In Parliament – Session 2022 - 2023

HS2

High Speed Rail (Crewe – Manchester)

Supplementary Environmental Statement 2 and Additional Provision 2 Environmental Statement

Volume 5: Appendix CT-001-00005

Route-wide: Water resources

Technical note – Updated guidance on flood risk assessment

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Department for Transport

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1 Introduction

1.1.1 This technical note describes the approach to flood risk assessment for the Supplementary Environmental Statement 2 (SES2) and Additional Provision 2 Environmental Statement (AP2 ES). It is intended as a guide to ensure a consistent approach to flood risk assessment, not as an exhaustive and prescriptive methodology.

1.1.2 A version of this note was initially published in the Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR) as part of the High Speed Two (HS2) High Speed Rail (Crewe – Manchester) Environmental Statement (ES) (the main ES)[1]; see Volume 5, Appendix: CT-001-00001, Part B. This note has been updated for the assessment of the Supplementary Environmental Statement 2 (SES2) scheme and Additional Provision 2 (AP2) revised scheme.

1.1.3 In order to differentiate between the original scheme and subsequent changes, the following terms are used:

- 'the original scheme' – the hybrid Bill (the Bill) scheme submitted to Parliament in 2022, which was assessed in the main ES;
- 'the SES1 scheme' – the original scheme with any changes described in SES1 that are within the existing powers of the Bill;
- 'the AP1 revised scheme' – the original scheme as amended by SES1 changes and AP1 amendments;
- 'the SES2 scheme' – the original scheme with any changes described in SES1 (submitted in July 2022) and the SES2; and
- 'the AP2 revised scheme' – the original scheme as amended by SES1 and SES2 changes (as relevant) and AP2 amendments.

1.1.4 The approach to flood risk assessment is based on the Government's planning practice guidance on flood risk and coastal change[2], CIRIA Publication C624 Development and flood risk: guidance to the construction industry[3], and the Design Manual for Roads and Bridges (DMRB)[4].

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[1] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Environmental Statement.* Available online at: https://www.gov.uk/government/collections/hs2-phase2b-crewe-manchester-environmental-statement.

[2] Department for Communities and Local Government (2017), *Planning practice guidance: flood risk and coastal change.* Available online at: https://www.gov.uk/government/collections/planning-practice-guidance.

[3] CIRIA (2004), *Development and flood risk: guidance to the construction industry, C624.*

[4] Highways Agency (2020), *Design Manual for Roads and Bridges (DMRB) LA 113 – Road drainage and the water environment, formerly HD45/09, Revision 1.* Available online at: https://www.standardsforhighways.co.uk/dmrb/search/d6388f5f-2694-4986-ac46-b17b62c21727.

1.1.6 Since the publication of the SMR in the main ES, the guidance in this technical note has been updated to include:

- updated peak river flow allowances published by the Environment Agency in July 2021(updated in 2022) using percentiles from UK Climate Projections 2019 (UKCP18) which are now based on management catchments instead of river basin districts[5]; and
- updated peak rainfall intensity allowances published by the Environment Agency in May 2022 using UKCP local projections of extreme rainfall[6].

1.1.7 For the main ES, and the AP1 revised scheme, the 2016 versions of the guidance and allowances have been used as the basis of assessment[7]. For the AP2 revised scheme, the July 2021 peak river flow and May 2022 peak rainfall guidance and allowances will be used as the basis of assessment.

1.1.8 Table 1 summarises where the methodology or approach presented within the technical note published in Part B of the EIA SMR has been amended.

Table 1: Summary of changes since the Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR)

Section number	Section title	Summary of change
6.2	Peak river flow allowances	Updated to include revised peak river flow allowances based on Environment Agency climate change guidance published in July 2021
6.3	Peak rainfall allowances	Updated to include revised peak rainfall intensity allowances based on Environment Agency climate change guidance published in May 2022
6.4	Sensitivity analysis	Updated to include revised credible worst-case scenario based on Environment Agency climate change guidance published in July 2021

[5] Environment Agency (2022), *Peak river flow climate change allowances by management catchment*. Available online at: https://www.gov.uk/government/publications/peak-river-flow-climate-change-allowances-by-management-catchment.

[6] Environment Agency (2022), *Peak rainfall climate change allowances by management catchment*. Available online at: https://www.gov.uk/government/publications/peak-rainfall-climate-change-allowances-by-management-catchment.

[7] Environment Agency (2016), *Adapting to Climate Change. Advice for Flood and Coastal Erosion Risk Management Authorities,* (withdrawn). Available online at: https://www.gov.uk/government/publications/adapting-to-climate-change-for-risk-management-authorities. Now replaced by Environment Agency (2022), *Flood and coastal risk projects, schemes and strategies: climate change allowances.* Available online at: https://www.gov.uk/guidance/flood-and-coastal-risk-projects-schemes-and-strategies-climate-change-allowances.

2 Approach overview

2.1 Introduction

2.1.1 The approach to the flood risk assessment should proceed as follows.

Step 1: Baseline assessment

2.1.2 All existing potential sources of flooding should be identified, together with the pathways or mechanisms by which they have potential to cause risk to life, economic or environmental damage, disruption or nuisance. All existing property and assets (receptors) at risk from these sources, and their relative vulnerability to flooding impacts, should then be determined. This process is described in Section 2.2 of this technical note.

Step 2: Incorporation of flood risk mitigation into the design

2.1.3 The design should be developed using the flood risk baseline as the basis for identification of appropriate flood risk mitigation measures. Section 2.3 of this technical note outlines the approach to flood risk mitigation that should be adopted, wherever reasonably practicable.

Step 3: Assessment of impacts and effects

2.1.4 An assessment of the magnitude of the impacts at each receptor, taking into consideration the mitigation measures incorporated into the design, should then be undertaken. The significance of the flood risk issues at affected receptors should be identified, together with suggestions for additional mitigation, where this is necessary to address any potentially significant residual effects identified. This process is described in Section 2.4 of this technical note.

Incorporation of climate change allowances

2.1.5 Section 2.5 outlines how climate change should be factored into the above process.

2.2 Step 1: Baseline assessment

Relevant flood sources and pathways

2.2.1 Baseline definition, and scoping of all flood risk issues, is to be undertaken on the basis of existing information in close consultation with flood risk consultees and stakeholders if appropriate, including the Environment Agency, Lead Local Flood Authorities, Canal & River Trust, Internal Drainage Boards and water companies. Key sources of information include:

- the Environment Agency's Flood map for planning (rivers and sea)[8] to scope the baseline flood hazard associated with main rivers and ordinary watercourses;
- the Environment Agency's Risk of Flooding from Surface Water (RoFSW) mapping[9] to scope surface water flood hazards or the potential flood hazard associated with main rivers and ordinary watercourses in the absence of Environment Agency flood zones;
- reservoir failure flood hazards should be scoped using the Environment Agency Risk of flooding from reservoirs national dataset; and
- the British Geological Survey (BGS) national Susceptibility to groundwater flooding dataset[10], should be used to scope the future risk of groundwater flooding.

2.2.2 This should be supplemented with other information that provides more detailed insight to the baseline that is available from flood risk consultees.

2.2.3 At locations where this scoping exercise identified a potential for the AP2 revised scheme to increase flood risk, hydraulic modelling, or other suitable quantitative techniques, should be used to define the baseline in more detail.

Identification of flood risk receptors

2.2.4 Receptors with potential to be affected by the AP2 revised scheme will be identified using Ordnance Survey mapping information and address point data. Receptor vulnerability is based on the definitions in Table 2 of the Government's planning practice guidance on flood risk and coastal change[11].

2.3 Step 2: Incorporation of flood risk mitigation into the design

Overall aims

2.3.1 The AP2 revised scheme will aim to avoid an increase in the risk of flooding from all sources, taking into account the projected impact of climate change.

[8] Environment Agency (2021), *Flood map for planning*. Available online at https://flood-map-for-planning.service.gov.uk/location.

[9] Environment Agency (2021), *Long term flood risk information*. Available online at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/.

[10] British Geological Survey (2022), *Groundwater Flooding.* Available online at: http://www.bgs.ac.uk/products/hydrogeology/groundwaterFlooding.html.

[11] Ministry for Housing, Communities and Local Government (2014), *Guidance: Flood risk and coastal change*. Available online at: https://www.gov.uk/guidance/flood-risk-and-coastal-change.

2.3.2 Where impacts that could lead to significant flood risk effects are unavoidable, the AP2 revised scheme will incorporate mitigation into the design in order to reduce the magnitude of the impact as far as practicable.

Route selection

2.3.3 The route has been selected with consideration for the sequential approach advocated in the technical guidance to the National Planning Policy Framework (NPPF)[12]. This approach aims to steer new development to areas with the lowest probability of flooding. Avoidance of areas with a high probability of flooding was a key consideration in the Phase 2 Appraisal of Sustainability[13] and consequently the route avoids flood zones wherever reasonably practicable. It is recognised within the NPPF that essential transport infrastructure has to cross areas at risk of flooding, for example at river crossings. In such circumstances, the Exception Test requires that it be demonstrated that the infrastructure would be safe from flooding over its lifetime, would not increase flood risk elsewhere and that the wider benefits to society outweigh flood risk. The manner in which the High Speed Two (HS2) scheme aligns with the Sequential Test and Exception Test in the NPPF is outlined in Volume 3 of the main ES.

Design standard

2.3.4 The AP2 revised scheme will be protected against flooding from any source during the current 1 in 1,000 (0.1%) annual probability flood, with water levels not rising closer than 1m to the top of rail level. Where this is not applicable (for example at tunnel portals) then flood protection measures may be required with appropriate freeboard, depending on local uncertainties and the consequence of design exceedance.

Hydraulic capacity

2.3.5 In locations where the route will cross watercourses or surface water flow paths, the design aim is for structures to accommodate flood flows up to and including the 1 in 100 (1%) annual probability storm with an appropriate allowance for climate change:

- A minimum of 600mm freeboard above the 1 in 100 (1%) annual probability plus climate change flood event has been allowed to the soffit of all bridges and viaducts.
- A minimum of 300mm freeboard above the 1 in 100 (1%) annual probability plus climate change flood event has been allowed to the soffit of all culverts.

[12] Ministry for Housing, Communities and Local Government (2014), *Guidance: Flood risk and coastal change.* Available online at: https://www.gov.uk/guidance/flood-risk-and-coastal-change.

[13] Temple-ERM (2012), *Options for Phase 2 of the high speed network – Appraisal of Sustainability* (now withdrawn). Available online at: https://www.gov.uk/government/publications/options-for-phase-two-of-the-high-speed-rail-network-appraisal-of-sustainability.

Floodplain storage

2.3.6 Watercourse crossings will be designed where reasonably practicable to avoid encroachment into floodplains.

2.3.7 Nevertheless, it is recognised that where the AP2 revised scheme crosses areas of floodplain, losses of flood storage may be unavoidable. Whilst individually these losses may not give rise to significant local increases in flood level, cumulatively they can amount to a significant reduction in flood storage volume. This loss of storage volume may lead progressively to increases in flood risk either local to the watercourse crossing or elsewhere within the catchment as a result of a cumulative effect.

2.3.8 Therefore, wherever losses of flood storage are anticipated, regardless of the predicted magnitude of impact within the area of assessment, provision has been made on a precautionary basis to replace this storage at the affected location on a 'volume for volume' and where practicable a 'level for level' basis.

2.3.9 Future design development of flood mitigation should also consider the benefits of nature based approaches to tackling flood risk. At locations where it can be demonstrated through more detailed analysis of the flooding mechanisms that natural flood management strategies have the potential to achieve wider strategic environmental benefits, this should be discussed at the earliest opportunity with the Environment Agency.

Maintenance access

2.3.10 An appropriate vertical clearance should be provided above floodplain ground level to the underside of viaducts to ensure access to riverbanks for inspection and maintenance purposes. Piers should be set back from the bank top. Specific local details should be agreed with the relevant risk management authority.

Off-site effects

2.3.11 The design of the AP2 revised scheme's drainage systems will ensure that there are no significant increases in flood risk to vulnerable receptors downstream, during storms up to and including the 1 in 100 (1%) annual probability design event, with an allowance for climate change.

2.4 Step 3: Assessing and reporting residual impacts and effects

2.4.1 Impact magnitude shall be considered in terms of increases in peak flood levels associated with floods with a range of annual probabilities. The significance of the resulting effects on flood risk reflects the vulnerability of the receptor and the magnitude of the predicted impact, as defined by the matrix in Table 2, which is based on Section 21 of the EIA SMR

published as part of the main ES. The text in bold highlights the combination of magnitude of impact and receptor value that gives rise to significant effects on flood risk.

Table 2: Significance of flood effects

Receptor value	Magnitude of impact on peak flood levels			
Criteria	Negligible (< +/- 10mm)	Minor > 10mm ≤ 50mm	Moderate > 50mm ≤ 100mm	Major > 100mm
Very high (Essential infrastructure or highly vulnerable development)	Negligible - not significant	**Moderate adverse - significant**	**Major adverse - significant**	**Major adverse - significant**
High (More vulnerable development)	Negligible - not significant	**Moderate adverse - significant**	**Moderate adverse - significant**	**Major adverse - significant**
Moderate (Less vulnerable development)	Negligible - not significant	Minor adverse - not significant	**Moderate adverse - significant**	**Moderate adverse - significant**
Low (Water compatible development)	Negligible - not significant	Negligible - not significant	Minor adverse - not significant	Minor adverse - not significant

2.4.2 Recommendations should be made for additional mitigation, where this is necessary to address any potentially significant effects identified. Regardless of the significance of the flood risk effects, the design aim will be to mitigate all impacts on flood risk during design development.

2.5 Climate change allowances

2.5.1 This section sets out how the climate change allowances in the updated guidance will be applied in practice to the SES2 and AP2 ES assessment.

Peak river flow allowances

Introduction

2.5.2 Peak river flow climate change allowances, selected according to management catchment, shall be used for any assessment within a catchment larger than 5km^2. Where catchment size is less than 5km^2, the peak rainfall guidance described in this technical note shall be used.

2.5.3 The allowances used in flood risk assessments prepared for any changes or updates to environmental information, scheme design or assumptions brought forward through the AP2 revised scheme are selected according to the criteria set out in the updated Environment Agency guidance and allowances for peak river flow published in July 2021.

2.5.4 There are two main changes of note for design and assessment with the updated peak river flow allowances and accompanying guidance:

- The allowances have increased within any given percentile band.
- The guidance has changed to direct development to use a lower percentile band in their design and assessments. Where previously Essential infrastructure within the flood zones was directed to use the Upper end allowances, it is now directed to use the Higher central allowances.

2.5.5 The Higher central allowances that are relevant to the SES2 and AP2 ES assessment are shown in Table 3.

Management catchments

2.5.6 Table 3 lists by management catchment, the percentage change that shall be applied for each allowance category based on Environment Agency published guidance in July 2021[8].

Table 3: Allowance percentages for each allowance category in each management catchment

Management catchment	Allowance category	Allowance
Weaver Gowy	Upper end	106%
	Higher central	67%
	Central	52%
Upper Mersey	Upper end	85%
	Higher central	53%
	Central	41%
Irwell	Upper end	75%
	Higher central	46%
	Central	35%

Flood zones and receptor sensitivity

2.5.7 The allowance category used depends on the flood zone within which the receptor lies. Except where agreed otherwise with the Environment Agency, the Flood map for planning (rivers and sea) should be used for the purposes of identifying which flood zone each flood risk receptor is located within.

2.5.8 The allowance categories that shall be used in the flood risk assessments prepared for any changes or updates to environmental information, scheme design or assumptions brought forward through the AP2 revised scheme are based on Environment Agency published guidance in July 2021 as shown in Table 4.

Table 4: Updated allowance categories for each existing property or land use type in different flood zones

Flood Zone	Receptor sensitivity	Allowance category
Flood zone 2 or 3a	Essential infrastructure	Higher central
	Highly vulnerable	Central
	More vulnerable	
	Less vulnerable	
	Water compatible	
Flood zone 3b	Essential infrastructure	Higher central
	Highly vulnerable	Development should not be permitted
	More vulnerable	
	Less vulnerable	
	Water compatible	Central

2.5.9 The allowances in Tables 3 and 4 are designed to ensure that where it is not possible to locate a new development in an area that has a lower risk flooding, the development is made safe for its lifetime, taking account of the vulnerability of its users, without increasing flood risk elsewhere.

2.5.10 The Higher central allowance in Table 3 shall be used in the SES2 and AP2 ES to assess off-site impacts and calculate floodplain storage compensation regardless of land use in affected areas.

2.5.11 All components of the HS2 railway corridor are considered Essential infrastructure. Railways, motorways and 'A' roads with one or two number identifiers (e.g. A1 or A34) are considered Essential infrastructure, while all other roads are considered Less vulnerable.

2.5.12 When assessing impacts of flooding on receptors, the receptor sensitivity level used for each assessment will correspond with the existing property or land use with the highest sensitivity within the area considered.

Peak rainfall allowances

2.5.13 Peak rainfall intensity climate change allowances shall be used for any assessment within a catchment of a size smaller than 5km^2. Where catchment size is more than 5km^2, the peak river flow guidance described in this technical note shall be used.

2.5.14 Any changes or updates to environmental information and scheme design or assumptions brought forward through the AP2 revised scheme should be assessed using a peak rainfall intensity allowance of 45%, in line with the Environment Agency published guidance in May 2022[6].

2.5.15 Where no modelling is required based on the outcome of the decision tree (see Figure 1), the RoFSW 1 in 1000 (0.1%) annual probability event will be used as a climate change proxy.

Sensitivity analysis

2.5.16 For peak river flow, the Upper end category from Table 3 should be used in the flood risk assessments prepared for the SES2 and AP2 ES to understand the worst case climatic conditions that the AP2 revised scheme could feasibly experience during its design life.

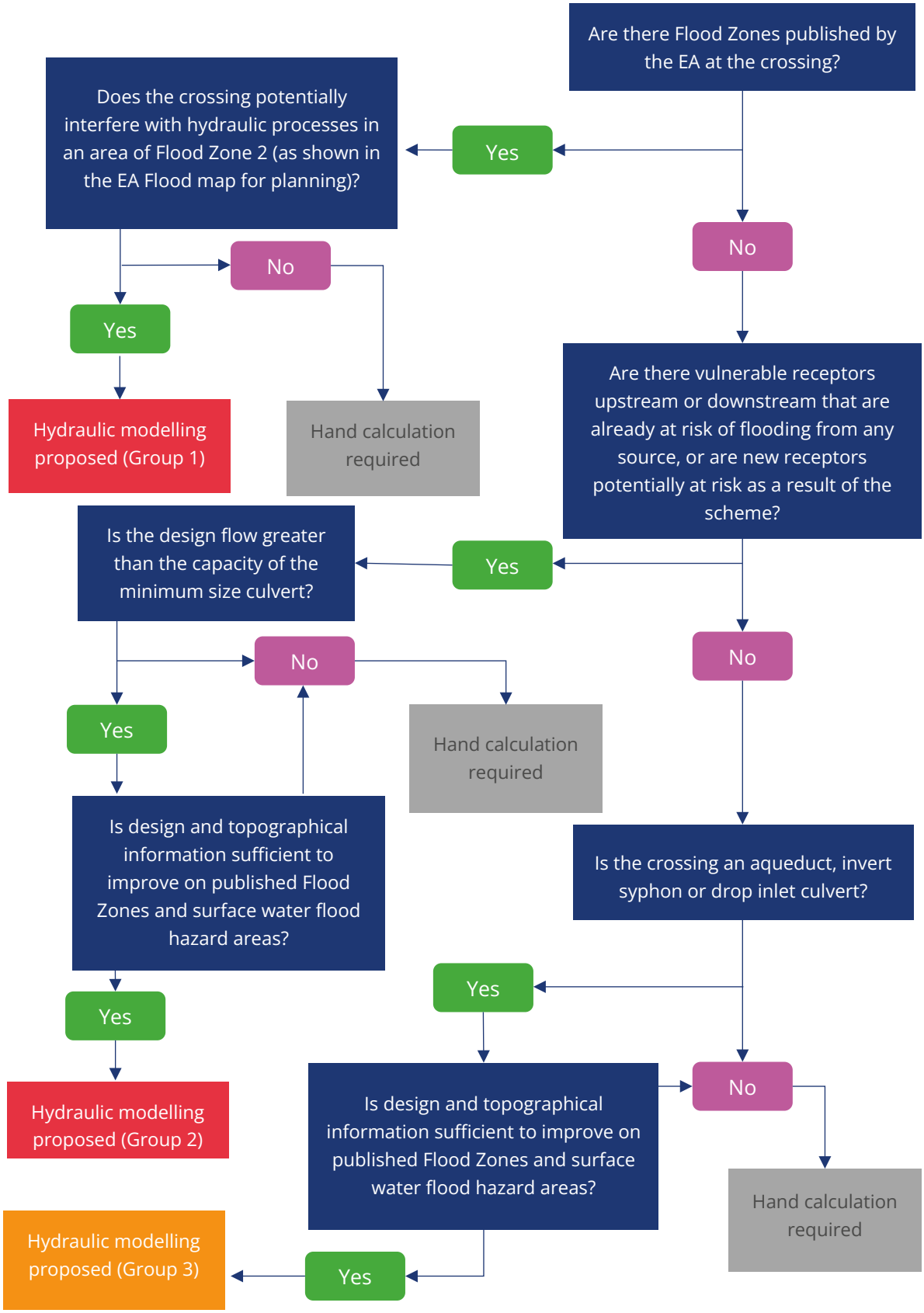
2.5.17 Where sensitivity analysis indicates that the AP2 revised scheme could potentially result in new or increased significant effects on receptors under this extreme scenario, the design shall be reviewed to ensure that the mitigation is still suitable and that the AP2 revised scheme is resilient to changes in climate for different future scenarios.

3 Hydraulic modelling decision tree

3.1.1 The decision tree in Figure 1 sets out the general approach to hydraulic modelling at each watercourse crossing or area of surface water flood hazard. Use of the decision tree results in four possible modelling decisions, as follows.

- **Group 1**: these sites correspond to crossings where there is known fluvial flooding (Flood Zone 2) and the AP2 revised scheme has potential to increase associated flood levels. Hydraulic modelling is proposed even if there are no receptors currently at risk, as the hydraulic model can inform the decision to replace a viaduct with a bridge or culvert for cost saving purposes.
- **Group 2**: these sites correspond to crossings where the capacity of the minimum HS2 culvert size is inadequate to convey the peak 1 in 100 (1%) annual probability flow, including an allowance for climate change, where there are receptors with potential to be affected.
- **Group 3**: these sites are where the proposed hydraulic infrastructure is more complex (e.g. inverted siphons) and checks may be required to assess whether the design flows can be conveyed through the AP2 revised scheme without causing flooding problems.
- **Group 4**: these sites correspond with straightforward crossings, with no existing flood risk issues, where only hand calculations are required. These are also locations where this represents the best data available subject to more detailed design or topographical survey data being made available.

Figure 1: Hydraulic modelling decision tree



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