A1 in Northumberland: Morpeth to Ellingham

Scheme Number: TR010059

7.9.1.2 Flood Risk Assessment Addendum – River Coquet

Rule 8(1)(c)

Infrastructure Planning (Examination Procedure) Rules 2010

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Infrastructure Planning

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The Infrastructure Planning (Examination Procedure) Rules 2010

The A1 in Northumberland: Morpeth to Ellingham

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Flood Risk Assessment Addendum – River Coquet

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1 INTRODUCTION

1.1.1. The A1 in Northumberland: Morpeth to Ellingham, hereafter referred to as 'the Scheme', comprises two sections known as Part A: Morpeth to Felton (Part A) and Part B: Alnwick to Ellingham (Part B). The Scheme aims to increase capacity by widening the existing single carriageway to a dual carriageway along an approximately 12.6 km section of Part A (approximately 6.5 km of online widening and approximately 6.1 km of new offline highway) and along an approximately 8 km section of Part B.

1.1.2. An application for development consent for the Scheme was submitted by Highways England (Applicant) on 7 July 2020. The application was accepted for Examination on 4 August 2020. The Applicant submitted a change request to the Examining Authority (ExA) at Deadline 4 of the Examination (Change Request). On 9 April 2021, the ExA accepted the Change Request as part of the Application.

1.1.3. The Change Request incorporated three proposed changes:

a. The Earthworks Amendments;
b. The Stabilisation Works; and
c. The Southern Access Works.

1.1.4. Further details as to the nature of each of these changes is set out in the Environmental Statement Addendum: Stabilisation Works for Change Request [REP4-063] and Environmental Statement Addendum: Southern Access Works for Change Request [REP4-064] submitted at Deadline 4 of the Examination.

1.1.5. As stated at paragraph 9.4.3 of the Environmental Statement Addendum: Stabilisation Works for Change Request [REP4-063] and paragraph 8.4.3 of Environmental Statement Addendum: Southern Access Works for Change Request [REP4-064], the assessments submitted at Deadline 4 of the Examination in respect of the Stabilisation Works and the Southern Access Works were prepared on the basis of a Manning's calculation and, in order to verify those assessments, hydraulic modelling of the River Coquet was required. The methods applied in the development of that modelling are set out in the River Coquet Hydraulic Modelling Report [6.50].

1.1.6. The existing River Coquet Bridge is located approximately 1.5km to the southwest of Felton in Northumberland where the A1 is orientated north to south, with the River Coquet flowing from west to east through a series of meanders to the North Sea. The centre of the existing River Coquet Bridge is located at approximate Ordnance Survey Grid Reference (OSGR) 417436E 599810N.

2 PREVIOUS ASSESSMENTS

2.1.1. A Flood Risk Assessment (FRA) (refer to Appendix 10.1, Volume 7 of the ES) (Application Document Reference: TR010041/APP/6.7) was originally undertaken which did not include detailed hydraulic analysis of the River Coquet as agreed with the Environment Agency (EA). This was based on the understanding the piers associated with the new A1 crossing over the River Coquet would be aligned with the piers of the existing crossing and were therefore assumed to have limited effect on the flows within the River Coquet. Instead, a Manning's calculation was completed to provide the peak water level for an estimated the 0.1% Annual Exceedance Probability (AEP) event only.

2.1.2. When the original FRA was produced, the proposals comprised a new River Coquet bridge adjacent to the existing bridge structure. The proposed bridge would have included the construction of two new piers which would have been aligned with the existing River Coquet bridge piers (see Figure 1, Appendix A). The original proposed north bank pier would have been above the expected 0.1% AEP (1000-year) flood level with the south bank pier below the 0.1% AEP (1000-year) flood level.

2.1.3. At Deadline 1 an addendum to the FRA was submitted to assess the impacts associated with the movement of the proposed piers. This considered the movement of the northern and southern piers a total of 6m and 2m north, respectively, of the positions assessed in the FRA. Hydraulic modelling was not considered to be required and a Manning's equation approach was applied to determine a flood level. The Manning's approach established a baseline (existing) 0.1% AEP (1000-year) flood level at the location of the proposed A1 crossing of 36.7m AOD. Accounting for the introduction of the bridge piers this water level was determined to rise by 0.25m to 36.95m AOD. The report acknowledged this was a small increase on previously assessed flood levels but would not result in a material change in flood risk to the nearest upstream receptors (Shothaugh Farm High Cottage and Otter House) which lie at an elevation of 44.4m AOD.

2.1.4. At Deadline 4, a change request was submitted for the 3 proposed changes described in paragraph 1.1.3. In considering the approach to flood risk in relation to those proposed changes, the summary of proposed changes to application [Appendix B of REP4-063 and REP4-064], paragraph 2.2.23 stated that:

"As there are minimal changes to the Scheme design next to the watercourse, based on professional judgement, there would be no changes to the assessment of flood risk effects. The nearest flood risk receptors are Shothaugh Farm High Cottage and Otter House located approximately 800 m upstream of the River Coquet bridge. The rip rap is not considered to increase the local flood risk to these receptors. Therefore, the flood risk assessment detailed in Appendix 10.1: Flood Risk Assessment Part A [APP-254] and Chapter 10: Road Drainage and the Water Environment Part A [APP-050] would remain the same. The measures set out in the Outline CEMP [APP-346] would also be applicable for the construction access, in particular the measures to reduce risk to construction workers during flood events".

2.1.5. This document has been prepared to update the assessment of flood risk associated with the design development of the A1 crossing over the River Coquet, taking into account the results of hydraulic modelling in order to confirm the robustness of the assessment presented in the Flood Risk Addendum [REP1-067] submitted at Deadline 1 and as applied to the change request in the Environmental Statement Addenda [REP4-063 and REP4-063].

3 PROPOSED RIVER COQUET BRIDGE DESIGN

3.1 PIER ALIGNMENT

3.1.1. Due to the significant geotechnical risks associated with the slopes of the River Coquet valley at the location of the proposed crossing, the design of the proposed River Coquet bridge has been revised to mitigate the risks associated with the instability in the area. The revised design is based on Parameter 10 which is included in Deadline 1 Flood Risk addenda [REP1-067]. This allows the northern pier to move by up to 6m to the north and the southern pier by up to 2m to the north. This means that the piers for the proposed River Coquet bridge will no longer be in alignment with the existing bridge piers.

3.2 SCOUR PROTECTION SYSTEM AND TEMPORARY WORKS ACCESS

3.2.1. A further effect of the most recent geotechnical investigations, in tandem with the revised design, necessitates that scour protection is provided on the north and south banks of the River Coquet to protect the new piers over their design life. Finally, the consequence of these works is the requirement for more extensive temporary works within the River Coquet gorge to facilitate the safe movement of plant and materials required for the construction of the bridge foundations. A more detailed description of the proposed works on the north and south banks can be found in Chapter 2 of Environmental Statement Addendum: Stabilisation Works for Change Request [REP4-063] and Chapter 2 of Environmental Statement Addendum: Southern Access Works for Change Request [REP4-064].

4 HYDRAULIC MODELLING APPROACH

4.1.1. Two-dimensional (2D) hydraulic modelling has been undertaken to assess the impacts of the proposed re-aligned bridge piers, scour protection and temporary works using TuFlow. The model extent is 3km, extending approximately 1.5km upstream and downstream of the River Coquet bridge and provides an assessment of flood levels (m AOD), depth (m) and extent. The model also provides data on bed shear stress and velocity (m/s) for consideration in other assessments.

4.1.2. Three model scenarios have been completed to assess flood risk. These include the existing conditions (baseline scenario), and to replicate the conditions expected during construction (temporary works) and operation. A breakdown of what each modelling scenario includes is provided in Table 4-1. Further detail on the hydraulic modelling including full descriptions of the works included in each scenario is provided in sections 3 and 4 of the River Coquet Hydraulic Modelling Report [6.50].

Table 4-1 - Features Modelled for each Scenario

Baseline	Construction	Operation
– Exiting River Coquet bridge – River training wall on southern pier of existing River Coquet bridge – Weir – Felton Bridges	– Baseline plus – Working platforms • North bank (38 m AOD) • South bank (38 m AOD) – Training walls supporting the working platform formation (x2) • North bank • South bank – Temporary construction access bridge	– Baseline plus • Proposed River Coquet bridge • Rock armour on north bank • Rock armour and new pier foundation on south bank

4.1.3. For each scenario, a range of flood events have been assessed including the 0.1% AEP (1000-year) event as was assessed in the Deadline 1 ES addenda and subsequently considered in the Deadline 4 summary of proposed changes to application.

4.1.4. Although no hydraulic modelling was undertaken for the River Coquet in the original FRA (Appendix 10.1 of the ES) (Application Document Reference: TR010041/APP/6.7), the flood events used in the hydraulic modelling of other rivers have been applied for the purposes of this study for consistency in reporting.

4.1.5. Annual Exceedance Probability refers to the chance that a flood of a particular size is experienced or exceeded during any year and is presented as a percentage value. For example, a 50% AEP equates to a 1 in 2 two chance of that flood occurring in a given year or the flood that is statistically expected to occur once every 2 years. The following AEP events have been simulated for the Baseline, Construction and Operational models:

a. 50% AEP (2-year)
b. 10% AEP (10-year)
c. 1% AEP (100-year)
d. 0.1% AEP (1000-year)
e. 1% AEP (100-year) + 65% CC

4.1.6. The original FRA applied a 25% increase in peak flows to the 1% AEP (100-year) event to account for climate change, following agreement from the Environment Agency. Instead, for this assessment, a CC allowance uplift of 65% has been applied to the peak river flow. This revised uplift reflects the extreme climate change scenario (H++) for the Northumbria River Basin District for the 2080's (2070 to 2115)[1]. This has been taken to represent the 'higher' climate change allowance referred to in the Design Manual for Roads and Bridges document CD356 Design of Highway Structures for Hydraulic Action[2] which is being applied for the design of the A1 crossing. This allowance also reflects a more conservative assessment on which to undertake the design in light of emerging climate science.

4.1.7. Modelled flood levels (m AOD) for each scenario have been assessed at four receptor locations. Details of each receptor are provided in Table 4-2.

4.1.8. Receptors A and B are consistent with those considered in the Deadline 1 ES addenda [REP1-067]. Receptors C and D are included to facilitate assessment of impact on the nearest receptors vulnerable to flooding in the reach of the River Coquet downstream of the A1 crossing. Assessment of impacts through this reach have not previously been possible but is now feasible due to the extended geographical coverage of the hydraulic model compared to the topographical data available for Manning's assessments. The locations of these receptors are highlighted in Figures 2, 3, 4, 5, 6, and 7.

Table 4-2 - Receptor Details for Assessment of Flood Risk

Receptor ID	Receptor name	Approximate receptor ground level (mAOD)*
A	Otter House / Farm at Shothaugh	44.4
B	The A1 crossing	(56.5)
C	Properties adjacent to the river on the north bank downstream of the weir	29.20

[1] Environment Agency (2020) Flood Risk Assessments: Climate Change Allowances. Available at https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances (Accessed May 2021)
[2] *Highways England, Transport Scotland, Welsh Government and The Department for Infrastructure Northern Ireland (2020).* DMRB CD 356: Design of highway structures for hydraulic action *(formerly BA 59/94), Revision 1. Available at: https://www.standardsforhighways.co.uk/dmrb/search/559b43dc-82db-46c9-be1a-f2b718e8db62 (Accessed May 2021*

D	Bridge(s) in Felton	(33)

* Ground levels provided in brackets represent approximate ground levels due to local elevation variations or multiple structural elements.

4.1.9. The categorisation of the adverse or beneficial impacts identified by the hydraulic modelling is shown in Table 4-3, which follows the impact magnitude categories provided in the Design Manual for Roads and Bridges[3].

Table 4-3 - Categorisation of Difference in Flood Levels

Potential flood impact		Criteria	Change in Peak Flood Level
	Major Adverse	Results in loss of attribute and/ or quality and integrity of the attribute	Increase in peak flood level >100mm
	Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute	Increase in peak flood level >50mm
	Minor Adverse	Results in some measurable change in attributes quality or vulnerability	Increase in peak flood level >10mm
	Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	Negligible change in peak flood level <+/- 10mm
	Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	Reduction in peak flood level >10 mm
	Moderate Beneficial	Results in moderate improvement of attribute quality	Reduction in peak flood level >50mm

[3] Highways England, Transport Scotland, Welsh Government and The Department for Infrastructure Northern Ireland (2020). *DMRB LA 113: Road Drainage and the Water Environment* (formerly HD 45/09), Revision 1. Available at: https://www.standardsforhighways.co.uk/dmrb/search?q=la%20113&pageNumber=1 (Accessed May 2021).

	Major Beneficial	Results in major improvement of attribute quality	Reduction in peak flood level >100mm

5 HYDRAULIC MODELLING RESULTS

5.1.1. Modelled flood extents and depths for the baseline, construction and operational scenarios are provided in Figure 2 through to Figure 5 in Appendix A. To assess the difference in depths between scenarios, a series of difference grids have been created to highlight the difference in modelled flood depths between the baseline and construction scenarios (Figure 6, Appendix A), and, between the baseline and operational scenarios (Figure 7, Appendix A).

5.1.2. Maximum modelled flood levels (m AOD) have been calculated at or in the vicinity of each receptor for the three scenarios (baseline (B), construction (C), proposed (operation) (O) and are presented in Table 5-2, with the water level difference compared to the baseline for each AEP event provided in brackets.

5.2 COMPARISON TO MANNING'S ASSESSMENT (DEADLINE 1 ES ADDENDA)

5.2.1. As mentioned in section 2, the FRA prepared in support of the ES [APP-254], used a Manning's calculation (paragraphs 5.3.3 & 5.3.4) to derive the estimated flood level for a flow assumed to be equivalent to 0.1% AEP event at the A1 Crossing (receptor B). This was repeated for the ES addenda submitted at Deadline 1 [REP1-067] in paragraphs 2.1.4 and 2.1.5. The cross-section used in the Manning's calculation was based on topographic data in the vicinity of the A1 Crossing. This provided an estimated flood level of 36.7 m AOD for the 0.1% AEP event. The Deadline 1 ES addenda presents a peak flood level of 36.95m AOD which accounted for the placement of the south bank pier. This equates to a water level increase of 0.25m which was considered to affect a limited extent upstream of the A1 Crossing.

5.2.2. To account for this localised increase on water levels upstream of the A1 Crossing, the original FRA and Deadline 1 ES addenda considered the impact a 0.25m increase on water levels would have on flood risk to Otter House / Shothaugh Farm (receptor A). It was determined that these properties would not to be at risk during the 0.1% AEP (1000-year) event with the additional 0.25m flood level increase due to a ground level of approximately 44.4m AOD, i.e. lying 7.45m above the operational phase 0.1% AEP flood level.

5.2.3. The baseline flood level derived from the hydraulic model (Table 5-2) for the 0.1% AEP event at the A1 Crossing (receptor B) is 37.303m AOD. By comparison, the modelled level for the same event for the operational scenario, which incorporates the revised pier alignment, is 37.336 m AOD (see Table 5-1 and Table 5-2) which is a +0.033m increase in water level. The increased baseline and operational levels (compared to the Deadline 1 ES addenda) are in part a consequence of a greater flow applied in the hydraulic model for the 0.1% AEP event (613.1m³/s) compared to that applied in the Manning's assessment (524m³/s). Further information on the derivation of the flows applied in the hydraulic model are available in Section 5 and Appendix A of the River Coquet Hydraulic Modelling Report [6.50].

5.2.4. Whilst the modelled baseline and operational scenario levels have increased compared to those determined for the ES addenda, the relative impact of the piers is less. The Manning's derived impact of the piers resulted in an estimated increase in flood level at the A1 crossing of 0.25m, compared to the 0.033m established with the hydraulic model, demonstrating the conservative assessment of impact provided by the manning's approach.

5.2.5. The modelled result at Otter House / Shothaugh Farm (receptor A) for both the baseline and operational scenarios is 41.012m AOD (see Table 5-2). This confirms flood risk to this receptor is unchanged (in real terms) as a consequence of the construction of the new A1 crossing, remaining dry during the 0.1% AEP event.

5.2.6. Table 5-1 provides a summary of these results confirming that whilst the levels derived using the Manning's approach were not accurate, the impact assessed using the Manning's calculation was greater than that derived through hydraulic modelling. Consequently, the hydraulic modelling supports the conclusion made paragraph 2.1.7 of the Deadline 1 ES addenda that the receptors of Otter House Farm / Shothaugh Farm remain above the 0.1% AEP flood level during the operational phase of the development.

Table 5-1 - Deadline 1 ES Addenda and Hydraulic Model Results Comparison

Scenario	Flood Levels (m AOD)			
	Deadline 1 Manning's Assessment (assessed 0.1% AEP (1000-year) flow of 524m³/s)		Hydraulic model results (assessed 0.1%AEP (1000-year) flow of 613.1m³/s)	
	A1 Crossing	Otter House / Shothaugh Farm*	A1 Crossing	Otter House / Shothaugh Farm
Baseline	36.7	36.7	37.303	41.012
Operational Phase	36.95	36.95	37.336	41.012
Change (m)	+0.25	+0.25	+0.033	0

* The flood levels at Otterhouse / Shothaugh Farm were assumed to be the same as those calculated for the A1 crossing

5.3 REVIEW OF HYDRAULIC MODEL RESULTS AGAINST SUMMARY OF PROPOSED CHANGES TO APPLICATION

OPERATIONAL PHASE

5.3.1. The Deadline 4 statement relating to flood risk, [paragraph 2.2.23 of Appendix B of REP4-063 and REP4-064] considered the information available at the time and in light of the hydraulic model results correctly concluded that the operational phase of the A1 crossing would result in no changes to the assessment of flood risk effects documented in the Deadline 1 ES addenda. This is evidenced by the results of the hydraulic model which

demonstrate no change in flood levels at receptors A, C and D for the operational phase (Table 5-2).

5.3.2. At receptor B a reduced impact on flood level (+0.033m) is modelled resulting in a minor adverse impact compared to that assessed in the Deadline 1 ES addenda (+0.25m) (as described in Section 5.1 above) which equates to a major adverse impact.

5.3.3. Consequently, the effect considered Deadline 4 [paragraph 2.2.23 of Appendix B of REP4-063 and REP4-064] at receptor B and receptor A for the operational phase of the development is robust in light of the hydraulic model results.

CONSTRUCTION PHASE

5.3.4. With the original proposed A1 crossing, it was assumed that there would be almost no need for in-channel temporary works which could have influenced flood risk in the area. At Deadline 4 there was no additional assessment of the construction phase on flood levels as it had already been previously found in the Flood Risk Addendum [REP1-067] submitted at Deadline 1 that Receptor B would be subject to flooding in the 0.1%AEP (1,000-year) event CEMP measures to evacuate the site were proposed to mitigate flood risk. These measures would mean that construction personnel would be evacuated in the event of a flood event and would be equally applicable to lower magnitude flood events that could pose a risk to site operations.

5.3.5. The temporary works associated with the revised proposed A1 crossing have now been incorporated into the construction phase hydraulic model (Table 4-1), providing the first opportunity to assess the impact of these works.

5.3.6. Table 5-2 identifies that the modelled levels for receptors C and D for the construction (and operation) scenario accounting for the temporary works results in no change in modelled flood levels.

5.3.7. At receptor C all flood levels exceed the ground level at this location which is approximately 29.2m AOD. Therefore, whilst not previously considered, this site is currently at risk of flooding and the construction (or operational) phase of the development does not change this.

5.3.8. Likewise, no change in water levels are observed for receptor D and flood levels are below the approximate ground level of 35m AOD for both scenarios and all modelled events.

5.3.9. The impact of the temporary works on flood levels is most pronounced at receptor B as this is located within the temporary works area. Here a maximum increase in flood level of 0.966m (major adverse impact) for the 0.1% AEP event is calculated. This increase in level is attributed to a 40% reduction in the channel cross-sectional area associated with the temporary works.

5.3.10. The reduction in channel cross sectional area associated with the temporary works also results in a backwater effect which extends upriver towards receptor A and farmland to its north. However, despite an increase of 0.144m (major adverse impact) in the 0.1% AEP event modelled flood levels at receptor A, they remain below the ground level for this receptor of 44.4m AOD. The effect of the increase in flood levels during construction is seen

as increased flood depth to farmland north of receptor A which is already subject to flooding during the 0.1% AEP baseline event.

5.3.11. When considering the range of events modelled at receptor A relevant during construction, a negligible impact is observed in the 50% AEP event, a minor adverse impact in the 10% AEP a moderate adverse during the 1% and the afore mentioned major adverse impact associated with the 0.1% AEP event. These correspond to a change in flood levels of 0.003m, 0.017m, 0.074m and 0.144m respectively. The 1% AEP plus allowance for climate change is not relevant to the assessment of impact during construction. These results are shown graphically in Figure 7 (a-e), Appendix A.

5.3.12. For receptor B moderate adverse impacts are modelled for all events during the construction phase. However, these are considered immaterial to the receptor (construction staff) as staff and equipment will have already been evacuated from the working area on receipt of a flood warning in accordance with the exiting measures outlined in the Outline CEMP [APP-346] and therefore before peak water levels are achieved. Consequently, the measures relating to the construction phase outlined in CEMP [APP-346] which were considered to be applicable at Deadline 4 remain applicable in light of the hydraulic model results.

5.3.13. Values provided in brackets show the +/- change in modelled flood level compared to the baseline for each modelled AEP. NC indicates no change. Colour coded in accordance with Table 4-3.

Table 5.2 - Mean Modelled Flood Levels (m AOD) at Receptor Locations for the Baseline Scenario (B), Construction Scenario (C) and Operational Scenario (O)

Receptor (approx. ground level mAOD)	Modelled Annual Event Probability (AEP)														
	50%AEP (2-year)			10%AEP (10-year)			1%AEP (100-year)			0.1%AEP (1000-year)			1%AEP (100-year) +65%CC		
	B	C	O	B	C	O	B	C	O	B	C	O	B	C	O
A (44.5)	37.283	37.286 (+0.003)	37.283 (NC)	38.168	38.185 (+0.017)	38.168 (NC)	39.491	39.565 (+0.074)	39.491 (NC)	41.012	41.156 (+0.144)	41.012 (NC)	41.195	Not relevant to assessment	41.195 (NC)
B (56.5)	33.887	34.283 (+0.396)	33.899 (+0.012)	34.766	35.290 (+0.524)	34.779 (+0.013)	35.922	36.746 (+0.824)	35.951 (+0.029)	37.303	38.434 (+0.966)	37.336 (+0.033)	37.468	Not relevant to assessment	37.501 (+0.033)
C (29.2)	30.496	30.496 (NC)	30.496 (NC)	31.377	31.377 (NC)	31.377 (NC)	32.518	32.518 (NC)	32.518 (NC)	33.917	33.917 (NC)	33.917 (NC)	34.076	Not relevant to assessment	34.076 (NC)
D (33)	29.547	29.547 (NC)	29.547 (NC)	30.154	30.154 (NC)	30.154 (NC)	30.961	30.961 (NC)	30.961 (NC)	31.896	31.896 (NC)	31.896 (NC)	31.988	Not relevant to assessment	31.988 (NC)

6 CONSIDERATION OF ADDITIONAL MITIGATION MEASURES

6.1.1. Prior to considering mitigation measures it is important to realise that the increase in flood levels during construction in the vicinity of receptor A and B results in no change in flood risk to either receptor. Despite the increase in flood levels receptor A remains dry for all events considered, whilst the increase in flood depth at receptor B is immaterial during construction as construction staff and equipment will have already been evacuated from the working area.

6.1.2. It is also worthwhile to reflect on the likelihood of a flood occurring during the construction phase. When assessing the likelihood of flooding, the risk is predominantly present during the construction phase. As the construction phase is of relatively short duration (<2 years), the following equation (from the Institute of Hydrology, 1978) has been used to define the likelihood of occurrence of a specific storm event.

$$R = 1 – (1-1/T)^L$$

Where:

R is the risk of occurrence

L is the duration of the phase of the project; and,

T is the return period in years

6.1.3. Table 6-1 shows the probability of the modelled events occurring within the anticipated construction period.

Table 6-1 - Probability of Occurrence

Design Event (Annual Probability)	Construction (Two Years) Probability
50% AEP (2-year)	75%
10% AEP (10-year)	19%
1% AEP (100-year)	2%
0.1% AEP (1000-year)	0.2%

6.1.4. Measures to mitigate for the impact on flood levels during construction would require either changes to the temporary works to reduce/ remove the reduction in channel cross sectional area and / or provision of compensatory flood storage within the River Coquet gorge or areas adjacent to the floodplain (i.e. farmland to the north west of Otter House / Shothaugh Farm.

6.1.5. Efforts to reduce the impact of the temporary works have already been expended resulting in an increase in the span of the bridge from 38m to 50m, thereby reducing

encroachment into the channel and reduction in cross sectional area. Any further reduction is considered impractical in terms of providing the required access for construction equipment and maintaining safety of construction workers.

6.1.6. The provision of compensatory storage within the gorge or within farmland would result in impacts to the SSSI or flooding of land which does not currently flood.

6.1.7. In summary, there is a 75% chance of the 50% AEP (2-year) event occurring during the construction window which would result in a negligible impact on flood levels in the vicinity of receptor A and is therefore considered to not warrant additional mitigation measures. For the 10% AEP (10-year) event there is a 19% chance of the event occurring which would result in a minor adverse impact (greater than10mm increase, less than 50mm) on flood levels in the vicinity of receptor A with no change in flood risk and is again considered to not warrant additional mitigation measures.

6.1.8. The probability of the 1% AEP (100-year) event occurring during the construction window is 2%. The scale and impact associated with mitigation measures to address the moderate effect arising from this event during construction is considered to be disproportionate to the probability of the event occurring. Finally there is a 0.2% probability of the 0.1% AEP (1000-year) event occurring within the construction phase of the new A1 crossing over the River Coquet. This is again considered to be a sufficiently rare likelihood of occurrence that the impact that would be incurred by the provision of mitigation measures is not warranted.

7 CONCLUSION

7.1.1. The hydraulic model provides a tool in which there is considerably greater confidence in the flows modelled for each return period event and the flood levels (and other hydraulic parameters) derived. The hydraulic model is able to account for the transfer and movement of water through the modelled reach providing a more accurate estimate of the total flow presented to any one point in the model at a given time. It is also able to better account for any backwater effects from structures within the modelled reach. These advantages of the hydraulic modelling approach are not possible using the manning's assessment method.

7.1.2. In light of the modelled results the statement made at Deadline 4 with regards to the impact of the development in its operational phase remains valid /robust. The model results demonstrate that with the exception of a localised decrease in flood levels (compared to that previously assessed) in the vicinity of the new crossing, there is no change in flood risk to local receptors as a consequence of the new pier positions and rock armour scour protection system.

7.1.3. With regards to the construction phase, the hydraulic model has identified a hitherto unidentified impact on flood levels upstream of the new crossing. Whilst this impact results in a maximum increase in flood level of 0.144m in the vicinity of receptor A (Otter House / Shothaugh Farm) during the 0.1% AEP (1000-year) event, this is insufficient to change the flood risk to this receptor in real terms which remains 3.244m above the 0.1% AEP (1000-year) flood level during construction. The impact of this increase in flood level is seen on farmland which is already subjected to extensive flooding during the 0.1% AEP (1000-year) event. Furthermore, the likelihood of this event occurring during the less than 2 year construction window is 0.02%. Measures to mitigate for this impact would require the provision of compensatory storage to be provided in areas near to the farmland but outside of the existing flooded area. Given the very low likelihood of the impact being realised during the construction period, the lack of effect to vulnerable receptors and wider environmental effects from providing compensatory storage it is considered that further mitigation measures are not required.

7.1.4. Considering the increase in flood levels at receptor B (the proposed A1 crossing), these are also only of any significance during construction but will be mitigated through the exiting measures outlined in the Outline CEMP [APP-346].

Appendix A

FIGURES

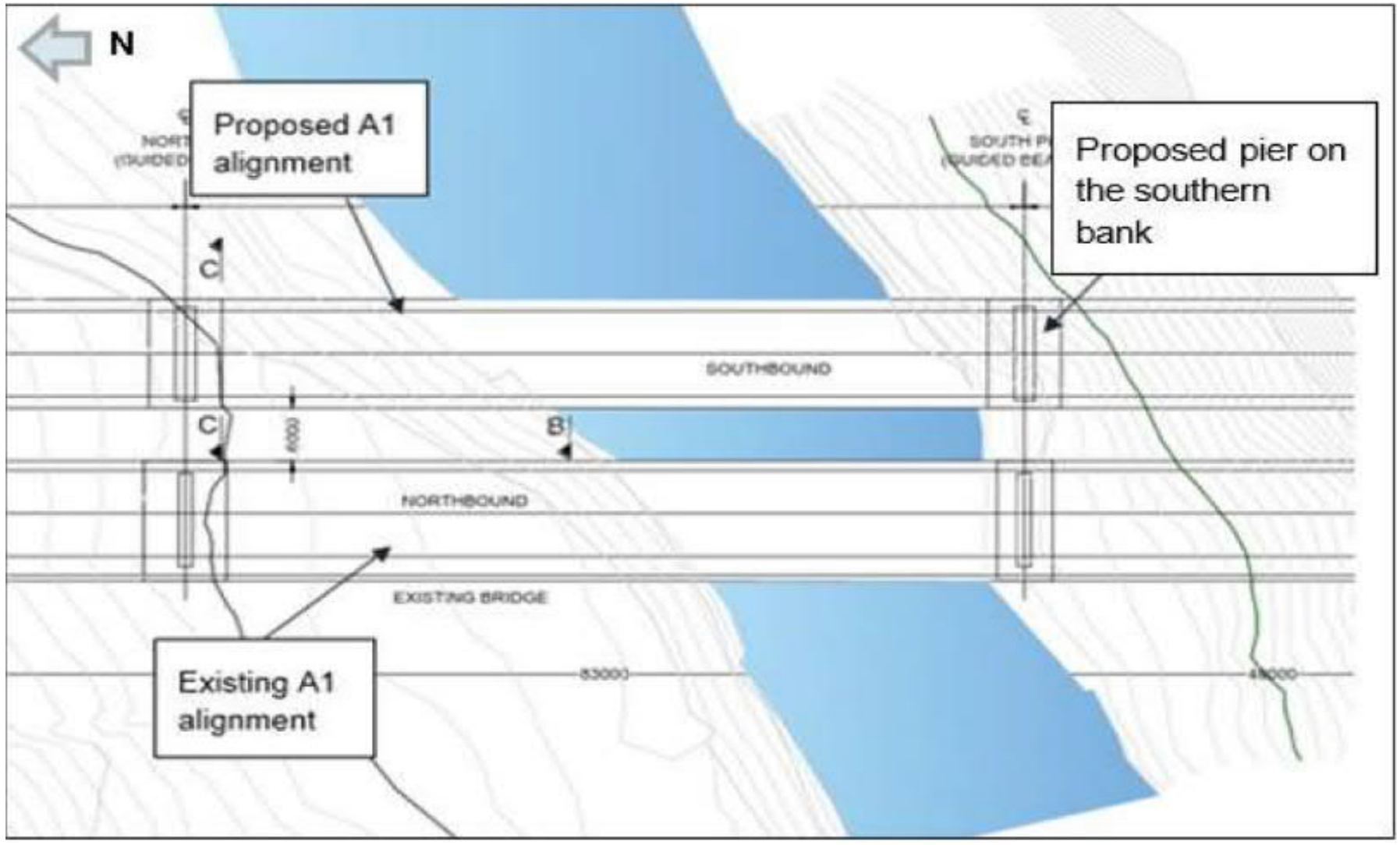

Figure 1 - Original Proposals for the River Coquet Crossing

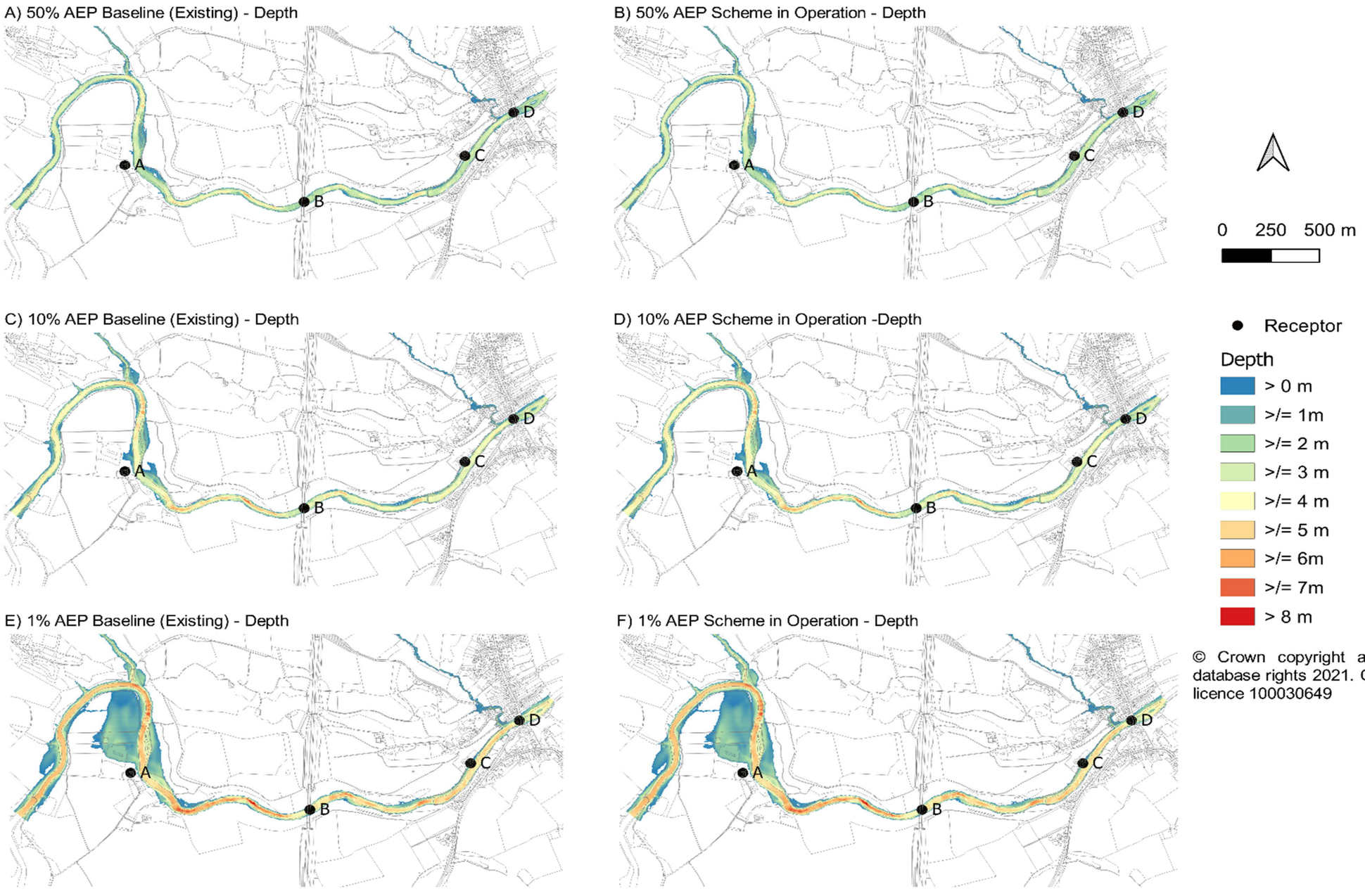

Figure 2 - Peak Flood Depth for the Baseline and Operational Scenario for the 50%AEP, 10% AEP and 1%AEP Events

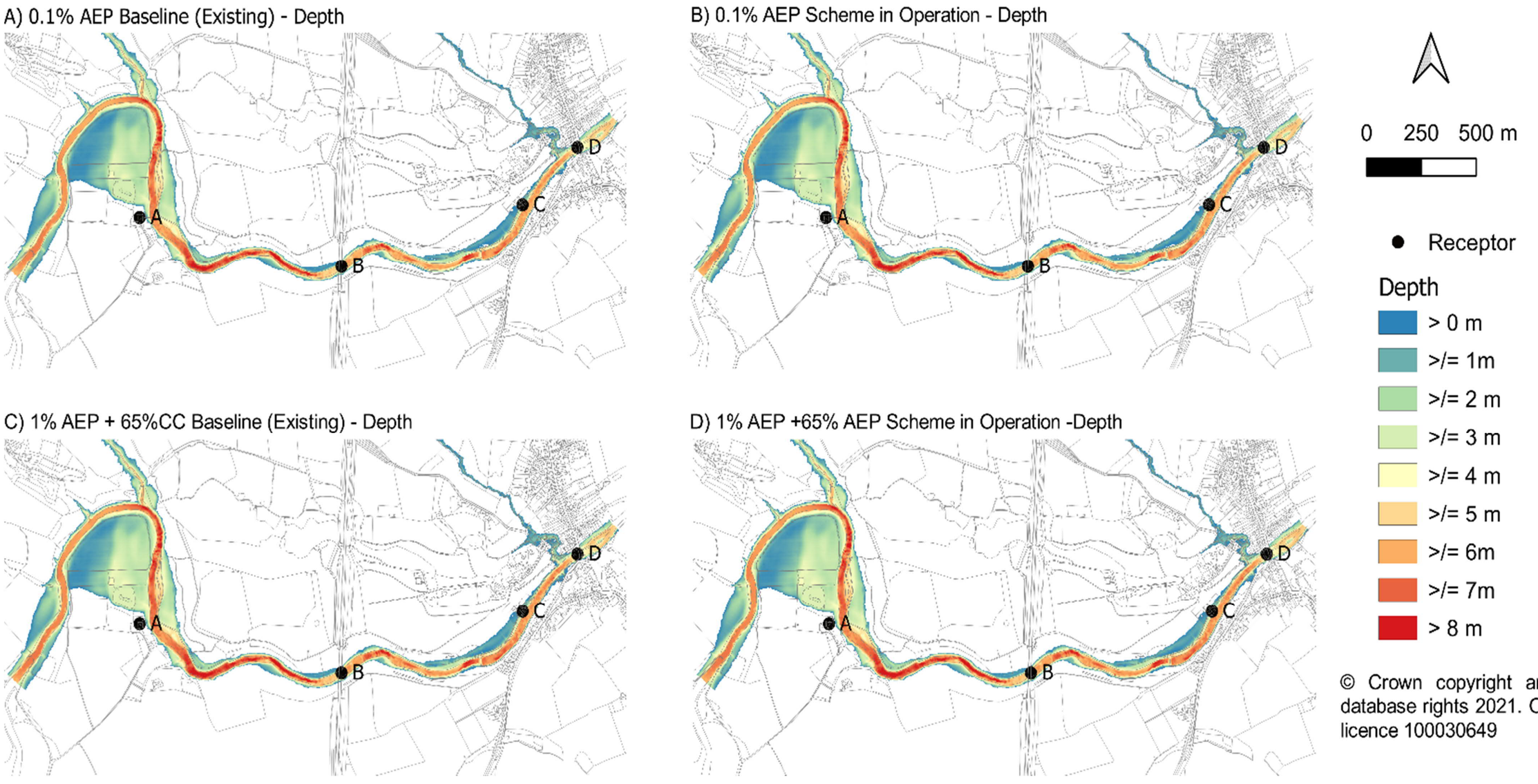

Figure 3 - Peak Flood Depth for the Baseline and Operational Scenario for the 0.1%AEP and 1%AEP plus 65%CC Events

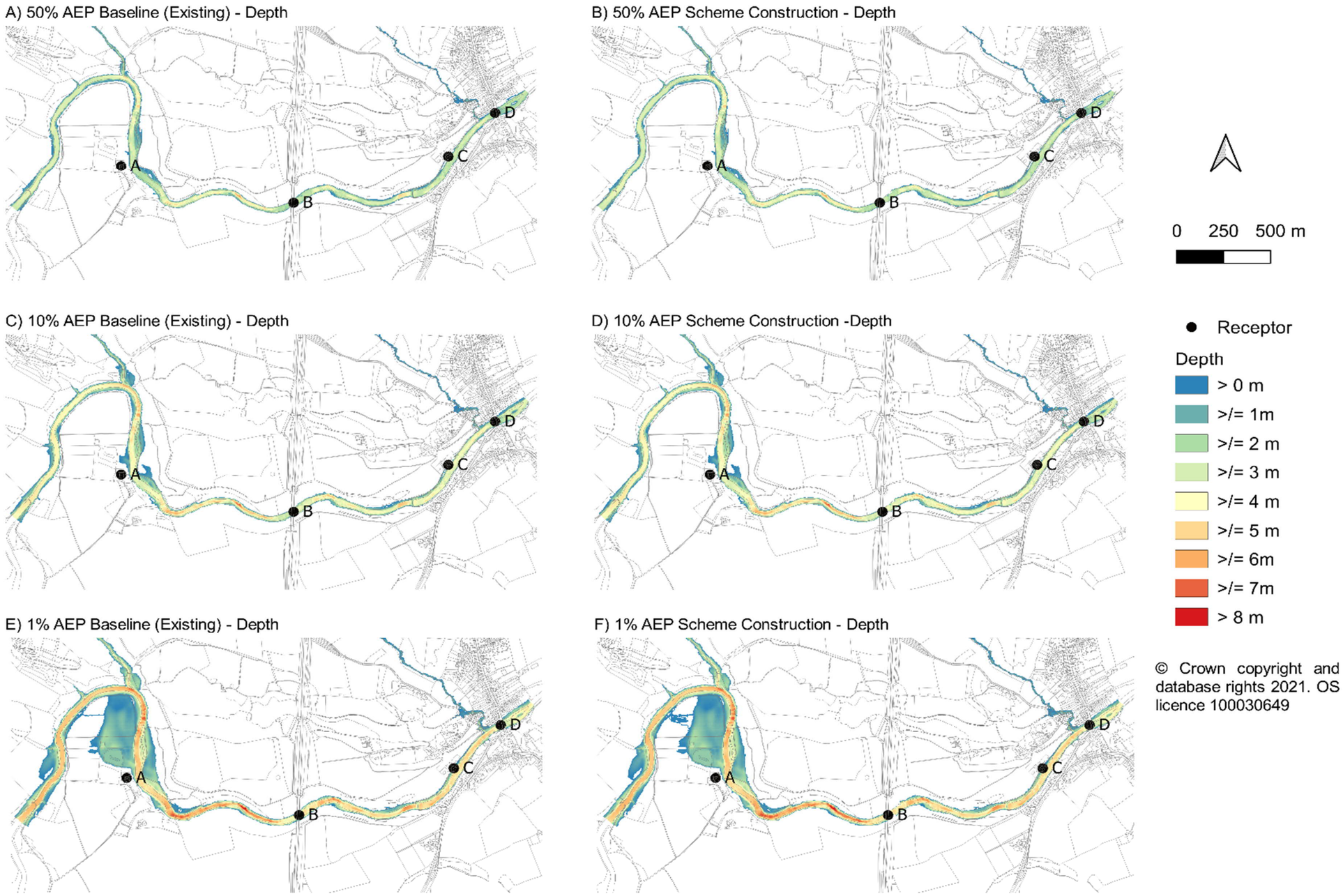

Figure 4 - Peak Flood Depth for the Baseline and Construction Scenario for the 50%AEP, 10% AEP and 1%AEP Events

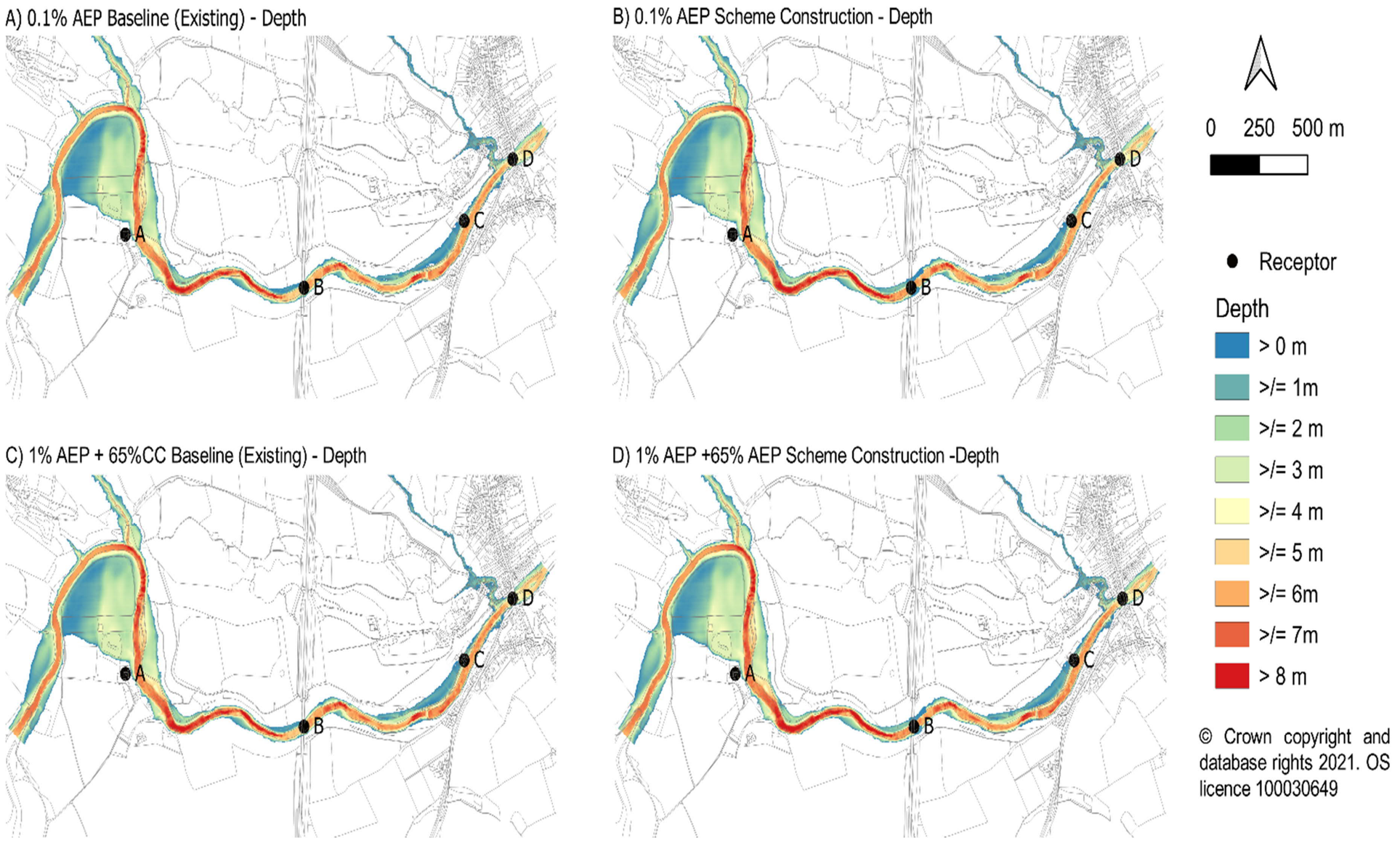

Figure 5 - Peak Flood Depth for the Baseline and Construction Scenario for the 0.1%AEP and 1%AEP plus 65%CC Events

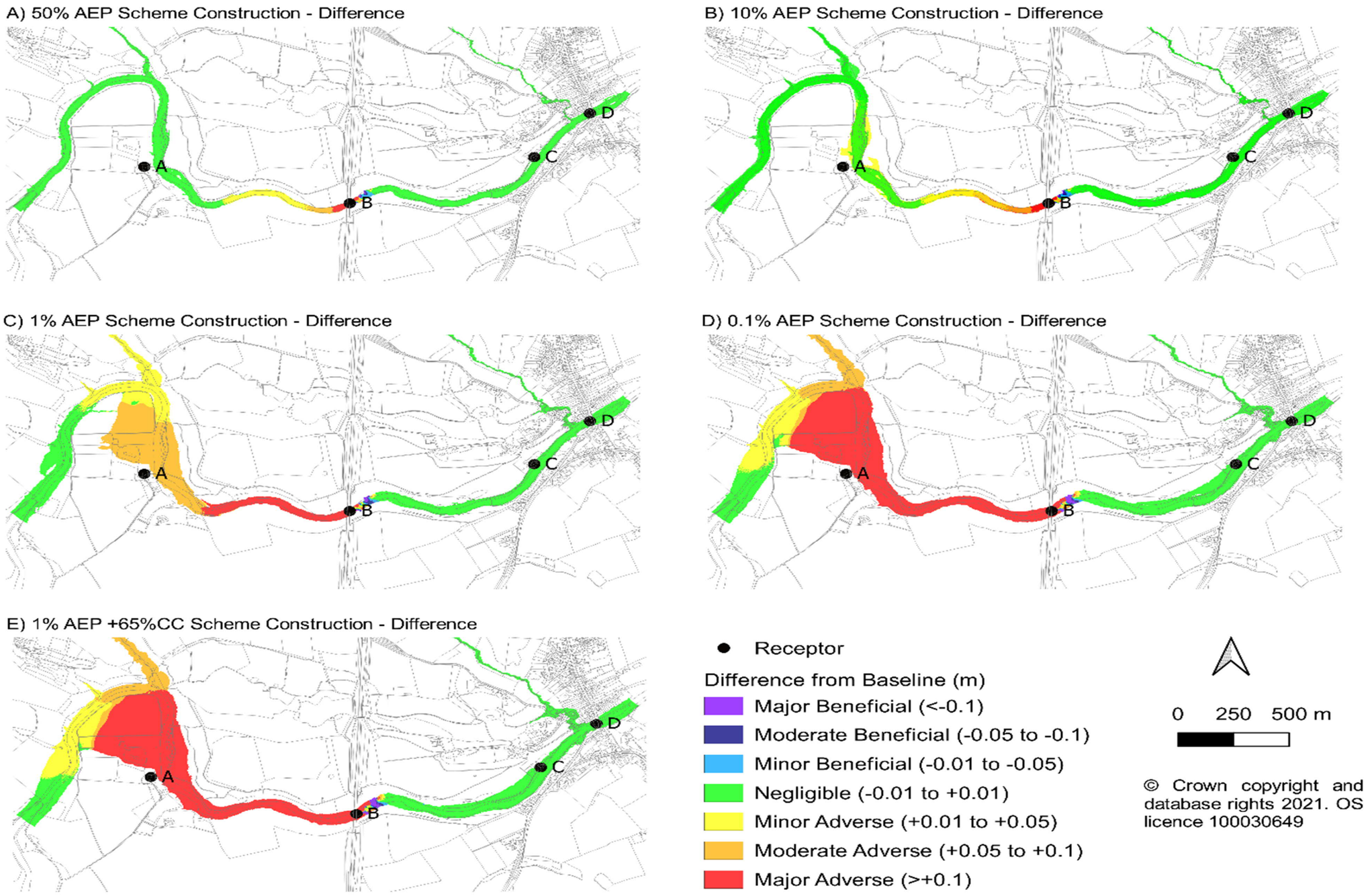

Figure 6 - Depth Difference Grids for the Baseline and Construction Scenario for the 50%AEP, 10%AEP, 1%AEP, 0.1%AEP and 1%AEP plus 65%CC Event

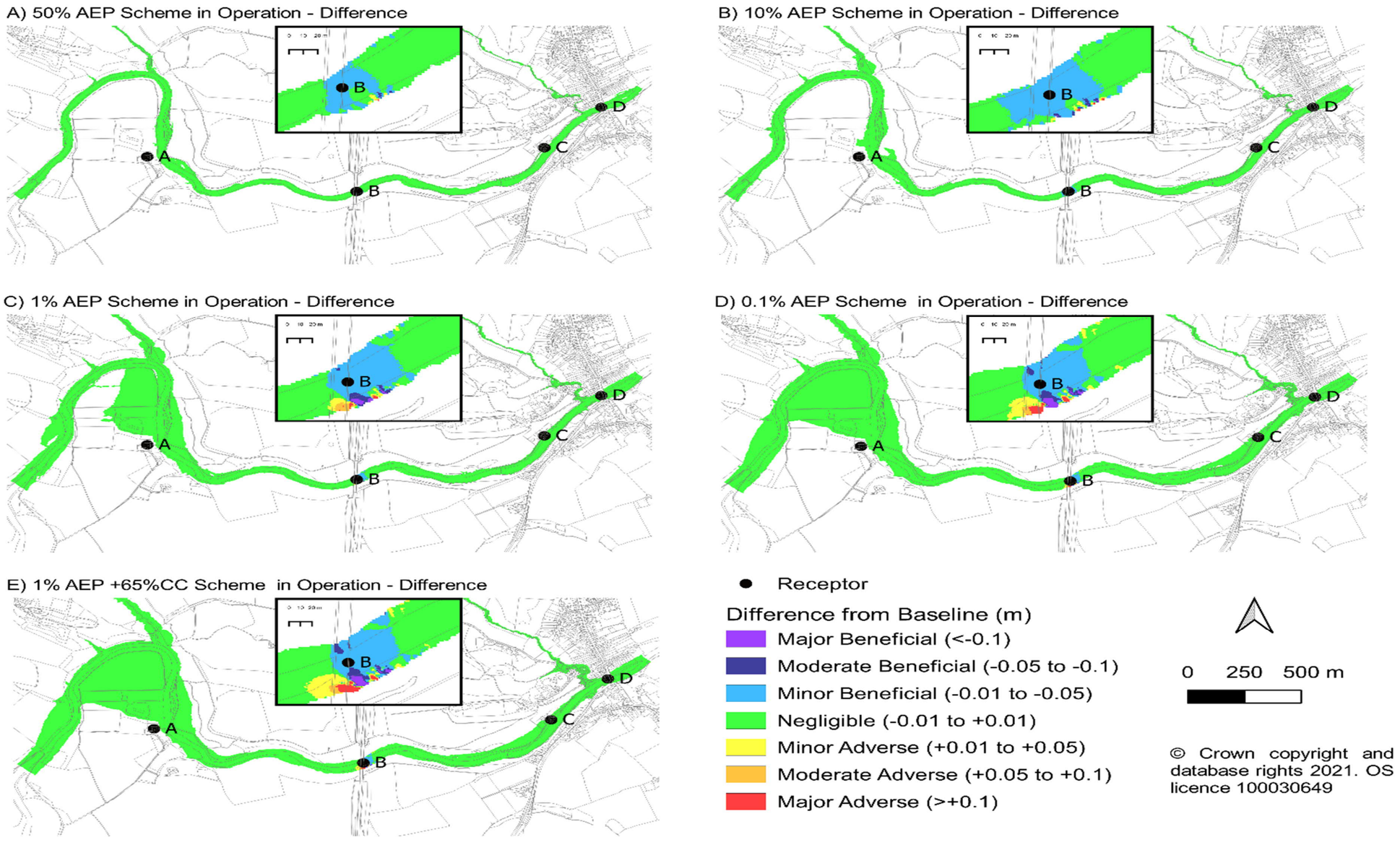

Figure 7 - Depth Difference Grids for the Baseline and Operational Scenario for the 50%AEP, 10%AEP, 1%AEP, 0.1%AEP and 1%AEP plus 65%CC Events

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If you have any enquiries about this document
A1inNorthumberland@highwaysengland.co.uk
or call **0300 470 4580***.