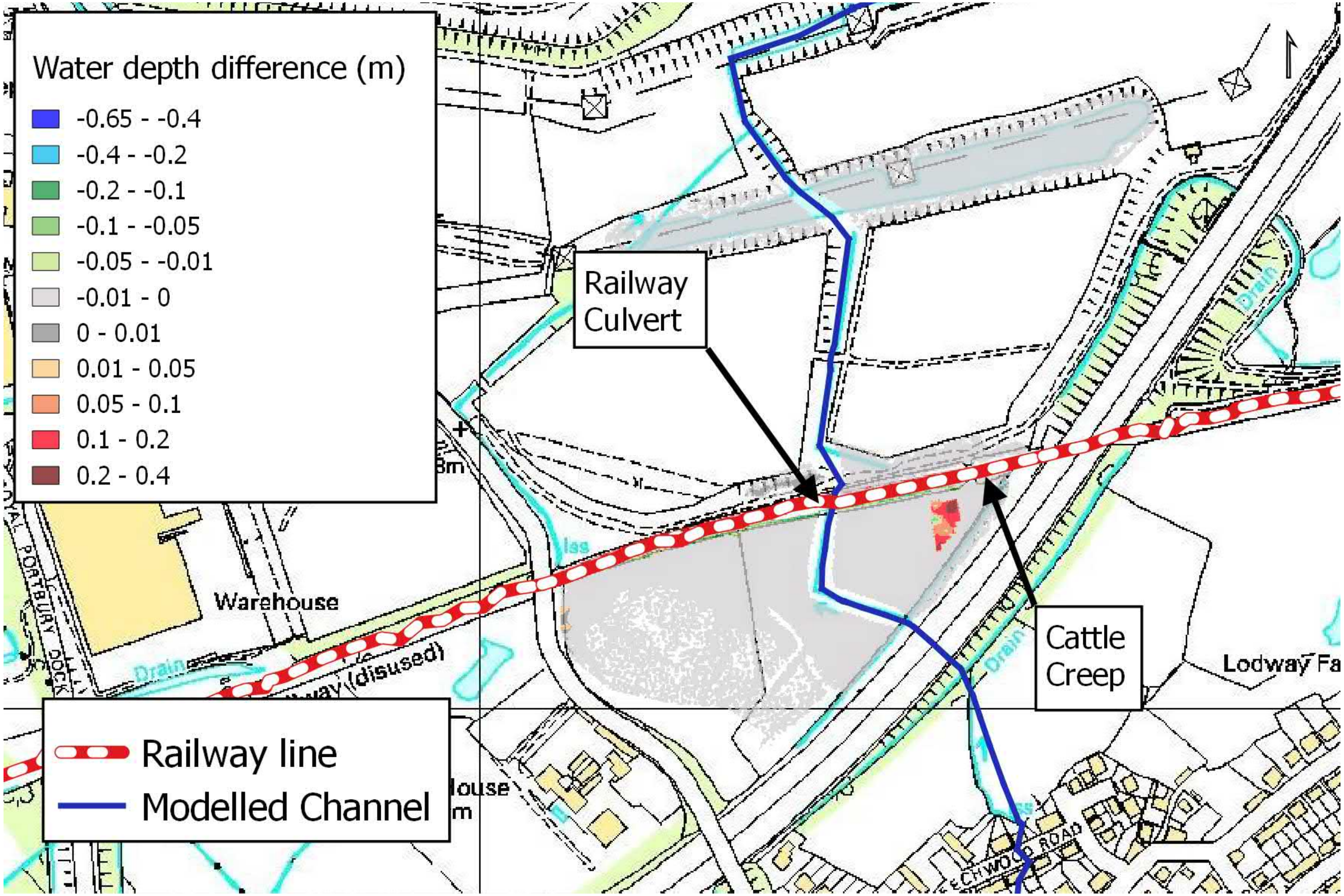


Figure 14: Easton-in-Gordano – Fluvial event – 100 year return period in 2015 – Difference in maximum depth

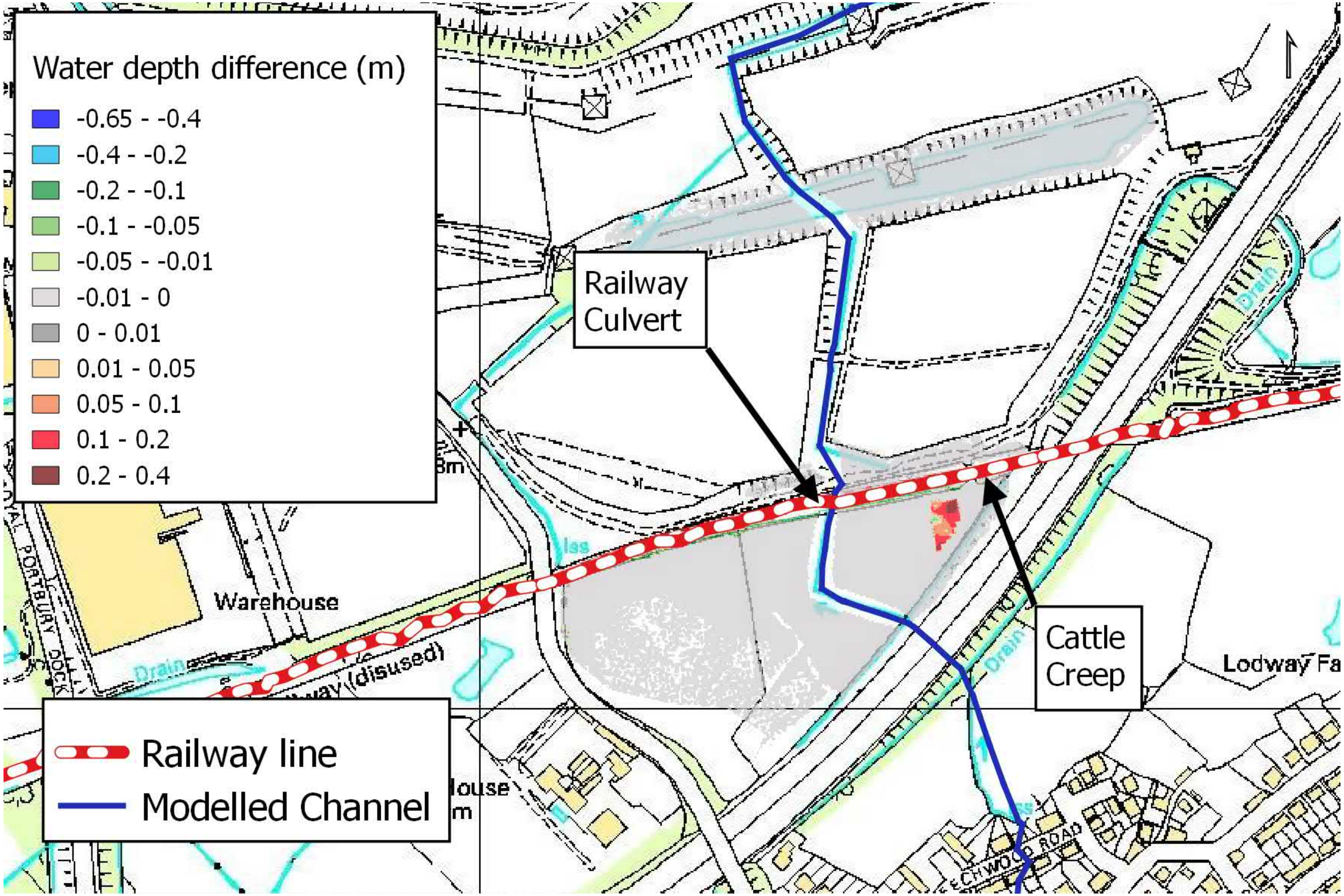


Figure 15: Easton-in-Gordano – Fluvial event – 100 year return period in 2075 – Difference in maximum depth

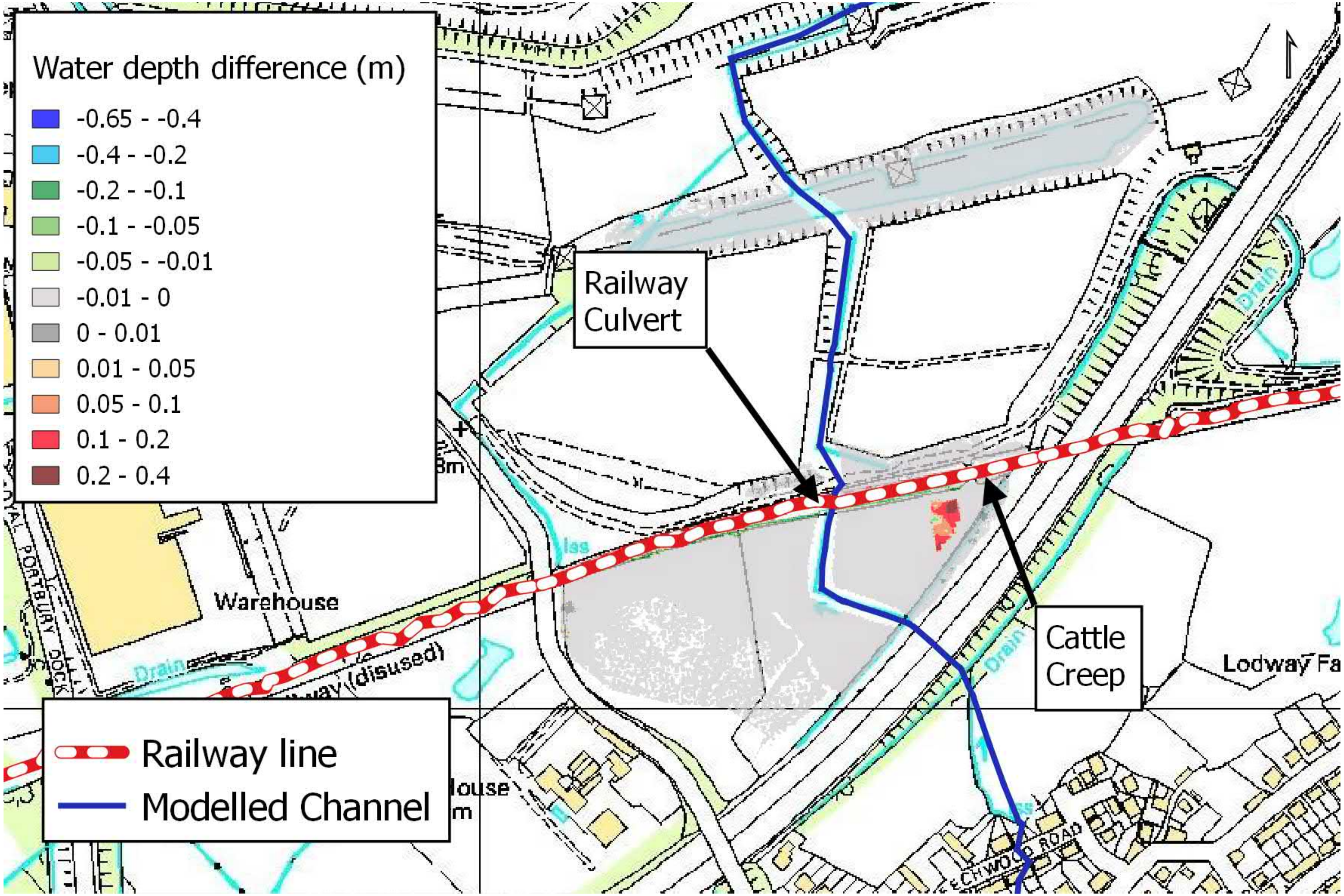
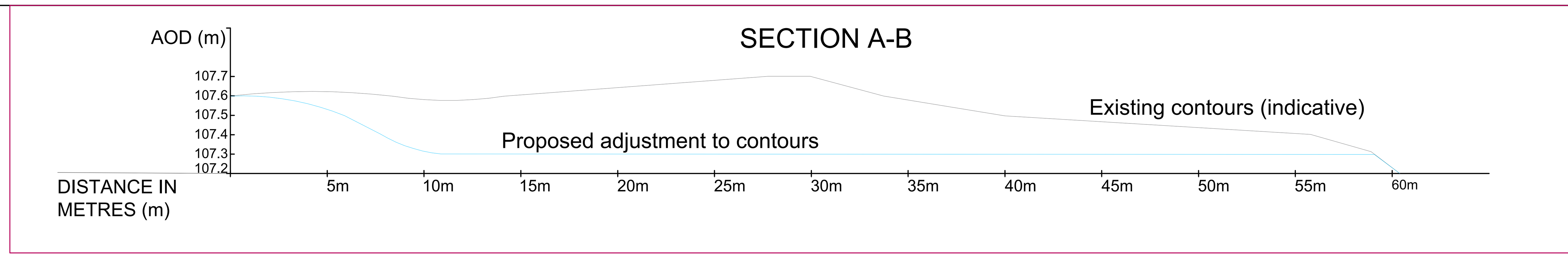


Figure 16: Easton-in-Gordano – Fluvial event – 100 year return period in 2115 – Difference in maximum depth

Appendix C. Floodplain compensation option (ground lowering east of Easton-in-Gordano Stream)

Drawing attached: **467470.BQ.04.20-SK20 Rev C-SK20.pdf**

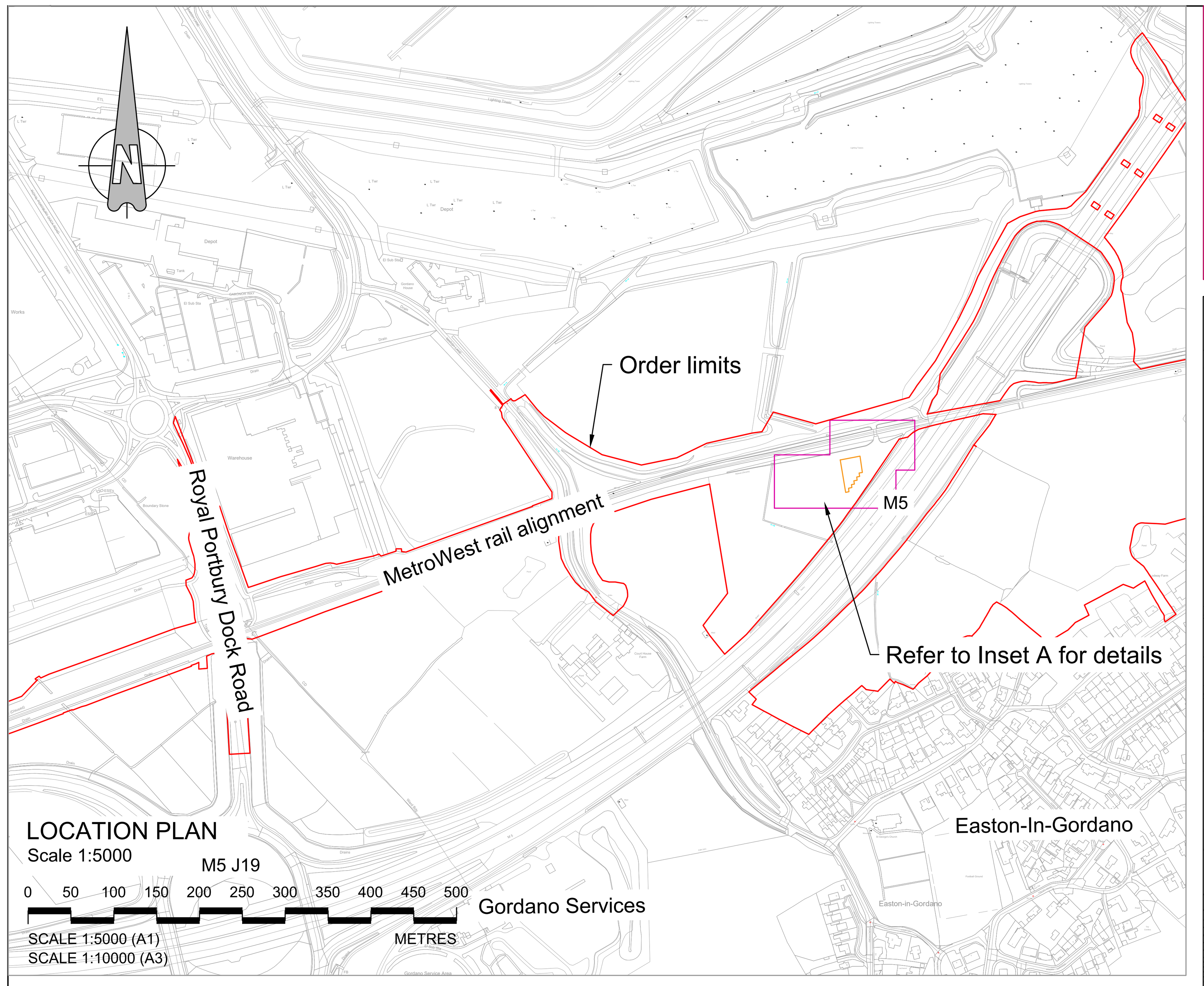


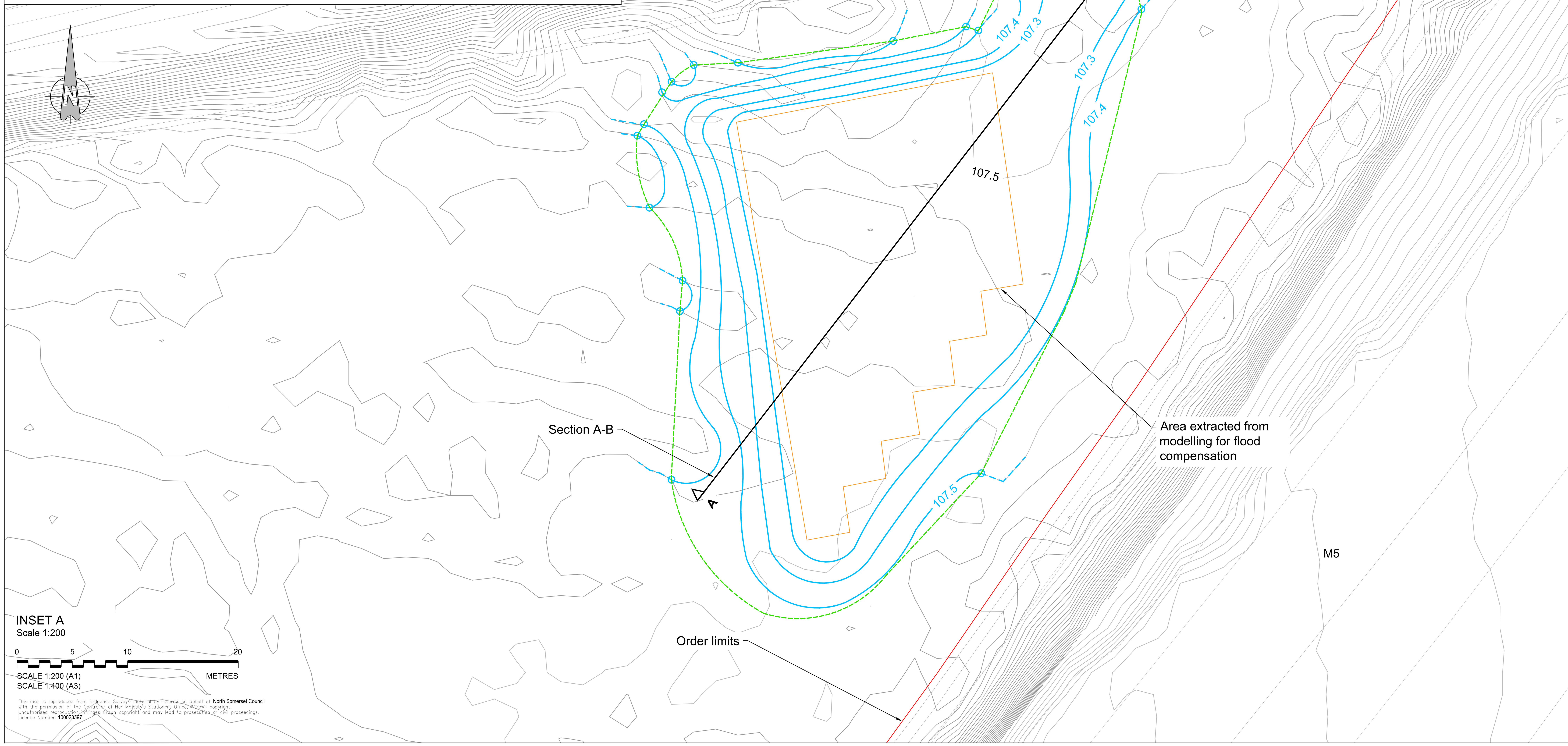
NOTES

1. All dimensions are in metres unless noted otherwise.
2. Elevations are shown at +100m due to Network Rail requirements.

KEY

107.4 (blue line)	Proposed contour
(green dashed box)	Approximate extent of stream compensation excavation
108.4 (grey line)	Existing contour





DO NOT SCALE. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialist Manufacturer's drawings and specifications. If in doubt please consult the Engineer.

Rev	By	Chkd	Apprvd	Date	Description
C	VS	ADL	ADL	13/07/2020	Compensation area redesigned
B	OHP	ADL	ADL	31/10/2019	Minor amendments
A	ADS	ADL	ADL	20/09/2019	Location plan added

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Project
PORTISHEAD BRANCH LINE
(METROWEST PHASE 1)

Drawing
EASTON-IN-GORDANO
FLOOD MITIGATION PLAN

Drawn by: VS	Date: 13/07/2020
Checked by: ADL	Date: 13/07/2020
Approved by: ADL	Date: 13/07/2020

Drawing No. 467470.BQ.04.20-SK20
Revision C
Drawing Scale: Varies

Drawing file path & name : \\brsfpp01\Proj\Consulting\Projects\467470 NSC Framework 2013\BQ.04.20 MW Phase 1 Highway Engineering\90 AutoCAD\91 AutoCAD Prelim\ 467470.BQ.04.20-SK20 Rev C.dwg

Appendix D Associated development FRA details

Proposed DCO Scheme Works No.	Description	Permanent or Temporary	Consideration of FRA scope for Associated Development in Flood Zones 2 and 3	Where addressed in FRA
2	Diversion of the highway of Quays Avenue, Portishead, of 181 metres in length, shown on sheets 1 and 1A of the works plans, from the junction of Quays Avenue and Galingale Way to a point west of the existing gyratory junction of Quays Avenue, Harbour Road and Phoenix Way, Portishead, together with connections to existing highways, widening of the southern footway of Harbour Road, landscaping, new bus waiting facilities, signage, lighting, pedestrian crossing facilities, pipes, drains, cables, ducts, troughs, telecommunications apparatus, conduits and apparatus for utilities as well as footways, and a connection to the pedestrian and cycle track forming part of Work No. 4;	Permanent	Works 2 and 2A are within the defended coastal floodplain. Modelling undertaken to assess the impacts of the residual risk associated with a breach of coastal flood defences indicates that Works 2 and 2A are outside of the simulated flood extent resulting from a breach of coastal flood defences during the 200 year return period coastal event in 2115 (the Project design life is 2075). For Works 2 and 2A, the FRA therefore focuses on surface water management and drainage design.	Drainage design for Works 2 and 2A is covered in the FRA Appendix O (APP-089, APP-090 and APP 091).
2A	Surface water drain, of 27 metres in length, shown on sheets 1 and 1A of the works plans north from Phoenix Way, Portishead into the watercourse known as the Cut;	Permanent		
3	A foot and cycle track, of 63 metres in length, shown on sheet 1 of the works plans, commencing at a junction with Work No. 4 east of the watercourse known as the Portbury Ditch, to a point west of Portbury Ditch, together with associated landscaping, signage, fencing, lighting, cables, ducts, troughs, telecommunication apparatus, conduits and apparatus for utilities;	Permanent	Work 3 is within the defended coastal floodplain (FZ3) and in fluvial FZ3a where it crosses Portbury Ditch. Modelling undertaken to assess the impacts of the residual risk associated with a breach of coastal flood defences indicates that Work 3 is outside of the simulated flood extent resulting from a breach of coastal flood defences during the 200 year return period coastal event in 2115 (the Project design life is 2075). Whilst Work 3 is within fluvial FZ3a at the crossing of Portbury Ditch, the proposed works are considered to be above the Portbury Ditch flood level - see FRA (APP-076) Section 8.1.2. For Work 3, the FRA therefore focuses on surface water management and drainage design.	Drainage design for Work 3 is covered in the FRA Appendix O (APP-089, APP-090 and APP 091).

Proposed DCO Scheme Works No.	Description	Permanent or Temporary	Consideration of FRA scope for Associated Development in Flood Zones 2 and 3	Where addressed in FRA
4	A car park of 4841 square metres in area, foot and cycle track of 275 metres in length and a new vehicular access to the highway of Harbour Road, shown on sheets 1 and 1A of the works plans, south of Harbour Road, Portishead and east of the Portbury Ditch, together with landscaping, lighting, signage, fencing, drainage in to the adjacent Portbury Ditch, to the west of Quays Avenue, Portishead;	Permanent	Works 4, 5 and 6 are partly within FZ1 and partly within the defended coastal floodplain. Modelling undertaken to assess the impacts of the residual risk associated with a breach of coastal flood defences indicates that Works 4, 5 and 6 are outside of the simulated flood extent resulting from a breach of coastal flood defences during the 200 year return period coastal event in 2115 (the Project design life is 2075). For Works 4, 5 and 6, the FRA therefore focuses on surface water management and drainage design.	Drainage design for Works 4, 5 and 6 is covered in the FRA Appendix O (APP-089, APP-090 and APP 091).
5	Railway station, of 396 metres in area, shown on sheets 1 and 1A of the works plans, to the south of Phoenix Way, Portishead, comprising platform, shelter, office, waiting area, storage and refuse area, seating, ticket vending machine, closed circuit television equipment, passenger help point, toilets, utilities connections, telecommunications equipment, public address system, information boards and displays, signage, lighting columns, fencing, acoustic barrier, landscaping, railway communications mast and surface water drain in to the adjacent watercourse known as the Cut;	Permanent		
6	Car park, of 4419 metres in area, shown on sheets 1 and 1A of the works plans, to the south of Phoenix Way, Portishead, including mobility impaired spaces, drainage, lighting, fencing, landscaping, signage, cycle parking facilities and utilities apparatus, together with access from the highway of Phoenix Way;	Permanent		
7	Public foot and cycle track bridge over Work No. 1, shown on sheets 1 and 1A of the works plans, to the south west of Trinity Primary School, Portishead, together with connections to cycle tracks, lighting, signage, fencing and hardstandings;	Permanent	Works 7, 7A, 7B, 7C, 7D and 7E are partly within FZ1 and partly within the defended coastal floodplain. Modelling undertaken to assess the impacts of the residual risk associated with a breach of coastal flood defences indicates that Works 7, 7A, 7B, 7C, 7D and 7E are outside of the simulated flood extent resulting from a breach of coastal flood defences during the 200 year return period coastal event in 2115 (the Project design life is 2075). For Works 7, 7A, 7B, 7C, 7D and 7E, the FRA therefore focuses on surface water management and drainage design.	Drainage design (where required) for Works 7, 7A, 7B, 7C, 7D is covered in the FRA Appendix O (APP-089, APP-090 and APP 091). There are no drainage requirements associated with the underground Work 7E.
7A	Public foot and cycle track, of 273 metres in length, shown on sheets 1 and 1A of the works plans, from Phoenix Way, Portishead to connect with Works Nos.7 and 7C, to the south of Tansy Lane and north of Work No. 1, together with signage, drainage, lighting, fencing and landscaping;	Permanent		
7B	Public foot and cycle track, of 150 metres in length, shown on sheets 1 and 1A of the works plans, from the diverted Quays Avenue, Portishead, to connect with Work No. 7, to the north of Galingale Way and to the south of Work No. 1, together with signage, drainage, lighting, fencing and landscaping;	Permanent		
7C	Public foot and cycle track, of 18 metres in length, shown on sheets 1 and 1A of the works plans, from Work No. 7 north to Tansy Lane, Portishead, together with signage, drainage, lighting, fencing and landscaping;	Permanent		
7D	Temporary construction compound, of 2876 square metres in area, shown on sheet 1 of the works plans, to the south of Tansy Lane, Portishead and to the north of Work No. 1;	Temporary		
7E	Underground electrical supply cables of 39.07 metres in length connecting from Work No. 7 to Tansy Lane, Portishead, shown on sheet 1 and 1A of the works plans;	Permanent		

Proposed DCO Scheme Works No.	Description	Permanent or Temporary	Consideration of FRA scope for Associated Development in Flood Zones 2 and 3	Where addressed in FRA
8	Temporary construction haul road of 486 metres in length, shown on sheets 1 and 2 of the works plans, on south side of, and parallel to, Work No. 1, from a point south of Fennel Road, Portishead, to the highway known as Sheepway, Portbury;	Temporary	Works 8, 9, 10, 10A, 11, 11A, 11B, 12 and 12A are all either within coastal FZ1, or defended coastal Flood Zone 2 and defended coastal Flood Zone 3. Modelling undertaken to assess the impacts of the residual risk associated with a breach of coastal flood defences indicates that the Works 8, 9, 10, 10A, 11, 11A, 11B, 12 and 12A are outside of the simulated flood extent resulting from a breach of coastal flood defences during the 200 year return period coastal event in 2015. The only pemanent work (of Works 8, 9, 10, 10A, 11, 11A, 11B, 12 and 12A) that are within the simulated flood extent resulting from a breach of coastal flood defences during the 200 year return period coastal event in 2115 is Work 11. The impacts on Work 11 are considered insignificant as (i) the farm access is at the edge of the simulated breach flood extent in 2115, and would likely not be flooded during an equivalent breach in 2075 i.e. the scheme design life (ii) the simulated flood depths and velocities in 2115 are low. For Works 8, 9, 10, 10A, 11, 11A, 11B, 12 and 12A, the FRA therefore focuses on surface water management and drainage design, where relevant.	Drainage design for Works 8, 9, 10A, 11A, 11B, and 12A is covered in the FRA Appendix O (APP-089, APP-090 and APP 091). Work 10 is a temporary path which will drain into the adjacent grass field. Work 11 is an agricultural access and drain into the adjacent grass field. Work 12 is a vehicular field access and will drain into the field.
9	Permanent vehicular compound of 1862 square metres, road/rail vehicle access point and access road from the highway of Sheepway, shown on sheet 2 of the works plans, to the north of the bridge carrying the highway of Sheepway over Work No.1, a permanent diversion of the existing permissive cycle path and works to the existing public car park to the north-west of Sheepway, together with fencing, drainage, communications apparatus, ducts, troughs, utilities apparatus, hardstanding and means of access to the highway of Sheepway;	Permanent		
10	Temporary diversion of the existing permissive cycle path, of 156 metres in length shown on sheet 2 of the works plans, on the north west side of the highway of Sheepway, opposite Shipway Gate Farm, Portbury;	Temporary		
10A	Temporary construction compound of 2179 metres in area shown on sheet 2 of the works plans, to the north-west of the highway of Sheepway at Shipway Gate Farm, Portbury;	Temporary		
11	Improvements to the existing agricultural access from Shipway Gate Farm, Portbury to the highway of Sheepway, shown on sheet 2 of the works plans, south of the disused Portishead Branch Line railway, including hardstanding, gate and visibility splays;	Permanent		
11A	Temporary construction haul road, of 590 metres in length, shown on sheet 2 of the works plans, east from the highway of Sheepway, to the south of and parallel to the disused Portishead Branch Line railway to Work No. 12A together with temporary field accesses and hardstanding;	Temporary		
11B	Temporary construction haul road of 269 metres in length shown on sheet 2 of the works plans, to the south of the highway of Sheepway at Shipway Gate Farm, Portbury, together with temporary field accesses and hardstanding;	Temporary		
12	Permanent vehicular access to the A369 classified road known as Portbury Hundred, shown on sheet 3 of the works plans, including hardstanding, gate and visibility splays;	Permanent		
12A	Temporary construction compound of 113,467 square metres in area, shown on sheets 2, 2B and 3 of the works plans, to the north of the A369 classified road known as Portbury Hundred and to the south of the disused Portishead Branch Line railway;	Temporary		

Proposed DCO Scheme Works No.	Description	Permanent or Temporary	Consideration of FRA scope for Associated Development in Flood Zones 2 and 3	Where addressed in FRA
13	Improvement of the existing access and parking area, shown on sheet 4 of the works plans, at The Drove, Portbury, to the north of the A369 classified road known as Portbury Hundred, including hardstanding and gates;	Permanent	Works 13, 13A and 14B are partly within FZ1 and partly within the defended FZ3 coastal floodplain. Modelling undertaken to assess the impacts of the residual risk associated with a breach of coastal flood defences indicates that Works 13, 13A and 14B are outside of the simulated flood extent resulting from a breach of coastal flood defences during the 200 year return period coastal event in 2115 (the Project design life is 2075). For Works 13, 13A and 14B, the FRA therefore focuses on surface water management and drainage design.	Drainage design for Works 13, 13A and is covered in the FRA Appendix O (APP-089, APP-090 and APP 091). Work 14B is a realignment (by approximately 1m) of the existing gravel path under the bridge, with no additional area, and hence no additional drainage requirement.
13A	Temporary vehicle turning space of 575.6 square metres in area, shown on sheet 4 of the works plans, south of the disused Portishead Branch Line railway, Portbury;	Temporary		
14B	Realignment of the existing permissive cycling route of 144.36 metres in length, shown on sheet 4 of the works plans, under Royal Portbury Dock Road, Portbury;	Permanent		
20	Temporary diversion of part of National Cycle Network Route 41 of 83 metres in length shown on sheet 6 of the works plans, north from its existing alignment on the street north of the Parson Street to Royal Portbury Dock railway, west of Avon Road, Pill to connect with the western turning head of Avon Road, Pill;	Temporary	The temporary cycle diversion is short (83m) and on higher ground than the existing cycle path. The flooding consequences are therefore less then currently expereinced. It has therefore been agreed with the Environment Agency no further assessment is required.	No further assessment
23	Temporary construction compound of 151 square metres in area, as shown on sheet 6 of the works plans, beneath and to the north of Pill Viaduct, Underbanks, Pill;	Temporary	This temporary compound is existing hardstanding that will not be altered, and will only be used for car parking during times of no flooding. No further assessment is therefore undertaken.	No further assessment
26	Permanent vehicular access, ramp, flood mitigation works and railway maintenance compound, of 2,948 square metres in area shown on sheet 15 of the works plans, east of the highway of the A369 classified road known as Clanage Road, Ashton, north of the Bedminster Cricket Club;	Permanent	Flood risk management for the permanent and temporary Clanage Road compounds, and its impact on flooding elsewhere is covered in the FRA main report (APP-076) and its addendum.	FRA main report (APP-076) sections 4.2.9 to 4.2.24, 8.1.18, 9.1.7 to 9.1.12 and Table 4.10 River Avon flood modelling presented in FRA Appendix N (APP-081 to APP-088) and further updated in REP2-022. The operational flood plan and draft Clanage Road construction compound flood plan are included in Appendix T of the FRA (APP-092).
26A	Temporaryconstruction compound of 3346 square metres in area, shown on sheet 15 of the works plans, east of the highway of the A369 classified road known as Clanage Road, Ashton, north of the Bedminster Cricket Club,	Temporary		
26B	Permanent vehicular access to the highway of the A369 classified road known as Clanage Road, Ashton from the land to the north of the Bedminster Cricket Club, shown on sheet 15 of the works plans;	Permanent		
28	Improvement of the highway of Winterstoke Road at its junction with Ashton Vale Road, as shown on sheet 16 of the works plans, including extension of existing left turn lane in to Ashton Vale Road, retaining wall, works to divert and install utility apparatus and installation of a new traffic signal control system, Ashton;	Permanent	The highway improvement works at Winterstoke Road involve a widening of the highway to extend an existing left turn lane. This will involve replacing the existing raised pavement at that location with highway at a slightly lower elevation (by approximately 100mm) than the existing pavement level, and an associated shift in the pavement alignment at that location. The works will result in a slight net gain in Longmoor/Colliter's Brooks floodplain storage in Flood Zone 2. Drainage design details compliant with current guidance will be developed at the detailed design stage.	No further assessment