



# High Speed Rail (West Midlands - Crewe)

Supplementary Environmental Statement and  
Additional Provision Environmental Statement

## Volume 5: Technical appendices

Flood risk assessment (WR-003-000)



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## Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

High Speed Two (HS2) Limited,  
Two Snowhill  
Snow Hill Queensway  
Birmingham B4 6GA

Telephone: 08081 434 434

General email enquiries: [HS2enquiries@hs2.org.uk](mailto:HS2enquiries@hs2.org.uk)

Website: [www.gov.uk/hs2](http://www.gov.uk/hs2)

A report prepared for High Speed Two (HS2) Limited:

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# 1 Introduction

## 1.1 Structure of the flood risk assessment appendix

- 1.1.1 This document is an appendix which forms part of Volume 5 of the Supplementary Environmental Statement (SES) and Additional Provision Environmental Statement (AP ES).
- 1.1.2 This appendix provides an update to the flood risk assessment (FRA) presented in the High Speed Rail (West Midlands - Crewe) Bill Environmental Statement (ES)<sup>1</sup> published in July 2017 (the main ES). This appendix concerns flood risk issues on Filly Brook in the Stone and Swynnerton community area (CA3). This update should be read in conjunction with Volume 5: Appendix WR-001-003 of the main ES.
- 1.1.3 Separate reports, describing the hydraulic modelling work described in this assessment, can be found in Background Information and Data (BID) reports BID-WR-004-000<sup>2</sup> which accompanies the SES and AP ES and BID-WR-004-007<sup>3</sup> which accompanies the main ES.
- 1.1.4 Maps referred to in this appendix are contained in the Volume 5: Water resources and flood risk Map Book of the main ES and also in the SES and AP ES Volume 5: Maps WR-05-110, WR-06-110 and WR-06-111.
- 1.1.5 In this report the scheme is referred to as the AP revised scheme, which is the original scheme (i.e. the Bill scheme submitted to Parliament in July 2017, which was assessed in the main ES) as amended by the SES changes and AP amendments.

## 1.2 Scope of the assessment

- 1.2.1 This FRA considers the flood risk implications of the AP revised scheme.
- 1.2.2 The assessments reported within this FRA have been carried out in general accordance with the requirements of the National Planning Policy Framework (NPPF)<sup>4</sup>. The NPPF aims to prevent inappropriate development in areas at risk of flooding and to ensure that, where development is necessary in areas at risk of flooding, it is safe to do so without increasing flood risk elsewhere.

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<sup>1</sup> HS2 Ltd (2017), *High Speed Rail (West Midlands-Crewe) Environmental Statement*. <https://www.gov.uk/government/collections/hs2-phase-2a-environmental-statement>.

<sup>2</sup> HS2 Ltd (2018), *High Speed Two (HS2) Phase 2a (West Midlands-Crewe), Background Information and Data, Hydraulic modelling reports*, BID-WR-004-000. [www.gov.uk/hs2](http://www.gov.uk/hs2).

<sup>3</sup> HS2 Ltd (2018), *High Speed Two (HS2) Phase 2a (West Midlands - Crewe), Background Information and Data, CA3: Stone and Swynnerton Hydraulic modelling report – Filly Brook*, BID-WR-004-007. [www.gov.uk/hs2](http://www.gov.uk/hs2).

<sup>4</sup> Department for Communities and Local Government (2012), *National Planning Policy Framework*. <https://www.gov.uk/guidance/national-planning-policy-framework>.

## 1.3 Methodology, data sources and design criteria

- 1.3.1 The methodology, design criteria and data sources used in this FRA are set out in the main ES Environmental Impact Assessment Scope and Methodology Report (SMR) and its Addendum (Volume 5: Appendix CT-001-001<sup>5</sup> and Appendix CT-001-002<sup>6</sup>).

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<sup>5</sup> HS2 Ltd (2017), High Speed Two (HS2) Phase 2a (West Midlands - Crewe), *Environmental Impact Assessment Scope and Methodology Report, Volume 5: Appendix CT-001-001*. [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/627187/E23\\_EIA\\_SMR\\_CT-001-001\\_WEB.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/627187/E23_EIA_SMR_CT-001-001_WEB.pdf).

<sup>6</sup> HS2 Ltd (2017), High Speed Two (HS2) Phase 2a (West Midlands - Crewe), *Scope and Methodology Report Addendum, Volume 5: Appendix CT-001-002*. [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/627189/E24-B\\_CT-001-002\\_Part\\_B\\_WEB.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/627189/E24-B_CT-001-002_Part_B_WEB.pdf)

## 2 Flood risk baseline

2.1.1 The flood risk baseline is set out in the main ES Volume 5: Appendix WR-003-003<sup>7</sup>. This information includes:

- relevant national, regional and local policy (Section 2); and
- Flood Zone 2 and Flood Zone 3 areas<sup>8</sup> associated with Filly Brook (Figure 1).

2.1.2 The communities and infrastructure assets currently at risk of flooding from Filly Brook (and their relative vulnerability to flood risk impacts based on NPPF criteria), include:

- the village of Stone (more vulnerable);
- the M6 motorway (essential infrastructure);
- the Norton Bridge to Stone Railway (essential infrastructure);
- properties next to the Norton Bridge to Stone Railway near Yarnfield (more vulnerable);
- Stone Golf Club golf course (less vulnerable/water compatible); and
- farmland (less vulnerable).

2.1.3 The mechanisms responsible for flooding are as follows:

- overtopping of the Filly Brook channel resulting in inundation of its associated floodplain areas. This flood mechanism has potential to flood the M6, areas of farmland, parts of Stone Golf Club's golf course and properties in Stone; and
- escape of floodwater from the Filly Brook catchment into the adjacent Meece Brook catchment. This mechanism is thought to be a consequence of the historic diversion of Filly Brook along the west side of the M6 when the motorway was constructed. The pathway taken by floodwater passes south west from the point at which Filly Brook flows under the M6. This floodwater would inundate farmland and a group of properties near Yarnfield, as well as the Norton Bridge to Stone Railway.

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<sup>7</sup> HS2 Ltd (2017), *High Speed Two (HS2) Phase 2a (West Midlands - Crewe), Volume 5: Technical appendices. CA3: Stone and Swynnerton. Flood risk assessment, Volume 5: Appendix WR-003-003*. [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/628409/E136\\_WR-003-003\\_WEB.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/628409/E136_WR-003-003_WEB.pdf).

<sup>8</sup> Flood Zone 2 comprises land assessed as having between a 1 in 100 (1%) and 1 in 1,000 (0.1%) annual probability of river flooding; Flood Zone 3 comprises land assessed as having a 1 in 100 (1%) or greater annual probability of river flooding.



### 3 Proposed development and flood risk implications

- 3.1.1 Since the submission of the Bill, further consideration has been given to the design of the original scheme in the vicinity of Filly Brook. The SES design changes and AP amendments in the AP revised scheme (AP-003-001) are intended to avoid track crossovers<sup>9</sup> being partially located on embankment and partially on viaduct. Placing track crossovers on separate structures raises the risk of differential settlement occurring, which has significant operational safety implications. A consequence of this amendment is that the embankments at the southern end of the Infrastructure Maintenance Base – Rail (IMB-R) will now extend over the floodplain and channel of Filly Brook.
- 3.1.2 To be aligned with NPPF policies, essential infrastructure of this kind should only be located in floodplain areas in exceptional circumstances. The Exception Test in NPPF requires evidence to be provided that the development provides wider sustainability benefits to the community that outweigh flood risk. It also requires that a site specific flood risk assessment must “demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall”<sup>10</sup>.
- 3.1.3 Extending the embankments southwards over Filly Brook floodplain has potential implications for flood risk. Approximately 0.3 hectares of floodplain, on the footprint of the proposed HS2 embankments, will be raised above flood level, with a consequent loss of natural floodplain attenuation. This amendment would displace 5,000m<sup>3</sup> of floodwater during the peak of a 1 in 100 (1%) annual probability flood, including an allowance for climate change.

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<sup>9</sup> A track crossover is a pair of switches connecting two parallel rail tracks, allowing a train on one track to cross over to the other.

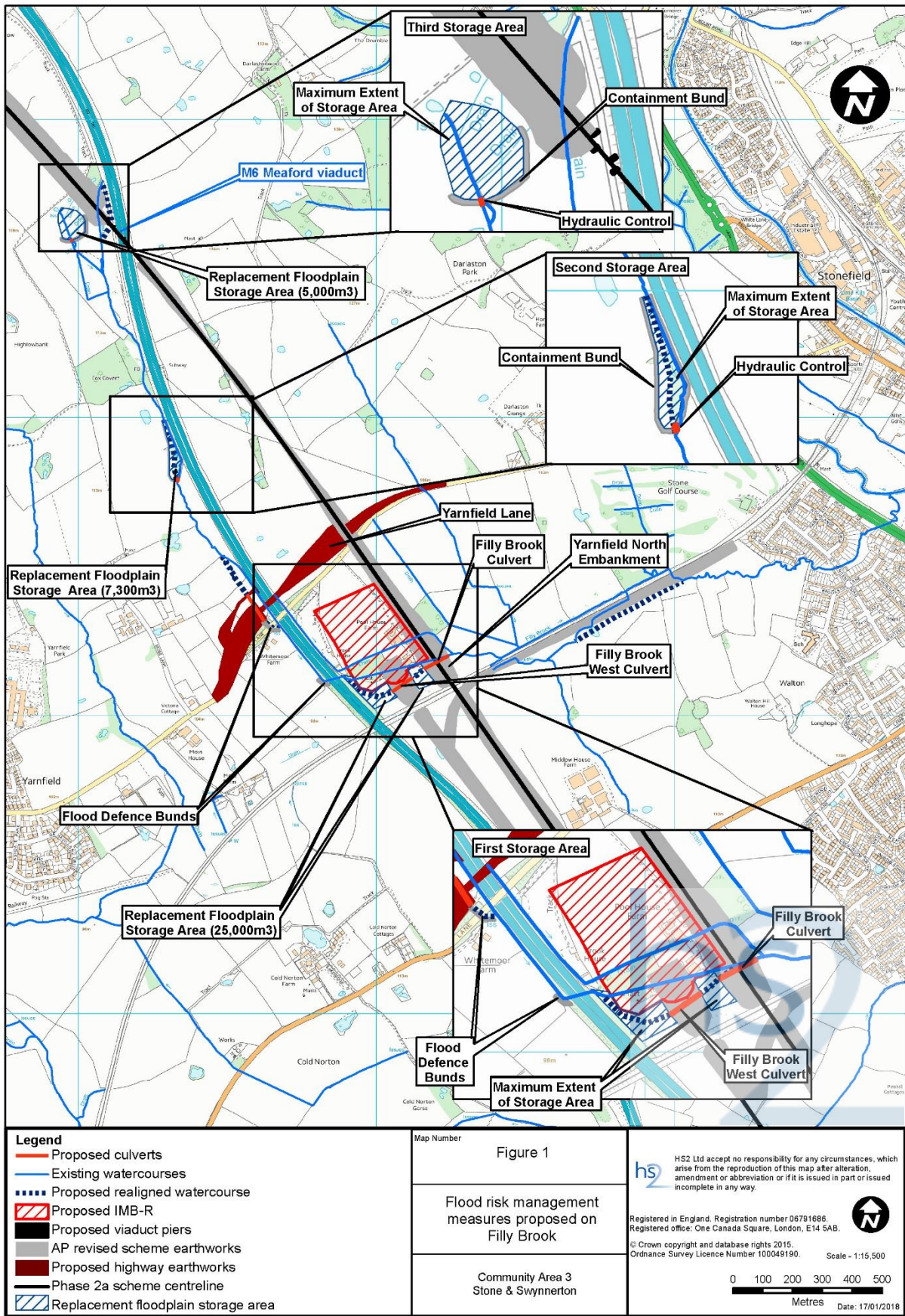
<sup>10</sup> Department for Communities and Local Government, National Planning Policy Framework 2012.

## 4 Flood risk management measures

### 4.1 Introduction

- 4.1.1 The overall approach to flood risk mitigation taken on HS2 is set out in the main ES Volume 5: Appendix WR-003-003.
- 4.1.2 In the case of the updated proposals on Filly Brook, a revised suite of measures (AP-003-002 as shown on Map CT-06-222, B8 in the SES and AP ES, Volume 2, CA3 Map Book) have now been incorporated into the AP revised scheme with the aim of both ensuring HS2 infrastructure in the vicinity of Filly Brook is safe from flooding over its lifetime and that flood risk to existing communities and infrastructure (as outlined in Section 2) is reduced overall.
- 4.1.3 The measures have been designed on a precautionary basis to take account of changes in peak flow that may occur due to climate change beyond 2080. Because the consequences of the design flows being exceeded has the potential to affect essential infrastructure, including the M6, Norton Bridge to Stone Railway and HS2, the Upper End climate change allowance for the Humber Basin (+50%), has been adopted.
- 4.1.4 The measures comprise a combination of flood embankments, formal flood storage areas and land drainage works, as outlined below and shown on Figure 1. Their objective is to protect the HS2 infrastructure from flooding over the scheme's lifetime, whilst ensuring no increases in flood risk to key receptors along the Filly Brook system. Opportunities have also been taken to reduce flood risk to existing assets and communities, where possible.

Figure 1: Flood risk management measures proposed on Filly Brook



## 4.2 Flood defence bunds

- 4.2.1 Two small sections of flood defence bund are proposed, between Yarnfield Lane and the M6. They are designed to contain floodwater associated with the 1 in 100 (1%) annual probability peak flows (plus climate change) on Filly Brook that would otherwise flow south westward towards Yarnfield and the Norton Bridge to Stone Railway (as described in Section 2).

## 4.3 Replacement floodplain storage areas

- 4.3.1 A total of three separate formal replacement floodplain storage areas are now proposed. All three will comprise embankments to temporarily hold back floodwater during the peak of the 1 in 100 (1%) annual probability flood, plus climate change. The hydraulic controls will comprise simple culverts. Each area will also be designed with an overflow, so that design exceedance flows can be safely passed forward without damage occurring to the embankments.
- 4.3.2 The largest storage area will have a volume of approximately 25,000m<sup>3</sup> at top water level. This will be upstream of the Yarnfield North Embankment, with pass forward flow restricted by the Filly Brook culvert. The storage will be created either side of the embankment associated with the IMB-R reception tracks in the floodplain of Filly Brook, which will be otherwise restored to open channel. Both embankments will be designed to be stable under appropriate hydraulic loading. The peak flood level within this storage area will be several metres lower than the IMB-R platform, controlled by a high level overflow. This storage area will be dealt with in accordance with the appropriate reservoirs legislation.
- 4.3.3 The second storage area will be upstream of Yarnfield Lane on the west side of the M6. It will have a volume of approximately 7,300m<sup>3</sup> at top water level, impounded within a large bunded area with the hydraulic control comprising two culverts. To achieve this volume of storage, ground levels will be lowered in this storage area and Filly Brook will be realigned and re-naturalised through the middle of it, creating wetland habitat.
- 4.3.4 The third storage area is on a tributary ditch adjacent to Meaford Viaduct. This has capacity to store approximately 5,000m<sup>3</sup> of floodwater at top water level that would be impounded behind a crescent shaped bund during floods. The basin of this flood storage area would be landscaped as wetland habitat.

## 4.4 Land drainage measures

- 4.4.1 A ditch that currently flows under Yarnfield Lane to the east of the M6 will be diverted eastwards along the side of the realigned Yarnfield Lane to join an existing ditch that then flows under Yarnfield Lane and south east into Filly Brook, upstream of the golf course. This avoids the need for a new culvert beneath the realigned section of Yarnfield Lane.



## **4.5 Operation and maintenance**

- 4.5.1 The flood embankments, storage areas and land drainage measures described above would comprise formal flood risk management infrastructure operated and maintained by HS2 Ltd. As such they would be regularly inspected and cleared of blockages. Embankments would be periodically mown and, where necessary, repaired. All storage areas would be designed with high level overflows so that they can safely overtop if their design capacity is exceeded. The largest storage area is likely to comprise a large raised reservoir and this would therefore be subject to the legal safety requirements of the Reservoir Safety Act, 1975.

## **4.6 Water Framework Directive (WFD) issues**

- 4.6.1 The impact of the AP amendments is described in detail in SES and AP ES Volume 5: Appendix WR-001-000, which forms an addendum to the WFD compliance assessment report submitted as part of the main ES (see main ES Volume 5: Appendix WR-001-000). This addendum demonstrates that the AP revised scheme will remain compliant with WFD legislation.

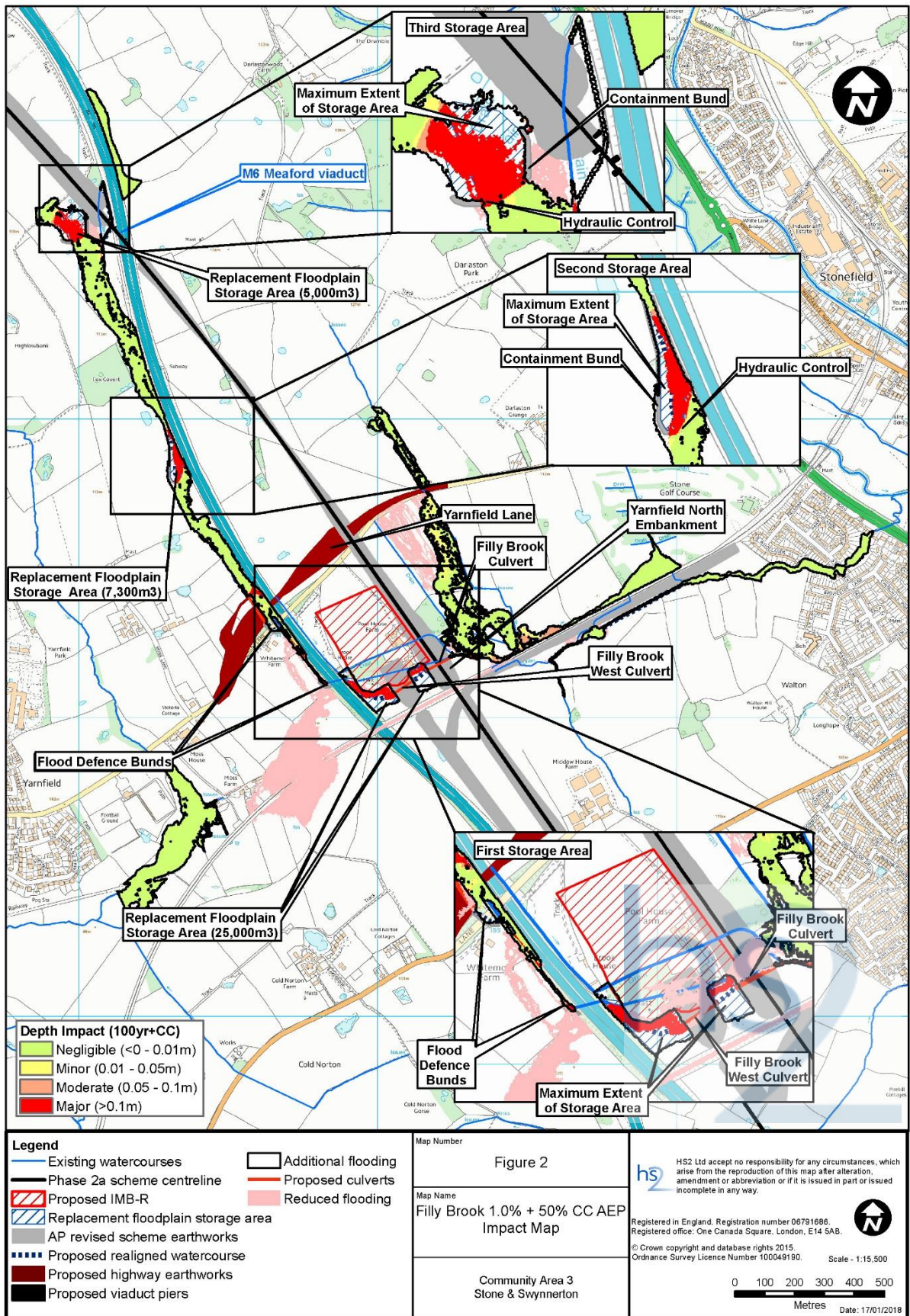
## 5 Flood risk assessment

- 5.1.1 The impacts of the flood risk management measures proposed has been assessed using a numerical model developed using ISIS-TuFlow (see BID document BID-WR-004-007<sup>11</sup> and SES and AP ES Volume 5: Volume 5: Maps WR-05-110, WR-06-110 and WR-06-111 which accompany the SES and AP ES). The results clearly illustrate that, by providing approximately 37,300 m<sup>3</sup> of additional storage within the Filly Brook system, in formal, maintained flood storage areas, flood risk to key receptors is reduced, in some cases significantly.
- 5.1.2 Figure 2 shows the redistribution of floodwaters that would occur during the 1 in 100 (1%) annual event with an allowance for climate change. The reduction in flood risk is most pronounced to the west of the M6 in the area north and south of the Norton Bridge to Stone Railway. This figure shows that flooding to the Norton Bridge to Stone Railway is entirely removed.
- 5.1.3 The flood extents downstream on Filly Brook are unaffected, although the modelling outputs indicate reductions in flood level of up to 270mm adjacent to the golf course and reductions of 30mm through Stone.
- 5.1.4 Figure 2 illustrates the impact of diverting the ditch under Yarnfield Lane northwards. This will prevent flooding of the fields directly north of the IMB-R, with only minor increases in flood depth on the larger drain it will be connected into.
- 5.1.5 The modelling indicates moderate localised increases in flood level of up to 100mm within the channel downstream of Yarnfield North Embankment. The detailed design of this flood defence infrastructure will aim to optimise the use of the storage available and it is anticipated that this localised adverse impact will be avoidable.
- 5.1.6 The areas where flooding would occur more often in the future are also shown on Figure 2. The areas showing the most impact include the three formal flood storage areas, as well as a small area upstream of Yarnfield Lane, which will comprise a landscaped area. All of these areas would be taken out of agricultural production and converted to water compatible land uses.
- 5.1.7 The formal flood storage area upstream of Yarnfield North Embankment, extends back up to the M6. The flood depths, which would be controlled by a high level overflow, are minimal at the toe of the M6 embankment. Nevertheless, the detailed design will ensure that the temporary storage of floodwater in this area would not affect the stability of the M6 embankment.

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<sup>11</sup> HS2 Ltd (2017), High Speed Two (HS2) Phase 2a (West Midlands - Crewe), *Background Information and Data*, CA3: Stone and Swynnerton Hydraulic modelling report – Filly Brook, BID-WR-004-007. [www.gov.uk/hs2](http://www.gov.uk/hs2).

Figure 2: Inundation extents associated with the 1 in 100 + climate change (CC) (1% + 50%) annual probability flood following construction of the AP revised scheme



## 6 Conclusions

- 6.1.1 The AP revised scheme is aligned with the requirements of NPPF. The loss of natural floodplain storage on Filly Brook, resulting from extension of the two embankments over this watercourse, will be more than compensated for by the flood risk management measures proposed in amendment AP-003-002. These measures incorporate approximately 37,300m<sup>3</sup> of replacement floodplain storage.
- 6.1.2 The flood risk management measures will reduce flood risk to the M6, Norton Bridge to Stone Railway, farmland and property, both near Yarnfield and all the way downstream to Stone.
- 6.1.3 The areas that will flood more frequently following construction of the AP revised scheme will be formal flood storage facilities owned and maintained by HS2 Ltd. These areas will be integrated into the landscape design and will provide a range of new habitats.
- 6.1.4 The modelling indicates moderate localised increases in flood level of up to 100mm within the channel downstream of Yarnfield North Embankment. The detailed design of this flood defence infrastructure will aim to optimise the use of the storage available and it is anticipated that this localised adverse impact will be avoided.



## 7 References

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High Speed Two (HS2) Limited  
Two Snowhill  
Snow Hill Queensway  
Birmingham B4 6GA

08081 434 434  
[HS2Enquiries@hs2.org.uk](mailto:HS2Enquiries@hs2.org.uk)