

HIGH SPEED RAIL (LONDON - WEST MIDLANDS)

Supplementary Environmental Statement 3 and
Additional Provision 4 Environmental Statement

Volume 5 | Water resources

(WR-002-009, WR-002-025, WR-003-023,
WR-003-025, WR-001-000)

October 2015

SES3 and AP4 ES 3.5.1.12



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Index

This table shows the topics covered by the technical appendices in this volume, and the reference codes for them.

CFA name and number	Code
CFA9, Central Chilterns	WR-002-009
CFA25, Castle Bromwich and Bromford	WR-002-025
CFA23, Balsall Common and Hampton in Arden	WR-003-023
CFA25, Castle Bromwich and Bromford	WR-003-025
All CFAs	WR-001-000
	WR-001-000 Annex A
	WR-001-000 Annex B

SES₃ and AP₄ ES Appendix WR-002-009

Environmental topic:	Water resources and flood risk assessment	WR
Appendix name:	Water resources assessment	002
Community forum area:	Central Chilterns	009

Contents

1	Introduction	1
1.1	Structure of the water resources and flood risk assessment appendices	1
Part 1 Supplementary Environmental Statement		
2	Baseline data update	1
2.1	General	1
2.2	Water Framework Directive surveys	1
2.3	Groundwater	1
Part 2 Additional Provision		
3	Summary of changes outside the existing limits of the Bill	4
4	Surface water assessment	4
5	Groundwater assessment	8
5.2	Effect of reduced aquifer thickness due to construction of lined tunnels	20
5.3	Effect of vent shafts on groundwater flow in CFAg	21
5.4	Assessment of South Heath cutting	21

List of tables

Table 1	: Extension of the Chiltern tunnel from Mantle's Wood portal to South Heath green tunnel north portal and associated works	4
Table 2	: Summary of potential impacts to surface water as a result of design changes outside the existing limits of the Bill	5
Table 3	: Summary of potential impacts to groundwater	8

List of figures

Figure 1	: Schematic cross section of geology and route in CFAg	3
Figure 2	: Map showing relative location of revised scheme and water dependant habitats	19

1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

- 1.1.1 This appendix provides an update to Appendix WR-002-009 Water resources assessment from the main Environmental Statement (ES) (Volume 5, technical appendices). This update should be read in conjunction with Appendix WR-002-009 Water resources assessment from the main ES.
- 1.1.2 Maps referred to throughout the water resources and flood risk assessment appendices are contained either in the Volume 5 Water resources Map Book of the main ES or the SES3 and AP4 ES Volume 5 Water resources Map Book.

Part 1 Supplementary Environmental Statement 3

2 Baseline data update

2.1 General

- 2.1.1 The following sub-sections provide a description of water resources surveys carried out since submission of the main ES, including surveys of surface water and groundwater.

2.2 Water Framework Directive surveys

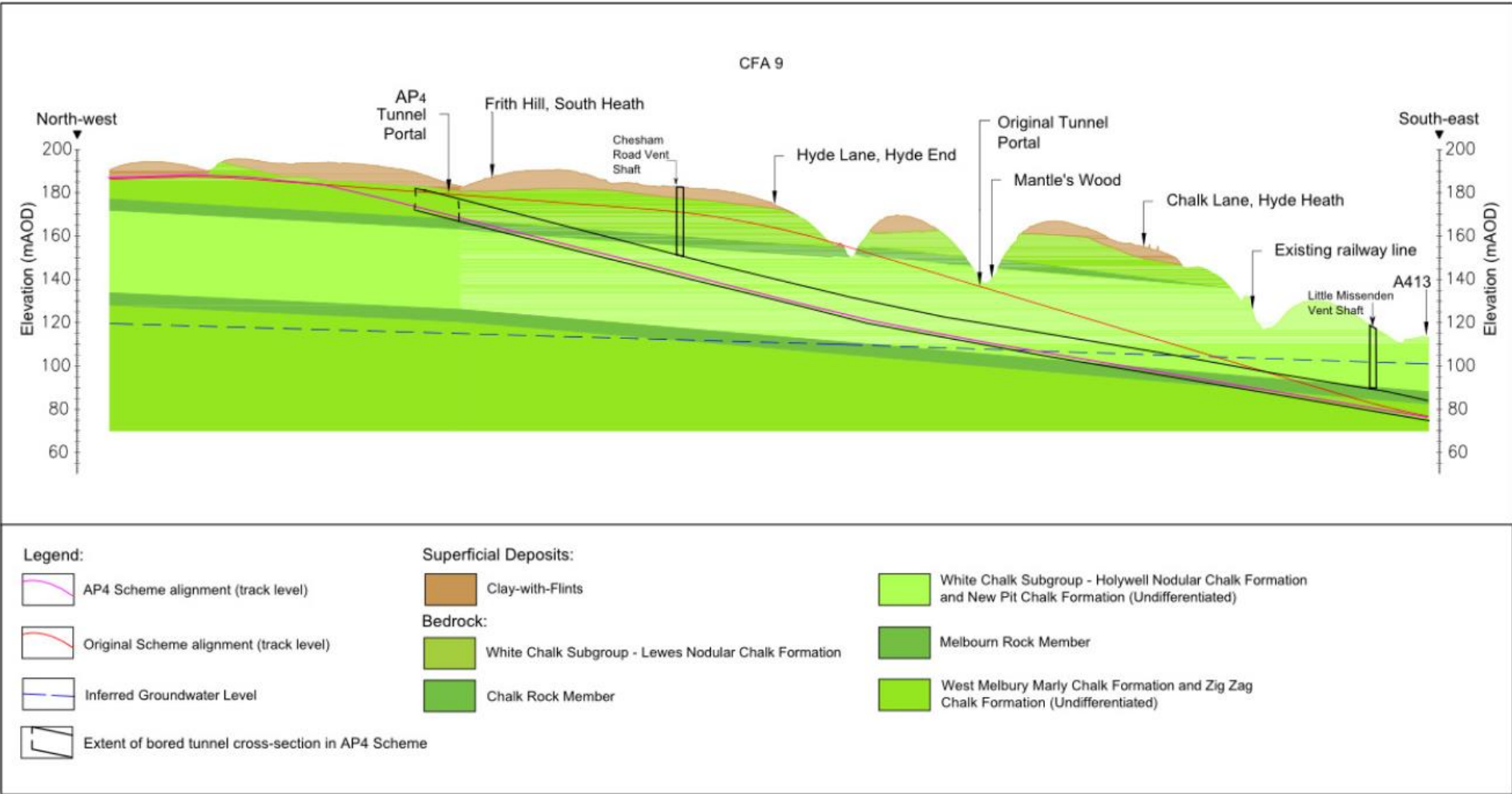
- 2.2.1 Water Framework Directive (WFD) surveys covering hydromorphology, surface water, groundwater, macrophytes and macro-invertebrates have been undertaken in CFA9 since submission of the main ES.
- 2.2.2 Details of all survey work undertaken in CFA9 since September 2013, and the results of the surveys, are contained in SES and AP2 ES Appendix WR-001-000 Annex A.
- 2.2.3 The additional baseline data does not generate any new or different significant effects.

2.3 Groundwater

- 2.3.1 Since the main ES was published, the Environment Agency has updated the source protection zones (SPZ) for a number of public water supply abstractions in the Chilterns area.
- 2.3.2 A summary of the geological units present in CFA9, together with the hydrogeological characteristics of the units, is presented in Volume 2, CFA Report 9, Section 5.1.

- 2.3.3 Map WR-02-009 (SES₃ and AP₄: Volume 5, Water Resources Map Book) illustrates the spatial distribution of the uppermost superficial and bedrock formations within CFA₉, together with the updated SPZ in this area.
- 2.3.4 A schematic cross-section along the line of the route in this study area, including geological strata, inferred average groundwater elevations and the original and AP₄ alignments of the scheme, is presented in Figure 1.

Figure 1: Schematic cross section of geology and route in CFA9



Part 2 Additional Provision

Environmental Statement 4

3 Summary of changes outside the existing limits of the Bill

- 3.1.1 There is one design change outside the existing limits of the Bill with the potential to affect water resources in CFA9. The design change is summarised in Table 1.

Table 1 : Extension of the Chiltern tunnel from Mantle's Wood portal to South Heath green tunnel north portal and associated works

AP4 ES No	Design change name
AP4-009-001	Extension of the additional land required to extend the Chiltern tunnel from Mantle's Wood portal to South Heath green tunnel north portal

4 Surface water assessment

- 4.1.1 Table 2 summarises the potential impacts and effects to surface water as a result of design changes outside the existing limits of the Bill. The table only includes water features which could potentially be impacted by the AP4 revised scheme. Features such as isolated ponds and drains which will lie outside the construction footprint and the area of impact of the revised scheme, i.e. features located more than 1km from the revised scheme, are not included.
- 4.1.2 The table contains details of the assessment from the main ES for comparison, so that changes can be readily identified.
- 4.1.3 The draft Code of Construction Practice (draft CoCP), referred to in Table 2, sets out the measures and standards of work that will be applied to the construction of the revised scheme (see Volume 5: Appendix CT-003-000/1 of main ES). These will provide effective management and control of the impacts during the construction period.

Table 2 : Summary of potential impacts to surface water as a result of design changes outside the existing limits of the Bill

	Surface water feature / receptor	Value of surface water feature	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Main ES	River Misbourne	High	Chilterns Tunnel	Negligible Impact Neutral effect (Not significant)	The design will ensure a river crossing in this area will be avoided. Potential mitigation for ground settlement due to crossing in CFA8 will extend only 20m into CFA 9 and so is described in detail in CFA8.	Refer to Volume 2, CFA Report 8, Section 13 for details.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Not applicable
AP4 ES	River Misbourne	High	Chilterns Tunnel extension	Negligible Impact Neutral effect (Not significant)	The AP4 revised Scheme design does not include a river crossing. Potential mitigation for ground settlement due to crossing in CFA8 will extend only 20m into CFA9 and so is described in detail in CFA8.	Refer to Volume 2, CFA Report 8, Section 13 for details.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Not applicable
Main ES	Unnamed Pond – Orchard	Low	South Heath Green Tunnel	Negligible impact	This pond will be adjacent to the route and will be lost	No mitigation required.	Negligible Neutral	None required	Negligible Neutral	Construction (Permanent)

	Cottage (CFA09-P08)			Neutral effect (Not significant)	to construction and landscaping. No significant effect on water resources.		(not significant)		(not significant)	
AP4 ES	Unnamed Pond – Orchard Cottage (CFA09-P08)	Low	South Heath Green Tunnel	Negligible impact Neutral effect (Not significant)	This pond will be adjacent to the route and will still be lost to construction and landscaping. No significant effect on water resources.	No mitigation required.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
Main ES	Unnamed Pond – Jenkin’s Wood (CFA09-P09)	Low	South Heath Cutting	Negligible impact Neutral effect (Not significant)	This pond will be adjacent to the track and will be lost to construction and landscaping. No significant effect on water resources.	No mitigation required	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction (Permanent)
AP4 ES	Unnamed Pond – Jenkin’s Wood (CFA09-P09)	Low	South Heath Cutting	Negligible impact Neutral effect (Not significant)	This pond will be adjacent to the track and will still be lost to construction and landscaping. No significant effect on water resources.	No mitigation required	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction (Permanent)
Main ES	Unnamed Pond – Park Farm	Low	South Heath Cutting	Negligible impact Neutral effect	This pond will be adjacent to the track and will be lost to construction and	No mitigation required	Negligible impact Neutral effect	None required	Negligible impact Neutral	Construction (Permanent)

	(CFA09-P10)			(Not significant)	landscaping. No significant effect on water resources.		(Not significant)		effect (Not significant)	
AP4 ES	Unnamed Pond – Park Farm (CFA09-P10)	Low	South Heath Cutting	Negligible impact Neutral effect (Not significant)	This pond will be adjacent to the track and will still be lost to construction and landscaping. No significant effect on water resources.	No mitigation required	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	Construction (Permanent)
Main ES	All water bodies	High	Construction sites	Minor impact Moderate Effect (Significant)	Potential for pollution or high levels of suspended solids to enter surface water bodies.	Appropriate mitigation as discussed in the draft CoCP, for polluting materials, and management of earthworks and rate of surface runoff.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (Temporary)
AP4 ES	All water bodies	High	Construction sites	Minor impact Moderate Effect (Significant)	Potential for pollution or high levels of suspended solids to enter surface water bodies. Impacts are not changed by tunnel extension, although the location of discharges will change.	Appropriate mitigation as discussed in the draft CoCP, for polluting materials, and management of earthworks and rate of surface runoff.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (Temporary)

5 Groundwater assessment

5.1.1 Table 3 summarises the potential impacts to groundwater, abstractions, water dependant habitats and surface water/groundwater interactions as a result of the design changes outside the existing limits of the Bill. The table contains details of the assessment from the main ES for comparison, so that changes can be readily identified.

Table 3 : Summary of potential impacts to groundwater

	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Main ES	Chalk Principal aquifer (High)	Chiltern tunnel	Minor impact Moderate effect (Significant)	<p>Dewatering during construction of the tunnel and cross passages could impact groundwater quality and flows.</p> <p>The tunnel will be approximately 20m below the water table at the boundary with CFA8 and will rise above the water table north of Lime Farm limiting the need for dewatering.</p>	<p>The tunnel methodology will be selected to avoid significant groundwater ingress to the tunnels and the need for major dewatering.</p> <p>Any dewatering effluents (groundwater) at cross passages will be pumped out for short periods (up to three months) and discharged back to ground (e.g. through soakage areas) where possible, under consent from the Environment Agency.</p> <p>Ground improvement and groundwater control at some cross passages will be</p>	<p>Negligible impact</p> <p>Neutral effect (Not significant)</p>	None	<p>Negligible impact</p> <p>Neutral effect (Not significant)</p>	Construction (Temporary)

	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
					undertaken below ground.				
AP4 ES	Chalk Principal aquifer (High)	Chiltern tunnel	Minor impact Moderate effect (Significant)	<p>Dewatering during construction of the tunnel and cross passages could impact groundwater quality and flows.</p> <p>The tunnel will be approximately 20m below the water table at the boundary with CFA8 and will rise above the water table around Mantles Wood, which is further into CFA9 than in the original scheme. Therefore the need for dewatering could extend further.</p>	<p>The tunnel methodology will be selected to avoid significant groundwater ingress to the tunnels and the need for major dewatering.</p> <p>Any dewatering effluents (groundwater) at cross passages will be pumped out for short periods (up to three months) and discharged back to ground (e.g. through soakage areas) where possible, under consent from the Environment Agency.</p> <p>Ground improvement and groundwater control at some cross passages will be undertaken below ground.</p>	<p>Negligible impact</p> <p>Neutral effect (Not significant)</p>	None	<p>Negligible impact</p> <p>Neutral effect (Not significant)</p>	Construction (Temporary)
Main ES	Chalk Principal aquifer (High)	Chiltern tunnel	Negligible impact	The cross-sectional areas of the tunnel, vent shaft and cross passages	None required	Negligible impact	None	Negligible impact	Not applicable

	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		Little Missenden vent shaft Cross passages	Neutral effect (Not Significant)	are relatively small in comparison with the assumed effective thickness of the Chalk aquifer. Groundwater flow is roughly parallel to the route so there is not expected to be a major impact on water levels due to the obstruction of groundwater flow. There is only a short section of route below the water table.		Neutral effect (Not significant)		Neutral effect (Not significant)	
AP4 ES	Chalk Principal aquifer (High)	Chiltern tunnel Little Missenden vent shaft Cross passages	Negligible impact Neutral effect (Not Significant)	The cross-sectional areas of the tunnel, vent shaft and cross passages are relatively small in comparison with the assumed effective thickness of the Chalk aquifer. Groundwater flow is approximately parallel to the route so there is not expected to be a major impact on water levels due to the	None required	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Not applicable

	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
				obstruction of groundwater flow. Refer to Section 5.2 of this report for further discussion					
Main ES	Chalk Principal aquifer (High)	Little Missenden vent shaft and Chiltern auto transformer station	Moderate impact Large effect (Significant)	Groundwater flows and discharges to the River Misbourne will be reduced by dewatering at the vent shaft.	Dewatering will take place from within the shaft walls and dewatering effluent will be re-injected into the aquifer nearby thus avoiding impacts away from the construction area.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (Temporary)
AP4 ES	Chalk Principal aquifer (High)	Little Missenden vent shaft and Chiltern auto transformer station	Moderate impact Large effect (Significant)	Groundwater flows and discharges to the River Misbourne will be reduced by dewatering at the vent shaft.	Dewatering will take place from within the shaft walls and dewatering effluent will be re-injected into the aquifer nearby thus avoiding impacts away from the construction area.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (Temporary)
Abstractions									
Main ES	PWS (TH011, TH316) (High)	Chiltern tunnel (south of Lime Farm)	Moderate impact	Tunnelling and piling/diaphragm wall construction could have the potential to impact	The route avoids SPZ1 and there is limited work below the water	Moderate impact	A hierarchy of further mitigation, as	Neutral (Not significant)	Construction (temporary)

	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		Little Missenden vent shaft Cross passages	Large effect (Significant)	on groundwater quality due to the migration of fluids or suspended bedrock particles giving rise to raised turbidity, particularly where fissures are connected to high value receptors such as PWS.	table in SPZ2. Additional mitigation is required during the tunnelling period to avoid unplanned withdrawal of public water supplies and potential impacts on customers. Monitoring will inform further mitigation requirements, if required.	Large effect (Significant)	discussed in Volume 2, CFA Report 9, Section 13.3, if monitoring indicates this will be necessary.		
AP4 ES	PWS (TH011, TH316) (High)	Chiltern tunnel (south of Mantles Wood Little Missenden vent shaft Cross passages	Moderate impact Large effect (Significant)	Tunnelling and piling/diaphragm wall construction could have the potential to impact on groundwater quality due to the migration of fluids or suspended bedrock particles giving rise to raised turbidity, particularly where fissures are connected to high value receptors such as PWS. (See Figure 2 for location)	The route avoids SPZ1. Implementation of the draft CoCP will ensure that materials in contact with groundwater will be selected and method statements developed to control any potential contaminants. Monitoring of yields and groundwater levels and quality will take place before, during and after construction until any impacts have been assessed.	Moderate impact Large effect (Significant)	A hierarchy of further mitigation, as discussed in Volume 2, CFA Report 9, Section 13.3, if monitoring indicates this will be necessary.	Neutral (Not significant)	Construction (temporary)

	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
					The monitoring data will be used to define appropriate mitigation, should it be required.				
Main ES	PWS (TH011, TH316) (High)	Chiltern tunnel (north of Lime Farm) Chiltern tunnel north cutting South Heath green tunnel South Heath cutting	Minor impact Moderate effect (Significant)	Potential impact to groundwater flows and quality at abstractions. To the north of Lime Farm the route is expected to be above the water table and the risk of impacts on groundwater quality, particularly at PWS, due to increased turbidity is reduced. There could, however, still be potential for quality to be impacted adversely.	Monitoring will inform further mitigation requirements, if needed.	Minor impact Moderate effect (Significant)	A hierarchy of further mitigation, as discussed in Volume 2, CFA Report 9, Section 13.3 of the main ES, if monitoring indicates this will be necessary.	Neutral (Not significant)	Construction (temporary)
AP ₄ ES	PWS (TH011, TH316) (High)	Chiltern tunnel (north of Mantles Wood) South Heath cutting	Minor impact Moderate effect (Significant)	Potential impact to groundwater flows and quality at abstractions. To the north of Mantles Wood the tunnel and South Heath cutting is expected to be above the water table and the risk of impacts on groundwater quality,	Monitoring will inform further mitigation requirements, if needed.	Minor impact Moderate effect (Significant)	A hierarchy of further mitigation, as discussed in Volume 2, CFA Report 9, Section 13.3 of the main ES, if	Neutral (Not significant)	Construction (temporary)

	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
				particularly at PWS, due to increased turbidity is reduced. There could, however, still be potential for quality to be impacted adversely.			monitoring indicates this will be necessary.		
Main ES	PWS (TH011, TH316) (High)	Balancing ponds	Negligible impact Neutral effect (Not significant)	Potential for infiltration from balancing ponds to pollute Chalk groundwater in areas of SPZs. SPZ1, however, is generally avoided. Water in track drainage or from intercepted land drainage is not expected to contain pollutants and the base of pond material and unsaturated thickness of the Chalk will provide some attenuation of any constituents within the drainage water.	None required	Negligible impact Neutral effect (Not significant)	None	None	Not applicable
AP4 ES	PWS (TH011, TH316) (High)	Balancing ponds	Negligible impact Neutral	The AP4 revised scheme between the original tunnel portal and the northern portal of the former South Heath	None required	Negligible impact Neutral effect	None	None	Not applicable

	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
			effect (Not significant)	green tunnel will now be in bored tunnel. The majority of the ponds, infiltration basins and land drains will no longer be required and this potential effect is removed as a result of the proposed amendment. The impact assessment for the remaining balancing ponds required in the AP4 revised scheme is consistent with that reported in the Main ES.		(Not significant)			

Surface water / groundwater interaction

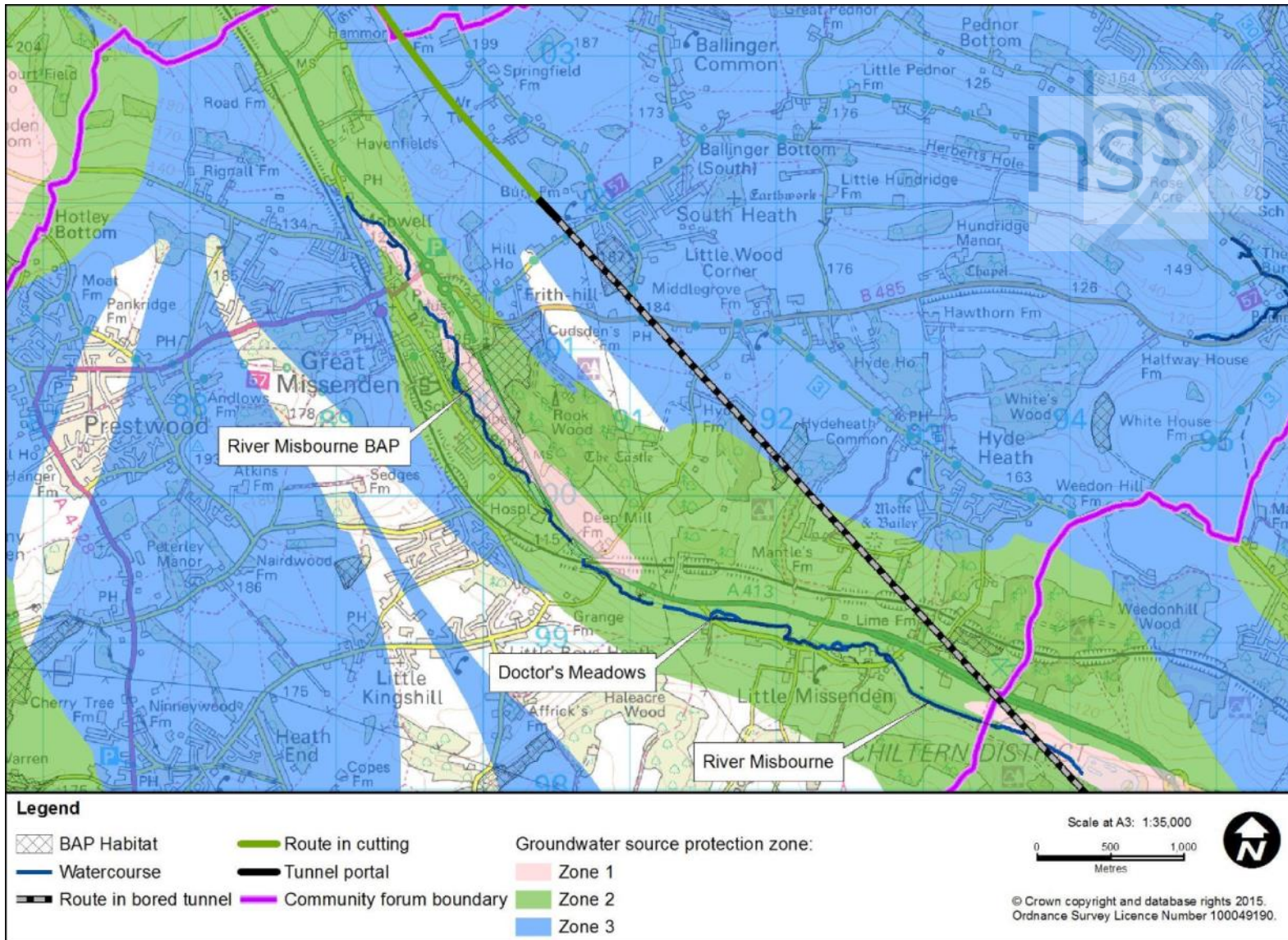
Main ES	River Misbourne (High)	Chiltern tunnel Chiltern tunnel north cutting South Heath green tunnel South Heath cutting	Negligible impact Neutral effect (Not significant)	Turbidity or other contaminants from construction could affect surface water quality. Times of travel, however, are likely to be long enough for attenuation (combining dispersion, diffusion and dilution), during migration to points of	None required	Negligible impact Neutral effect (Not significant)	None	None	Not applicable
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	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
				natural emergence, to reduce turbidity to levels that are unlikely to affect surface water quality.					
AP4 ES	River Misbourne (High)	Chiltern tunnel South Heath cutting	Negligible impact Neutral effect (Not significant)	Turbidity or other contaminants from construction could affect surface water quality. Times of travel, however, are likely to be long enough for attenuation (combining dispersion, diffusion and dilution), during migration of the groundwater to points of natural emergence, to reduce turbidity to levels that are unlikely to affect surface water quality. (See Figure 2 for location)	None required	Negligible impact Neutral effect (Not significant)	None	None	Not applicable
Water dependant habitats									
Main ES	River Misbourne BAP (west of	Chiltern tunnel	Negligible impact	As there will be no significant effect on the	None required	Negligible impact	None	None	Not applicable

	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
	proposed scheme) (High)	Chiltern tunnel north cutting South Heath green tunnel South Heath cutting	Neutral effect (Not significant)	river flows/levels, there will be no adverse impact to the ecological status of this BAP.		Neutral effect (Not significant)			
AP4 ES	River Misbourne BAP (west of revised scheme) (High)	Chiltern tunnel South Heath cutting	Negligible impact Neutral effect (Not significant)	As there will be no significant effect on the river flows/levels, there will be no adverse impact to the ecological status of this BAP. (See Figure 2 for location)	None required	Negligible impact Neutral effect (Not significant)	None	None	Not applicable
Main ES	Doctor's Meadow (south-west of the Proposed scheme at Little Missenden) (Moderate)	Chiltern tunnel Chiltern tunnel north cutting South Heath green tunnel South Heath cutting	Negligible impact Neutral effect (Not significant)	This meadow is in connectivity with the River Misbourne and potentially groundwater. As there will be no adverse effect to the groundwater levels or the River Misbourne at Doctor's Meadow, there will be no adverse effect to the meadow as a	None required	Negligible impact Neutral effect (Not significant)	None	None	Not applicable

	Groundwater receptor (and value)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
				result of changes to the hydraulic and hydrogeological regime.					
AP4 ES	Doctor's Meadow (south-west of the revised scheme at Little Missenden) (Moderate)	Chiltern tunnel South Heath cutting	Negligible impact Neutral effect (Not significant)	This meadow is in connectivity with the River Misbourne and potentially groundwater. As there will be no adverse effect to the groundwater levels or the River Misbourne at Doctor's Meadow, there will be no adverse effect to the meadow as a result of changes to the hydraulic and hydrogeological regime. (See Figure 2 for location)	None required	Negligible impact Neutral effect (Not significant)	None	None	Not applicable

Figure 2: Map showing relative location of revised scheme and water dependant habitats



5.2 Effect of reduced aquifer thickness due to construction of lined tunnels

5.2.1 The construction of the Chilterns tunnel as a fully sealed entity could affect groundwater flow as a result of obstructing groundwater flow over the tunnel's height. The following calculation, based on Darcy's Law, indicates that lowering the effective transmissivity (by reducing the cross-sectional area of the aquifer) will increase the groundwater elevation up-hydraulic gradient of the tunnel.

5.2.2 Darcy's Law Equation:

$$Q = K \times A \times i$$

in which:

- Q is the aquifer flow (m³/d);
- K is the hydraulic conductivity (m/d);
- A is the cross-sectional area of flow (m²); and
- i is the hydraulic gradient (i.e. $\Delta h \div \Delta L$ or the change in groundwater head (h) over the spatial length between head measurements (L)).

5.2.3 The tunnel, which has a total height of 10m, will reduce the nominal original aquifer thickness of 50m to 40m. As a result, A (the cross-sectional area of flow) would be reduced by 20% across the width of the tunnel. For the same Q passing through the reduced cross-sectional area of flow, a 25% increase in hydraulic gradient is required. As a consequence, there would be a slight increase in head over a spatial length of 10m, equivalent to the width of the tunnel.

5.2.4 The regional hydrogeology map indicates that the hydraulic gradient between the boundary of CFA9 with CFA8 and Mantles Wood is about 10m in 2.7km (see Section 3.3, Volume 5 Appendix WR-002-009 of main ES). The tunnel runs approximately parallel to the hydraulic gradient indicated on the hydrogeology map. However, there is also likely to be a localised hydraulic gradient towards the river along the valley sides, as the river is known to gain flow from groundwater in the area. The tunnel will run at an oblique angle to the localised hydraulic gradient.

5.2.5 Assuming that the localised hydraulic gradient towards the river is of a similar order of magnitude to the regional gradient, then the increase in groundwater level on the up-gradient side of the two tunnels, away from the river valley, would be about 2cm. The increase in groundwater level would be required to force the same groundwater flow through the zone of reduced aquifer thickness across the tunnels.

5.2.6 A change in groundwater level of about 2cm is considered to be too small to change the general pattern of groundwater flow across the study area. In addition, as the increase in groundwater level would occur on the up-gradient side of the tunnel, away from the river valley, it could not affect the current

extent of groundwater flooding observed. Therefore the impact is assessed as negligible.

5.3 Effect of vent shafts on groundwater flow in CFAg

5.3.1 The Little Missenden vent shaft will partially penetrate the Chalk Principal aquifer with the base of the shaft below the water table. As the cross sectional area of the vent shaft will be small in comparison with the overall aquifer dimensions, there will be neutral effect on groundwater flow. Any dewatering from groundwater will be re-injected via recharge wells within the vicinity of the vent shaft with neutral effect on groundwater flow.

5.3.2 The Chesham Road vent shaft will partially penetrate the Chalk Principal aquifer but the base of the shaft will be above the water table. Therefore, the Chesham Road vent shaft will not impact on groundwater flow.

5.4 Assessment of South Heath cutting

5.4.1 The revised scheme South Heath cutting will be deeper and wider than that proposed in the original scheme. However, the cutting for the revised scheme will not penetrate below the groundwater table and there will be no interception of Chalk groundwater.

SES3 and AP4 ES Appendix WR-002-025

Environmental topic:	Water resources and flood risk assessment	WR
Appendix name:	Water resources assessment	002
Community forum area:	Castle Bromwich and Bromford	025

Contents

1	Introduction	1
1.1	Structure of the water resources and flood risk assessment appendices	1
Part 2 Additional Provision Environmental Statement 4		2
2	Summary of changes outside the existing limits of the Bill	2
3	Surface water assessment	3
4	Groundwater assessment	4
List of tables		
Table 1: Design changes outside the existing limits of the Bill relevant to CFA25		2
Table 2: Summary of potential impacts to surface water as a result of design changes outside the existing limits of the Bill		3

1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

- 1.1.1 This appendix provides an update to Appendix WR-002-025 Water resources assessment from the main Environmental Statement (ES) (Volume 5: Appendix WR-001-000). This update should be read in conjunction with Appendix WR-002-025 Water resources assessment from the main ES.
- 1.1.2 This appendix comprises Part 2: Additional Provision 4 Environmental Statement (AP₄ ES).
- 1.1.3 Two specific appendices for each community forum area are provided. For community forum area (CFA) 25 these are:
- a water resources assessment (i.e. this appendix); and
 - a flood risk assessment (Supplementary Environmental Statement 3 (SES₃) and AP₄ ES Appendix WR-003-025).
- 1.1.4 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5 Water resources Map Book.

Part 2 Additional Provision Environmental Statement 4

2 Summary of changes outside the existing limits of the Bill

2.1.1.1 There is one design change outside the existing limits of the Bill with the potential to affect water resources in CFA25, summarised in Table 1.

Table 1: Design changes outside the existing limits of the Bill relevant to CFA25

AP4 ES No	Design change name
AP4-025-001	Change to National Grid diversion through Park Hall nature reserve

3 Surface water assessment

3.1.1 Table 2 summarises the potential impacts and effects to surface water as a result of design changes outside the existing limits of the Bill.

Table 2: Summary of potential impacts to surface water as a result of design changes outside the existing limits of the Bill

	Surface water feature / receptor	Value of surface water feature	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Main ES	River Tame, Dunlop Channel and Plants Brook	High	Rail and associated infrastructure	Minor adverse	Disturbance during construction	Mitigation measures outlined in draft Code of Construction Practice (CoCP). This will include preparation of site specific flood risk management plans for those areas of the site at risk of flooding.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)
AP4 ES	River Tame, Dunlop Channel and Plants Brook	High	Rail and associated infrastructure including change to National Grid diversion	Minor adverse	Disturbance during construction	Mitigation measures outlined in draft CoCP. This will include preparation of site specific flood risk management plans for those areas of the site at risk of flooding.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

4 Groundwater assessment

- 4.1.1 There are no potential new or different impacts to groundwater from the AP4 design amendment.

SES3 and AP4 Appendix WR-003-023

Environmental topic:	Water resources and flood risk assessment	WR
Appendix name:	Flood risk assessment	003
Community forum area:	Balsall Common and Hampton-in-Arden	023

Contents

1	Introduction	1
	1.1 Structure of the water resources and flood risk assessment appendices	1
	1.2 Scope of this assessment	1
	Part 1 Supplementary Environmental Statement 3	3
2	Corrections to Appendix WR-003-023 within the main ES	3
3	Design changes within the existing limits of the Bill	3
	Part 2 Additional Provision 4	4
4	Summary of changes outside the existing limits of the Bill	4
	4.1 Proposed development	4
	4.2 Existing flood risk	5
	4.3 Flood risk management measures	6
	4.4 Post-design change flood risk assessment	7
5	References	11

List of tables

Table 1 - Adjusted flood risk category matrix for surface water flood risk	2
Table 2: Local flood risk receptors	5
Table 3: A452 Kenilworth Road flood levels	8
Table 4: Marsh Lane flood levels	8
Table 5: Summary of potential impacts and effects on flood risk from design changes	9

1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

- 1.1.1 This appendix provides an update to Appendix WR-003-023 Flood risk assessment from the main Environmental Statement (ES) (Volume 5, CFA₂₃). This update should be read in conjunction with Appendix WR-003-023 Flood risk assessment from the main ES.
- 1.1.2 This appendix is structured as follows:
- Part 1: Supplementary Environmental Statement 3 (SES₃); and
 - Part 2: Additional Provision 4 Environmental Statement (AP₄ ES).
- 1.1.3 Two specific appendices for each community forum area (CFA) are provided. For CFA₂₃ these are:
- a water resources assessment report, Main ES Volume 5: Appendix WR-002-023: Water Resources Assessment report
 - a flood risk assessment (FRA) (i.e. this appendix).
- 1.1.4 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5 water resources map book, within this SES₃ and AP₄ ES.

1.2 Scope of this assessment

- 1.2.1 This FRA considers changes to flood risk as a result of:
- design changes outside the existing limits of the Bill (Part 2 of this appendix).
- 1.2.2 The assessments reported within this FRA have been carried out in accordance with the requirements of the National Planning Policy Framework (NPPF)¹. 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.

Methodology, data sources and design criteria

- 1.2.3 This FRA has used the same methodology, design criteria and data sources as reported in sections 2, 3 and 4 of Appendix WR-003-023 within the main ES.
- 1.2.4 The exception to this is the primary data set used to assess surface water flood risk. Since submission of the original scheme ES, the Environment Agency's Flood Map for Surface Water (FMfSW) has since been updated (now referred to as the uFMfSW) using an improved modelling methodology and topographical representation. The uFMfSW provides mapped flood extents for rainfall events with different return

¹ Department for Communities & Local Government, 2012, The National Planning Policy Framework,

SES3 and AP4 ES Appendix WR-003-023

periods to those mapped in the FMfSW and which were used in the assessment of flood risk to the original scheme. Therefore, the criteria for determining high, medium and low risk baseline conditions for surface water flood risk in relation to SES3 and AP4 amendments have been adjusted as set out in Table 1.

Table 1 - Adjusted flood risk category matrix for surface water flood risk

Source of flooding	Flood risk category				
	No risk	Low	Medium	High	Very high
Surface water	No surface water flooding.	Chance of surface water flooding between 1 in 1000 (0.1% AEP) and 1 in 100 (1% AEP)	Chance of surface water flooding between 1 in 100 (1% AEP) and 1 in 30 (3.3% AEP)	Chance of surface water flooding of greater than 1 in 30 (3.3% AEP).	

Part 1 Supplementary Environmental Statement 3

2 Corrections to Appendix WR-003-023 within the main ES

2.1.1 There are no corrections to Appendix WR-003-023.

3 Design changes within the existing limits of the Bill

3.1.1 There are no design changes within the existing limits of the Bill which are relevant to this assessment.

Part 2 Additional Provision 4

4 Summary of changes outside the existing limits of the Bill

4.1 Proposed development

4.1.1 The Bill provides for the realignment of the A452 Kenilworth Road over a distance of 1.7km and with a deviation of approximately 100m east of the existing alignment. AP4-023-001 provides a new roundabout at the A452 Kenilworth Road/Marsh Lane junction.

4.1.2 The proposed development involves the following amendments to the original scheme:-

- a new A452 Kenilworth Road / Marsh Lane roundabout providing exits to Marsh Lane and Mercote Hall Lane (Bridleway M218). A culvert beneath Mercote Hall Lane extended to 46m and increase of the span from 4.6m to 5.1m. The hydraulic model produced for the original scheme assumed a single culvert length beneath the A452 and Mercote Hall Lane of 85m, however, the amended AP4 revised scheme provides scope to increase the distance between the culverts and the proposed scheme model now separates these into two culverts;
- The culvert beneath the A452 Kenilworth Road unchanged from the original scheme but span increased to 5.1m;
- the AP4 revised scheme may result in the flood compensation area proposed for the original scheme being undersized, as the proposed Mercote Hall Lane (Bridleway M218) accommodation overbridge earthworks encroach further into the Bayleys Brook floodplain; and
- earthworks to the new balancing pond located between the HS2 route and the A452 Kenilworth Road are now modelled and encroach further on the existing Bayleys Brook channel.

4.1.3 The amendment also requires the following new scheme elements:-

- extension of the existing culvert crossing beneath Marsh Lane to accommodate the required vehicle access;
- a new 25m culvert to convey the Bayleys Brook under the realigned Marsh Lane; and
- overall there is a net increase in the modelled culvert length of 46m.

Local flood risk receptors

Table 2: Local flood risk receptors

Receptor	Vulnerability Classification (from NPPF)	Pathway	Impacts
A452 Kenilworth Road	More vulnerable	Watercourse	No change in flood risk and no change in status from hybrid bill scheme
Marsh Lane	Less vulnerable	Watercourse	Less than 20mm increase in downstream flood levels. Minor increase in flood levels compared with original scheme due to increase in length to the existing culvert beneath Marsh Lane
Berkswell Marsh SSSI	Water compatible	Watercourse	No change in flood risk and no change in status from original scheme
Mercote Lodge	More vulnerable	Watercourse	Less than 10mm increase in flood levels. No change in status from original scheme
Agricultural Land	Less vulnerable	Watercourse	Localised increase in depths immediately downstream of the proposed scheme. No change in status from original scheme

Description of AP4 amendments relevant to flood risk

4.1.4 The following AP4 amendments at the Kenilworth Road / Marsh Lane junction may impact flood risk:

- extension of the culverts beneath both Mercote Hall Lane may increase flood levels and impact flood risk; and
- the proposed scheme may result in the hybrid bill flood compensation area being undersized as the proposed Mercote Hall Lane diversion encroaches further into the Bayleys Brook floodplain.

4.1.5 The proposed development also requires the following new scheme elements:-

- extension of the existing culvert crossing beneath Marsh Lane to accommodate the required vehicle manouvers; and
- an additional cvlert to convey the Bayleys Brook beneath the new Marsh Lane exit from the proposed roundabout.

4.1.6 All of the changes documented above may change the local flood risk regime and change the flood risk to local receptors.

4.2 Existing flood risk

Risk of flooding from rivers

Bayleys Brook

4.2.1 There is no change in existing flood risk from this source.

Risk of flooding from surface water

4.2.2 There is no change in existing flood risk from this source.

Risk of flooding from groundwater

4.2.3 There is no change in existing flood risk from this source.

Risk of flooding from drainage systems

4.2.4 There is no change in existing flood risk from this source.

Risk of flooding from artificial sources

4.2.5 There is no change in existing flood risk from this source.

Summary of baseline flood risk

4.2.6 There are no changes in flood risk from baseline sources of flood risk from those represented in the original scheme ES.

4.3 Flood risk management measures

Risk of flooding from rivers

4.3.1 The amendment to provide a roundabout at the A452 Kenilworth Road/Marsh Lane junction results in a net increase in the length of culverted watercourse when compared with the original scheme. The net increase in culverted section of watercourse results in a corresponding increased in flood levels impacting agricultural land. To manage flood levels the span of the culverts beneath the Mercote Hall Lane and A452 Kenilworth Road realignment will be increased from 4.8m to 5.1m. The new culvert beneath Marsh Lane will also be sized to a 5.1m span.

Risk of flooding from surface water

4.3.2 No additional management measures are proposed.

Risk of flooding from groundwater

4.3.3 No additional management measures are proposed.

Risk of flooding from drainage systems

4.3.4 No additional management measures are proposed.

Risk of flooding from artificial sources

4.3.5 No additional management measures are proposed.

Summary of baseline flood risk

4.3.6 No additional management measures are proposed.

4.4 Post-design change flood risk assessment

- 4.4.1 There is the potential for the scheme to change the baseline risk of flooding described in Section 4.2 of this appendix. Though designed such that the probability of the scheme flooding in any given year is less than 1 in 1,000, any change to the baseline risk of flooding could impact on the assessment of flood risk to the scheme. All cases of flood risk discussed in Section 4.2 of this appendix are therefore reconsidered regardless of whether or not third party local receptors are present.

Impact on risk of flooding from rivers

Bayleys Brook

Description

- 4.4.2 The amendment to provide a roundabout at the A452 Kenilworth Road/Marsh Lane junction as described in section 4.1 of this appendix may impact flood risk. The potential impact to receptors are assessed in the following sections.

Local receptors and land use

- 4.4.3 Land use impacted is typically floodplain and replacement floodplain storage which is water compatible. Kenilworth Road and Mercote Lodge are also potential receptors and classified as more vulnerable. Marsh Lane, located downstream of Kenilworth Road is also a potential receptor and classified as less vulnerable.
- 4.4.4 The A452 Kenilworth Road and Mercote Hall Lane (Bridleway M218) accommodation overbridge crosses the Bayleys Brook immediately east (upstream) of the existing A452 Kenilworth Road which will be realigned.
- 4.4.5 The A452 Kenilworth Road realignment and culvert conveying Bayleys Brook have been incorporated into the baseline hydraulic model of the Bayleys Brook to produce a post-development model. The A452 Kenilworth Road realignment in the original scheme is also included. The full range of flood events (50%, 10%, 5%, 2% and 1% AEP) up to the 1% AEP plus climate change (CC) have been simulated within this model to determine the impact on the performance of the Bayleys Brook.
- 4.4.6 The relative changes in water level between the baseline model and the post-development model are presented in Table 3.

Table 3: A452 Kenilworth Road flood levels

HS2 Feature	Return Period (years)					
	2	10	20	50	100	100 plus CC
A452 Kenilworth Road realignment and Mercot Hall Lane (Bridleway M218)- Baseline	89.605	89.704	89.707	89.741	89.843	90.028
(XS 8 – U/S A452)						
A452 Kenilworth Road realignment and Mercot Hall Lane (Bridleway M218)- - PD	89.443	89.586	89.642	89.735	89.845	90.016
(XS 8 – U/S A452)						
XS 8 – Change	-0.162	-0.118	-0.065	-0.006	0.002	-0.012

4.4.8 The flood levels indicate a significant reduction in flood levels upstream of the culvert structure at lower return periods due to an increase in culvert capacity. The reduction is less than predicted for the original scheme and no increase in flood level is predicted at higher return periods.

Marsh Lane & Mercote Lodge

4.4.9 The relative changes in water level between the baseline model and the post-development model upstream of Marsh Lane are presented in Table 4.

Table 4: Marsh Lane flood levels

HS2 Feature	Return Period (years)					
	2	10	20	50	100	100 plus CC
(XS 5 – U/S Marsh Lane) – Baseline	88.764	88.993	89.081	89.358	89.518	89.731
(XS 5 – U/S Marsh Lane) – Post Development	88.768	88.999	89.086	89.372	89.533	89.734
XS 5 - Change	0.004	0.006	0.005	0.014	0.015	0.003

4.4.10 There is a predicted increase in flood level of 16mm upstream of the existing Marsh Lane culvert which has been extended to accommodate the revised turning access. The levels of the existing Marsh Lane are below the 1 in 100 year plus climate change event levels and the culvert extension may therefore pose an increase in risk to this receptor. Further mitigation may be explored once the extent of the turning area and exact length of the culvert increase is understood. It is anticipated that this risk could be managed by increasing the dimensions of the culvert extension if necessary. Mercote Lodge to the north of Marsh Lane is located above the existing flood level but with minimal freeboard and as such there would be a potential increase in flood risk without further mitigation.

Berkswell Marsh SSSI

4.4.11 There is no predicted change in flood levels to Berkswell Marsh SSSI.

Agricultural Land

4.4.12 Flood levels to the land located between the Marsh Farm viaduct and the A452 Kenilworth Road are maintained at levels similar to those reported in the main ES but there is still a predicted increase in flood levels of up to 54mm locally within the area between the viaduct and Mercote Hall Lane. These flood levels do not take into account the proposed flood compensation area.

Summary of potential impacts and effects on flood risk

Table 5: Summary of potential impacts and effects on flood risk from design changes

Receptor	Vulnerability classification	Pathway	Design change resulting in impact	Effects
Bayleys brook	Water Compatible	Watercourse - Fluvial	AP4-023-001	With the proposed mitigation in place there is a minor increase in predicted flood level upstream of the realigned Marsh Lane
A452 Kenilworth Road	More vulnerable	Watercourse - Fluvial	AP4-023-001	Reduction in flood levels compared with the original scheme.
Marsh Lane	Less vulnerable	Watercourse - Fluvial	AP4-023-001	With the proposed mitigation in place there is a minor increase in predicted flood level upstream of the realigned Marsh Lane
Berkswell Marsh SSSI	Water compatible	Watercourse - Fluvial	AP4-023-001	No change from original scheme. No change in flood levels.

Receptor	Vulnerability classification	Pathway	Design change resulting in impact	Effects
Mercote Lodge	More vulnerable	Watercourse - Fluvial	AP ₄ -023-001	With the proposed mitigation in place there is a minor increase in predicted flood level upstream of the realigned Marsh Lane that may impact flood risk to Mercote Lodge
Agricultural Land	Less vulnerable	Watercourse - Fluvial	AP ₄ -023-001	No significant change from hybrid bill scheme

Residual flood risk

- 4.4.13 The amendment to provide a new roundabout at the A₄₅₂ Kenilworth Road/Marsh Lane junction will result in a predicted minor increase in flood levels associated with the increase in culverting of the Bayleys Brook. Without further mitigation this would result in an increase in the residual flood risk to both Marsh Lane and potentially Mercote Lodge. The flood risk assessment assumes extension of the existing culvert to match the existing dimensions. It is expected that this risk can be managed by increasing the culvert dimensions and / or improving the existing inlet conditions.

5 References

Department for Communities & Local Government, (2012), The National Planning Policy Framework.

Environmental topic:	Water resources and flood risk assessment	WR
Appendix name:	Flood risk assessment	003
Community forum area:	Castle Bromwich and Bromford	025

Contents

1	Introduction	3
1.1	Structure of the water resources and flood risk assessment appendices	3
1.2	Scope of this assessment	3
	Part 1 Supplementary Environmental Statement 3	5
2	Corrections to Appendix WR-003-025 within the main ES	5
3	Design changes within the existing limits of the Bill	5
	Part 2 Additional Provision 4	6
4	Summary of changes outside the existing limits of the Bill	6
4.1	Proposed development	6
4.2	Existing baseline - flood risk	8
4.3	Flood risk management measures	8
4.4	Post-design change flood risk assessment	9
5	References	17
	List of tables	
	Table 1: Adjusted flood risk category matrix for surface water flood risk	4
	Table 2: Local Flood Risk Receptors for 1 in 100 year plus allowance for climate change river flooding	7
	Table 3: Comparison of 1 in 10 year river flood events at Kingsbury Pallets	11
	Table 4: Summary of potential impacts and effects on flood risk from amendments at a 1 in 100 year plus climate change river flood event	14
	Table 5: Summary of potential impacts and effects on flood risk from amendments at other river return periods examined to date	15

1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

- 1.1.1 This appendix provides an update to Appendix WR-003-025 Flood risk assessment from the main Environmental Statement (ES) (Volume 5, CFA 25). This update should be read in conjunction with Appendix WR-003-025 Flood risk assessment from the main ES.
- 1.1.2 This appendix is structured as follows:
- Part 1: Supplementary Environmental Statement 3 (SES₃); and
 - Part 2: Additional Provision 4 Environmental Statement (AP₄ ES).
- 1.1.3 Two specific appendices for each community forum area (CFA) are provided. For CFA₂₅ these are:
- a water resources assessment (SES₃ and AP₄ ES Appendix WR-002-025); and
 - a flood risk assessment (FRA) (i.e. this appendix).
- 1.1.4 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5 water resources map book, within this SES₃ and AP₄ ES.

1.2 Scope of this assessment

- 1.2.1 This FRA considers changes to flood risk as a result of:
- design changes which require a change to the Bill (Part 2 of this appendix).
- 1.2.2 The assessments reported within this FRA have been carried out in accordance with the requirements of the National Planning Policy Framework (NPPF)¹. 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.

Methodology, data sources and design criteria

- 1.2.3 This FRA has used the same methodology, design criteria and data sources as reported in sections 2, 3 and 4 of Appendix WR-003-025 within the main ES.
- 1.2.4 The exception to this is the primary data set used to assess surface water flood risk. Since submission of the main ES, the Environment Agency's Flood Map for Surface Water (FMfSW) has since been updated (now referred to as the

¹ Department for Communities & Local Government, 2012, The National Planning Policy Framework,

uFMfSW) using an improved modelling methodology and topographical representation. The uFMfSW provides mapped flood extents for rainfall events with different return periods to those mapped in the FMfSW and which were used in the assessment of flood risk to the original scheme. Therefore, the criteria for determining high, medium and low risk baseline conditions for surface water flood risk in relation to SES3 and AP4 amendments have been adjusted as set out in Table 1.

Table 1: Adjusted flood risk category matrix for surface water flood risk

Source of flooding	Flood risk category				
	No risk	Low	Medium	High	Very high
Surface water	No surface water flooding.	Chance of surface water flooding between 1 in 1000 (0.1% AEP) and 1 in 100 (1% AEP)	Chance of surface water flooding between 1 in 100 (1% AEP) and 1 in 30 (3.3% AEP)	Chance of surface water flooding of greater than 1 in 30 (3.3% AEP).	

Part 1 Supplementary Environmental Statement 3

2 Corrections to Appendix WR-003-025 within the main ES

2.1.1 There are no corrections proposed to Appendix WR-003-025 within the main ES.

3 Design changes within the existing limits of the Bill

3.1.1 There are no design changes within the existing limits of the Bill which are relevant to this assessment.

Part 2 Additional Provision 4

4 Summary of changes outside the existing limits of the Bill

4.1 Proposed development

- 4.1.1 The Bill provides for the permanent diversion of the existing overhead power lines and pylons through Park Hall nature reserve. Since submission of the Bill, further design development also confirmed that the diversion route shown in the Bill was not acceptable to National Grid due to the topography of the area, and the likely addition of Parkhill Wood and Langley Wood to the ancient woodland inventory. The AP₄ revised scheme includes an amendment to provide an alternative overhead line diversion at Park Hall nature reserve (AP₄-025-001).
- 4.1.2 The overhead line route in the original scheme, included the removal of the two pylons founded on islands (as shown in Figure 1). This is no longer proposed and the overhead power line will remain in its original location. In order to achieve sufficient vertical clearance of the overhead lines above the HS2 route, the two pylons will be replaced with taller pylons on the island platforms. Retaining the pylons on islands will result in a reduction in the replacement floodplain storage proposed at Park Hall nature reserve.
- 4.1.3 An area of additional replacement floodplain storage has been identified and a modification to the storage area in the eastern extent of Park Hall nature reserve has been made as shown in Figure 1.

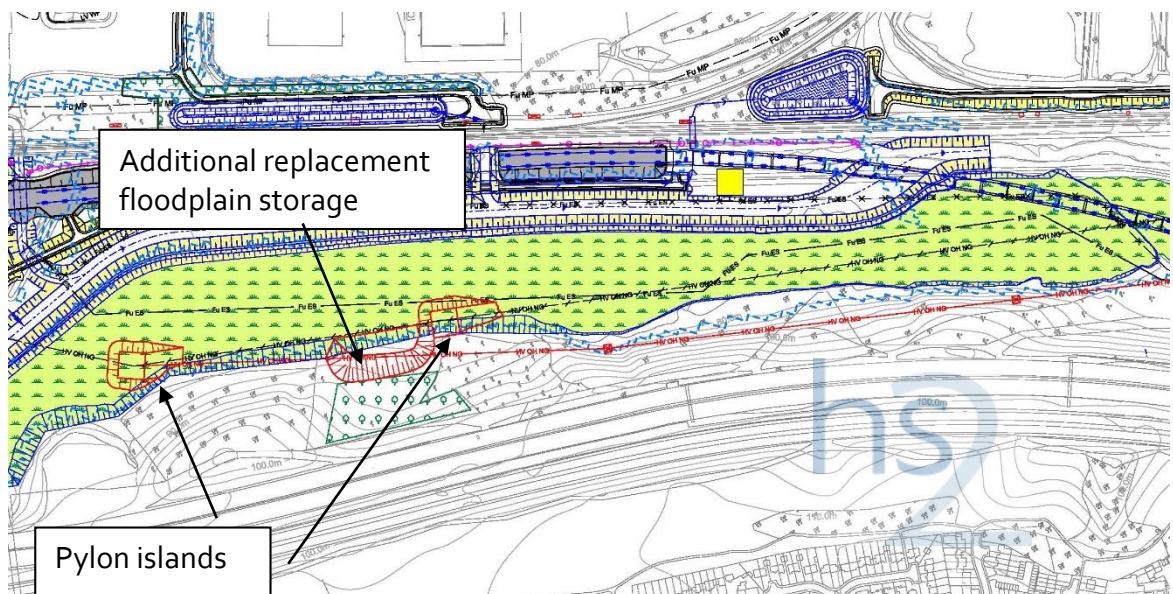


Figure 1: Location of retained pylons and additional replacement floodplain storage

Local flood risk receptors

4.1.4 Table 2 provides details of receptors potentially affected by the amendment to the overhead line diversion at Park Hall nature reserve (AP4-025-001). It excludes any impacts at the boundary of the flood extent as it is unlikely that the amendment has introduced these and they are not deemed to be true impacts. These are generally small changes that can be introduced due to rounding errors within model runs which can result in a few cells changing in extent or level.

Table 2: Local Flood Risk Receptors for 1 in 100 year plus allowance for climate change river flooding

Receptor	Vulnerability Classification (from NPPF)	Pathway	Impacts
Park Hall nature reserve	Water compatible	Watercourse	River realignment work required for implementation of the original scheme requires local replacement floodplain storage within Park Hall nature reserve. This will increase the extent of the floodplain in this area while safeguarding other areas against any increase. In places there is a major increase in flood depths and a change to the Defra flood hazard classification in the westerly area of Park Hall nature reserve to "Danger to all". In the main ES the westerly extent of Park Hall nature reserve was classed as "Danger to most".
Dunlop channel	Water compatible	Watercourse	There is minor increase to flood depths in this area and also change of extents.
Industrial area off Water Orton Lane	Less vulnerable	Watercourse	New receptor The hydraulic model predicts minor increases to flood depths in three, 36m ² areas. There is no change to the Defra flood hazard classification nor frequency of flooding, therefore the scheme will not change the flood risk at this location.
River Tame	Water compatible	Watercourse	Minor changes to flood depths in the river channel upstream of Park Hall nature reserve.

4.1.5 In addition to the receptors identified at the 1 in 100 year plus an allowance for climate change river flood (1%AEP +CC) event, there are changes to flood risk at lower return periods. To date, the 1 in 10 year (10% AEP), 1 in 75 year (1.3% AEP) and 1 in 100 year (1% AEP) events have been modelled and the results discussed in subsequent sections.

Description of AP4 amendments relevant to flood risk

4.1.6 The amendment to provide an alternative overhead line diversion at Park Hall nature reserve includes a temporary diversion of the overhead line and a permanent diversion along the original alignment. Taller pylons (approximately 9m taller) will be replaced on the retained island platforms at existing ground level. These "islands" will be in the form of an approximately 25m by 25m flat platform with 1 in 3 side slopes down to the replacement floodplain storage level. This results in a decrease in the area of replacement floodplain storage.

- 4.1.7 Retaining the overhead line and the taller pylons on the island platforms along the existing alignment reduces the available storage by 8720m³ at the 1 in 100 year river flood event with an allowance for climate change. The provision of the additional replacement floodplain storage area shown in Figure 1 provides 5090m³ of new storage.

4.2 Existing baseline - flood risk

Risk of flooding from rivers

River Tame

Flood risk to AP4-025-001

- 4.2.1 There is no change in existing flood risk from this source.

Dunlop channel

Flood risk to AP4-025-001

- 4.2.2 There is no change in existing flood risk from this source.

Plants Brook

Flood risk to AP4-025-001

- 4.2.3 There is no change in existing flood risk from this source.

Risk of flooding from surface water

- 4.2.4 There is no change in existing flood risk from this source.

Risk of flooding from groundwater

- 4.2.5 There is no change in existing flood risk from this source.

Risk of flooding from drainage systems

- 4.2.6 There is no change in existing flood risk from this source.

Risk of flooding from artificial sources

- 4.2.7 There is no change in existing flood risk from this source.

Summary of baseline flood risk

- 4.2.8 There are no changes in flood risk from baseline sources of flood risk from those represented in the main ES.

4.3 Flood risk management measures

Risk of flooding from rivers

- 4.3.1 A new area of replacement floodplain storage has been identified adjacent to the amendment within Park Hall nature reserve, as shown in Figure 1.
- 4.3.2 A modification to the easterly replacement floodplain storage has been included. This modification is within the original limits of the Bill.

Risk of flooding from surface water

4.3.3 Not applicable to this assessment.

Risk of flooding from groundwater

4.3.4 Not applicable to this assessment.

Risk of flooding from drainage systems

4.3.5 Not applicable to this assessment.

Risk of flooding from artificial sources

4.3.6 Not applicable to this assessment.

Summary of baseline flood risk

4.3.7 No additional management measures are proposed.

4.4 Post-design change flood risk assessment

4.4.1 There is the potential for the AP4 revised scheme to change the baseline risk of flooding described in Section 4.2 of this appendix. Though designed such that the probability of the scheme flooding in any given year is less than 1 in 1,000, any change to the baseline risk of flooding could impact on the assessment of flood risk. All cases of flood risk discussed in Section 4.2 of this appendix are therefore reconsidered regardless of whether or not third party local receptors are present.

Impact on risk of flooding from rivers

River Tame and associated tributaries

Description

4.4.2 As a result of the amendment to the overhead line diversion at Park Hall nature reserve and the retention of two pylons on island platforms within the replacement floodplain storage area, there is an increased risk of flooding due to loss of floodplain volume.

Local receptors and land use

4.4.3 Land use impacted is typically floodplain and replacement floodplain storage which is classified as water compatible. Downstream of Park Hall nature reserve there is an industrial area which is classified as less vulnerable.

Potential effects

Potential for the 1 in 100 year plus an allowance for climate change river flood event

4.4.4 The amendment to the overhead line diversion at Park Hall nature reserve has the potential to affect flood risk to third parties. The impacts of the 1 in 100 year plus an allowance for climate change (1% AEP + CC) event will have a minor impact on flood levels extents in the River Tame upstream of Park Hall nature reserve.

4.4.5 Within Park Hall nature reserve there will be changes of flood extents introduced by the introduction of the amendment, and a negligible impact to water levels in general. To the west of Park Hall nature reserve there is a major increase in flood levels, however, as Park Hall nature reserve is classified as a water compatible area, this has been deemed to have a slight significance effect overall. These are shown in Figure 2.

4.4.6 In Dunlop Channel there will be a minor increase in flood levels and change of extents. Due to the water compatible nature of this area the significance of the effects will be slight.

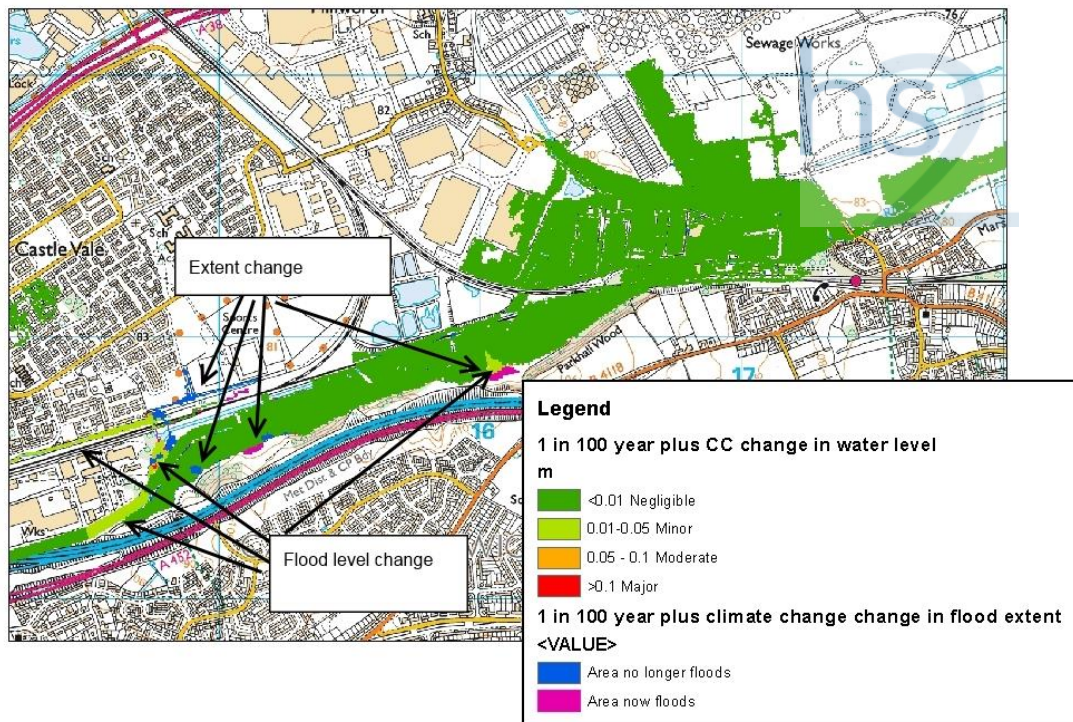


Figure 2: Change in water levels and flood extent between original scheme and AP4 revised scheme for 1 in 100 year plus climate change

4.4.7 There are a few isolated locations at the model boundary where there is a minor increase in water levels, but no change in the Defra FD2321² flood hazard classification. Due to the large distance of these locations in relation to the amendment, it is not considered that these are directly attributable to the AP4 revised scheme.

Potential effects for other return periods examined

4.4.8 Three other return periods have been modelled to date, the 1 in 10 year (10% AEP), 1 in 75 year (1.3% AEP) and 1 in 100 year (1% AEP) river flood events.

4.4.9 At the 1 in 10 year (10% AEP) event there is a major increase in flood levels at the easterly extent of Park Hall nature reserve, within the Water Orton Flood Relief Channel and in the wooded area to the east of the industrial estate off Water Orton

² Defra /Environment Agency Flood and Coastal Defence R&D Programme (2006), Flood Risks to People, Phase 2, FD2321/TR2, Guidance Document

Lane as shown in Figure 3. Due to the water compatible nature of this land the significance of the effect is considered to be slight.

- 4.4.10 There is also a moderate increase in flood levels and flood extent at the outdoor yard of Kingsbury Pallets (an industrial site in the industrial estate off Water Orton Lane) when comparing to the original scheme. Flood depths in this area are typically 70mm with the original scheme. Taking into account the amendment, there is a 27mm increase on average depth and a maximum increase of 96mm when comparing to the Original Scheme. When comparing the Defra flood hazard classification at Kingsbury Pallets, there is a larger area within the "Low" category and 1 model cell (representing an area of 36m²) moves from "Low" into "Danger to Some" as shown in Figure 4.
- 4.4.11 However, comparing to the baseline modelling, there appears to be negligible change to the water level or Defra flood hazard category and hence the effect due to the amendment to the overhead line diversion at Park Hall nature reserve is considered to be neutral which is not significant. Flood depths in this area are typically 99mm under baseline conditions and with the amendment there will be a negligible change to the flood depths in this area.
- 4.4.12 Table 3 gives a comparison of water depths and hazard ratings for the 1 in 10 year (10% AEP) flood event for the baseline, original scheme and the AP4 amendment for the 1 in 10 year (10% AEP) event.

Table 3: Comparison of 1 in 10 year river flood events at Kingsbury Pallets

	Baseline	Original scheme	AP4 amendments
Maximum flood depths	Flood depths of up to 0.235m.	Flood depths of up to 0.180m.	Flood depths of up to 0.230m.
Average flood depths	99mm	70mm	97mm
Maximum change in flood level due to AP4 revised scheme	-	-	<10mm change in water level when compared to baseline. 96mm when compared to original scheme
Flood extents	-	Minor decrease in flood extents compared to baseline	Similar extents to baseline model. Increase in flood extent in comparison to original scheme.
Flood hazard rating	-	Typically in the "low" category	Slight increase from original scheme but negligible difference when compared to baseline.

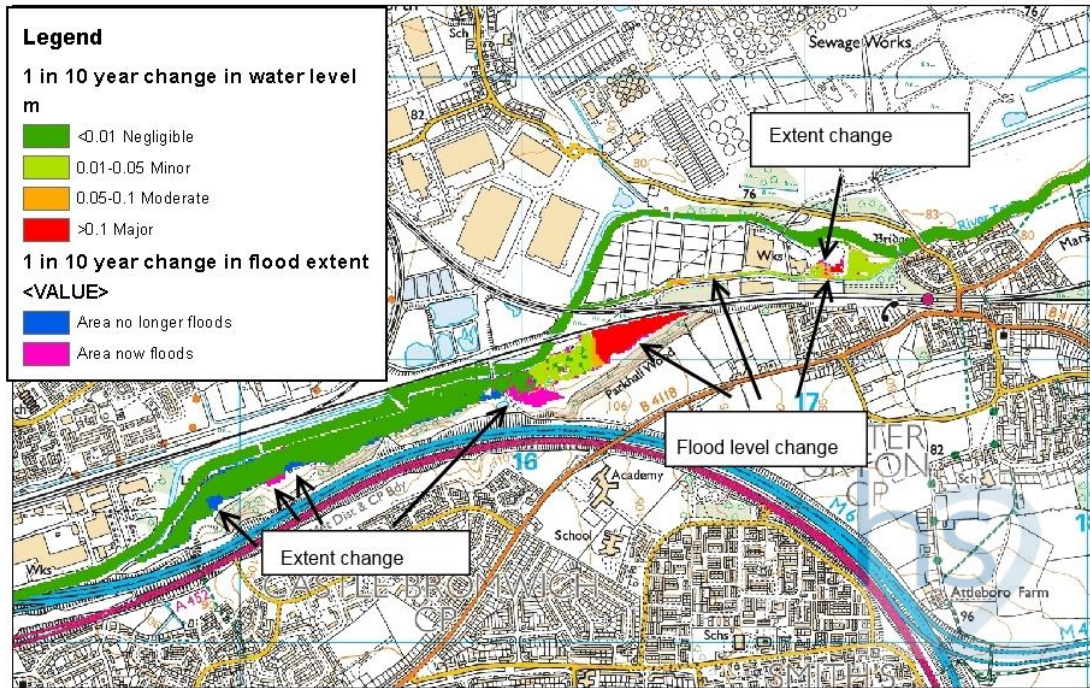


Figure 3: Change in water levels and flood extent between original scheme and AP4 revised scheme for 1 in 10 year plus climate change

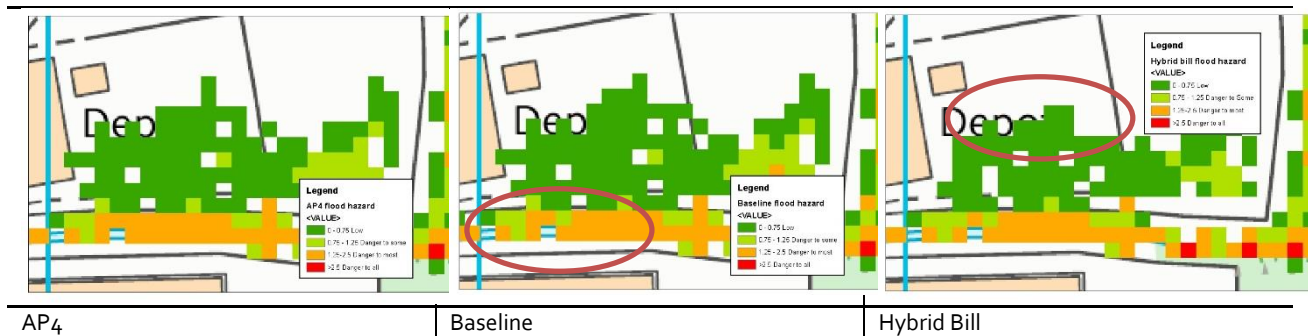


Figure 4: Hazard classification for 1 in 10 year river flood event at Kingsbury Pallets

4.4.13 At the 1 in 75 year (1.3% AEP) flood event there are small changes to flood extent in Park Hall nature reserve due to the amendment and changes at the boundary of the model which are not deemed to be as a direct impact of the AP4 revised scheme. These are shown in Figure 5.

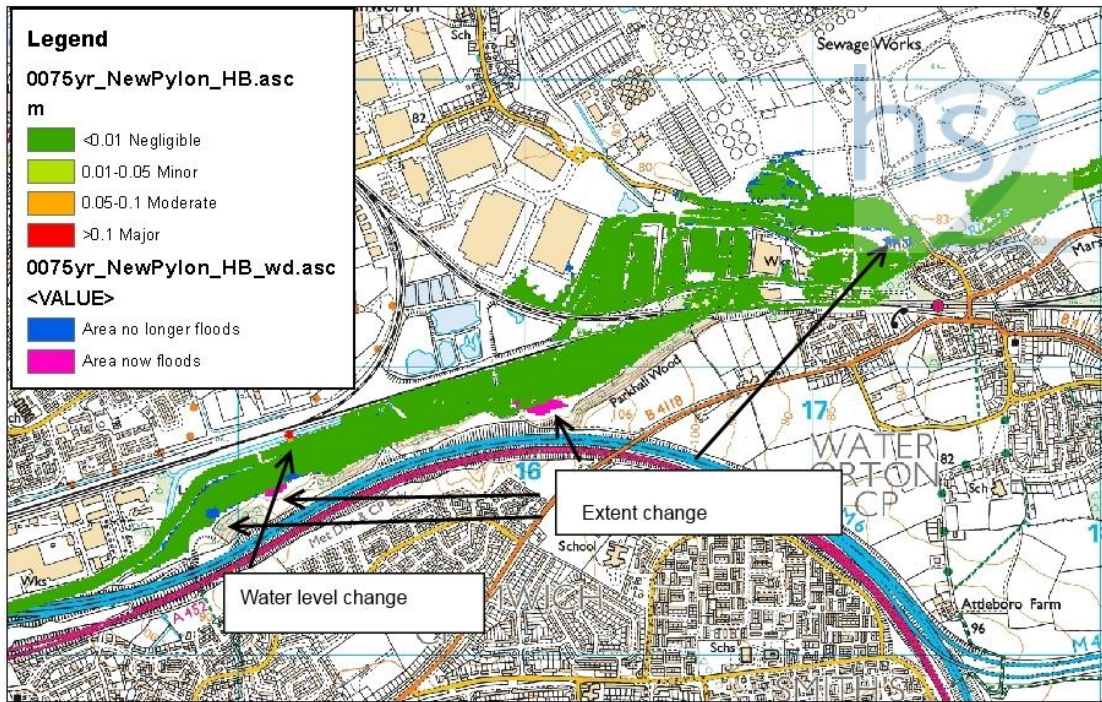


Figure 5: Change in water levels and flood extent between Hybrid Bill and AP4 for 1 in 75 year

- 4.4.14 At the 1 in 100 year (1% AEP) flood event, there is a minor increase in flood levels in the River Tame immediately upstream of Park Hall nature reserve in a localised area. Due to the water compatibility of this receptor the impact is negligible. There are changes to flood extents in Park Hall nature reserve due to the amendment.
- 4.4.15 There is a minor impact on water levels in the River Tame upstream of Park Hall nature reserve as shown in Figure 6. Due to the water compatible nature of this area the effect is considered to be neutral which is not significant.

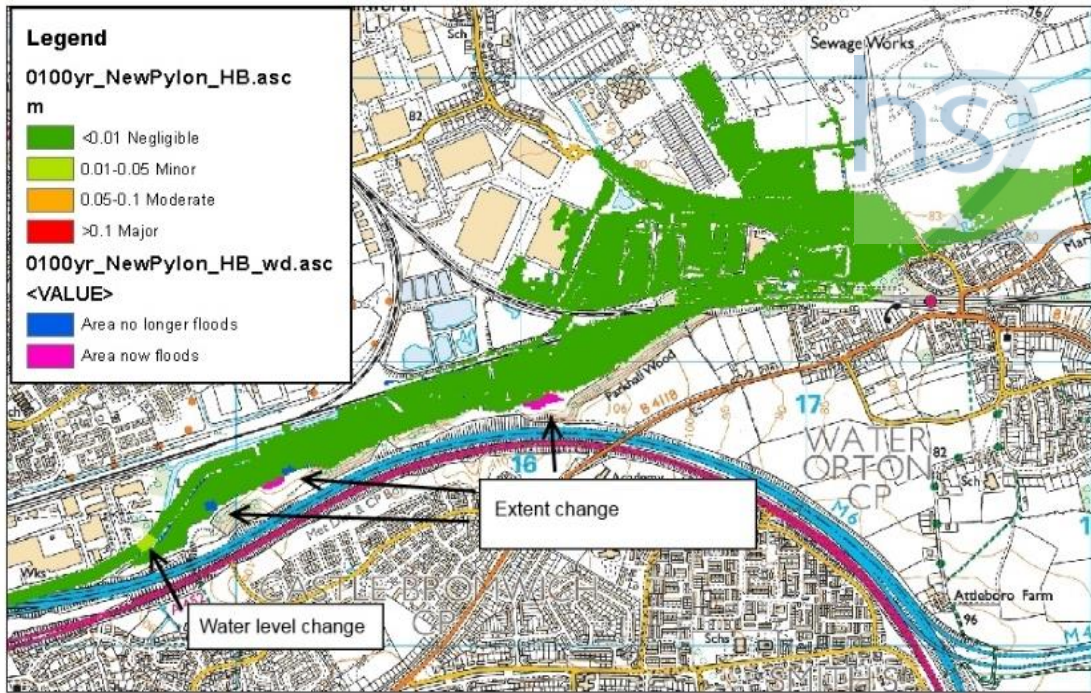


Figure 6: Change in water levels and flood extent between Hybrid Bill and AP4 for 1 in 100 year

Assessment of effects

Impact on the risk of flooding from surface water

4.4.16 Not assessed as part of this AP.

Impact on the risk of flooding from groundwater

4.4.17 Not assessed as part of this AP.

Impact on the risk of flooding from drainage systems

4.4.18 Not assessed as part of this AP.

Impact on the risk of flooding from artificial sources

4.4.19 Not assessed as part of this AP.

Summary of potential impacts and effects on flood risk

Table 4: Summary of potential impacts and effects on flood risk from amendments at a 1 in 100 year plus climate change river flood event

Receptor	Vulnerability classification	Pathway	AP4 amendment leading to impact	Effects
River Tame	Water compatible	Watercourse	AP4-025-001	Minor impacts on water levels.
Dunlop Channel	Water compatible	Watercourse	AP4-025-001	Minor impacts on water levels and change of extents (in some places

SES3 and AP4 ES Appendix WR-003-025

Receptor	Vulnerability classification	Pathway	AP4 amendment leading to impact	Effects
				increased and other decreased).
Park Hall Nature Reserve	Water compatible	Watercourse	AP4-025-001	Negligible impacts on water level. Change of flood extent (in some places increased and other decreased).
Area to west of Park Hall Nature Reserve	Water compatible	Watercourse	AP4-025-001	Major impact on water levels.

Table 5: Summary of potential impacts and effects on flood risk from amendments at other river return periods examined to date

Receptor	Vulnerability classification	Pathway	AP4 amendment leading to impact	Effects
River Tame	Water compatible	Watercourse	AP4-025-001	Minor impacts on water levels.
Park Hall Nature Reserve	Water compatible	Watercourse	AP4-025-001	Major impacts on water level. Change of flood extent (in some places increased and other decreased).
Water Orton Flood Relief Channel	Water Compatible	Watercourse	AP4-025-001	Major impact on water levels.
Industrial area off Water Orton Lane	Less vulnerable	Watercourse	AP4-025-001	Moderate impacts on water levels. Change of extent. No change to flood hazard classification.
Wooded area to east of industrial area off Water Orton Lane	Water compatible	Watercourse	AP4-025-001	Major impact on water levels. A few cells move into a Danger to Some hazard classification but majority of area is unchanged.

Receptor	Vulnerability classification	Pathway	AP4 amendment leading to impact	Effects
Water Orton Flood Relief Channel	Water compatible	Watercourse	AP4-025-001	Major impact on water levels. No change on flood hazard classification.
Plants Brook	Water compatible	Watercourse	AP4-025-001	Major impact on flood levels. No change to flood extents.

Residual flood risk

- 4.4.20 There is a residual risk to a number of water compatible areas. Due to the nature of these areas, the significance is rated as slight and therefore not significant.
- 4.4.21 There is also a residual risk at the industrial area off Water Orton Lane and in particularly Kingsbury Pallets which has a moderate increase in water levels and a change of extent when comparing to the original scheme as reported in the main ES (Volume 5:Appendix WR-003-025). When comparing to the baseline, the changes in depth is negligible and results in no change to flood extents or hazard. Therefore, the impact on this area is negligible and the significance is neutral, which is not significant.

5 References

Department for Communities & Local Government, (2012), The National Planning Policy Framework.

SES₃ and AP₄ ES Appendix WR-001-000

Environmental topic:	Water resources and flood risk assessment	WR
Appendix name:	WFD Route-wide	001
Community forum area:	Route-wide	000

Contents

1	Introduction	1
1.1	Structure of the water resources and flood risk assessment appendices	1
1.2	Purpose of this appendix	1
1.3	Stakeholder engagement	2
2	Water Framework Directive Additional Provision 4	3
2.1	Introduction	3
2.2	Additional Provision 4 changes relevant to the Water Framework Directive	5
2.3	Additional Provision 4 Water Framework Directive assessment conclusions	11

List of tables

Table 1 - Scoped in AP4 amendments	6
Table 2 - Summary of surface water AP4 WFD assessment changes	8
Table 3: Summary of groundwater AP4 WFD assessments	10

List of Annexes

Annex A: Surface water WFD assessments
Annex B: Groundwater WFD assessments

1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

- 1.1.1 This appendix provides an update to Appendix WR-001-000 Route-wide Appendix of the Environmental Statement (ES) published in November 2013 (the 'main ES') (Volume 5 of the main ES) and Appendix WR-001-000 (Volume 5 of the SES and AP2 ES deposited in July 2015).
- 1.1.2 The route-wide water resources and flood risk assessment appendices comprise three main sections. The first of these is a route-wide appendix (i.e. this appendix).
- 1.1.3 Specific appendices for each community forum area (CFA) are also provided, as follows, where there has been a new or different significant effect or an additional provision (AP)4 amendment requiring supporting explanatory material:
- a water resources assessment; and
 - a flood risk assessment (FRA).
- 1.1.4 For some CFA, additional appendices give details of site specific hydraulic models that were created to assist the FRA.
- 1.1.5 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5, Water Resources and Flood Risk Assessment Map Book.
- 1.1.6 This appendix is structured as follows:
- Additional Provision 4 Water Framework Directive (WFD) assessments; and
 - annexes containing the details of the WFD surveys and WFD assessment.
- 1.1.7 There is no requirement for Part 1 SES3 because a scoping exercise determined that the SES3 design changes did not have the potential to give rise to new or different significant route-wide effects in terms of water resources and flood risk. The scoping exercise also determined that the SES3 design changes would not affect WFD water bodies at the catchment scale.

1.2 Purpose of this appendix

- 1.2.1 This appendix reports on water resources related assessments that have been carried out on a route-wide basis since submission of the AP2 ES. It encompasses an assessment of compliance of the AP4 amendments with the requirements of the Water Framework Directive (WFD) 2000/60/EC¹.

¹ Water Framework Directive - Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Strasbourg, European Parliament and European Council.

1.3 Stakeholder engagement

- 1.3.1 Discussions were held with the Environment Agency during the scoping and WFD assessment of AP4 amendments. Issues raised by the Environment Agency were addressed during the preparation of this report and, where considered appropriate, their comments were incorporated.

2 Water Framework Directive Additional Provision 4

2.1 Introduction

Overview of the Water Framework Directive

- 2.1.1 The WFD aims to protect and enhance the quality of the water environment across all European Union (EU) member states. It takes a holistic approach to the sustainable management of water by considering the interactions between surface water, groundwater and water-dependent ecosystems.
- 2.1.2 Under the WFD, 'water bodies' are the basic management units and are defined as all or part of a river system or aquifer. These water bodies form part of a larger 'river basin district' (RBD), for which 'river basin management plans' (RBMPs) are developed by EU member states and environmental objectives are set. These RBMPs are produced every six years, in accordance with the river basin management planning cycle. The most recent RBMPs were produced in 2009. The next plans are due in 2015.
- 2.1.3 The WFD requires all EU member states to classify the current condition or 'status or potential' of surface water and groundwater bodies and to set a series of objectives for maintaining or improving conditions so that water bodies maintain or reach 'good status or potential'.

Water Framework Directive requirements for new developments

- 2.1.4 To ensure compliance with the WFD, decision makers must consider whether proposals for new developments have the potential to:
- cause a deterioration of a water body from its current status or potential; and/or
 - prevent future attainment of good status or potential where not already achieved.

2.1.5 This appendix assesses potential for deterioration.

2.1.6 The assessment of prevention of future attainment of good status or potential was presented in the main ES taking into account the Environment Agency reasons for failure and programme of measures in the RBMP. The assessment concluded that the original scheme will not prevent future attainment of good status or potential where not already achieved.

2.1.7 The Environment Agency is generally responsible for implementation of the WFD in England.

Water Framework Directive assessment in the main ES

2.1.8 The original scheme will cross a large number of surface water bodies and groundwater bodies. An assessment of the original scheme's compliance against the WFD objectives of the potentially affected water bodies was provided in the Volume 5 Appendix WR-001-000 of the main ES.

- 2.1.9 The route-wide WFD assessment considered effects on 60 surface water bodies and 15 groundwater bodies which lie within the original scheme boundary, and those which lie up and downstream for which there is a potential risk of impacts. The scope and the assessment methodology were agreed with the Environment Agency.
- 2.1.10 The majority of the original scheme is predicted to result in local or temporary effects that are considered unlikely to affect WFD status at the water body scale even though potential risks to individual WFD elements were identified for a number of the water bodies. A detailed description of the WFD elements is provided in Appendix WR-001-000 of the main ES.
- 2.1.11 The assessment concluded that the original scheme will not prevent future attainment of good status or potential where not already achieved.
- 2.1.12 The assessment also concluded that 45 surface water bodies and six groundwater bodies will not experience any deterioration in current status or potential.
- 2.1.13 For 15 surface water bodies and nine groundwater bodies there was considered to be a risk of deterioration. For 11 of the surface water bodies and eight of the groundwater bodies, the risk of deterioration in status was considered to be low.
- 2.1.14 For the remaining four surface water bodies and one groundwater body a higher risk of deterioration in current status or potential was documented despite mitigation measures identified in all the CFA reports.
- 2.1.15 The assessment was undertaken on a precautionary basis given that the baseline data was not available for all the affected water bodies and tributaries, and that the design of mitigation measures is at an outline stage.

Water Framework Directive assessment of SES design changes and AP amendments

- 2.1.16 Scoping of SES design changes and AP amendments on WFD compliance concluded that:
- AP₁ amendments are not considered likely to affect WFD water bodies at the catchment scale;
 - SES design changes, including the results of WFD surveys carried out in 2014, and AP₂ amendments should be assessed; and
 - SES₂ changes and AP₃ amendments are not considered likely to affect WFD water bodies at the catchment scale.
- 2.1.17 A WFD compliance assessment was therefore not included within Volume 3 or Volume 5 of the AP₁ ES or the SES₂ and AP₃ ES.
- 2.1.18 Compliance with the WFD was considered in Volume 3 of the SES and AP₂ ES. Details of the assessment are presented in Appendix WR-001-000 Volume 5 of the SES and AP₂ ES.
- 2.1.19 The conclusions from assessment of the SES and the WFD survey results were that, of the 15 water bodies considered to be at amber risk of deterioration in the main ES, six

surface water bodies have a reduced risk of deterioration. The amber risk of deterioration for the other nine surface water bodies remains unchanged and the risk to groundwater bodies also remains unchanged.

- 2.1.20 The assessment concluded that, as for the original scheme, there would be no breach of the WFD as a result of the SES design changes and AP₂ amendments.
- 2.1.21 The WFD assessment of AP₄ amendments uses the SES and AP₂ WFD assessments as the baseline. This is a precautionary approach which allows for the cumulative effect of the original scheme and all SES design changes and AP amendments up to the SES₃ and AP₄ ES which may have an adverse effect.

2.2 Additional Provision 4 changes relevant to the Water Framework Directive

- 2.2.1 Ten AP₄ amendments were scoped in as having the potential to have a significant effect on WFD compliance. The AP₄ amendments, along with three utility changes, and the relevant water bodies are summarised in Table 1.

SES₃ and AP₄ ES Appendix WR-001-000

Table 1 - Scoped in SES₃ and AP₄ design changes and amendments

CFA number and name	Design change or amendment reference	WFD assessment reference	Design change or amendment name	Scoped in for surface water body	Scoped in for groundwater body
6 – South Ruislip to Ickenham	SES ₃ -006-001	AP-C221-082	Extension of West Ruislip (porous) portal	Yeading Brook (West Arm)	N
7 – Colne Valley	AP ₄ -007-003	AP-C222-061	Affinity Water Turbidity Treatment	River Colne & GUC	Mid-Chilterns Chalk
	AP ₄ -006-004	AP-C221-088	Haul Road through Uxbridge Golf Course	River Colne & GUC	Radlett Tertiaries
9 – Central Chilterns	AP ₄ -009-001	AP-C222-284	Chiltern Tunnel Extension	Misbourne	Mid-Chilterns Chalk
11- Stoke Mandeville and Aylesbury	AP ₄ -011-001	AP-C222-072	Move Footpath Overbridge SBH/32	Stoke Brook Aylesbury	N
16 – Ladbroke and Southam	AP ₄ -016-002	AP-C223-202	Relocation of the viaduct crossing the Oxford Canal	Oxford Canal	N
18 - Stoneleigh, Kenilworth and Burton Green	SES ₃ -018-002	AP-C223-220	Extend Burton Green tunnel south porous portal by 40m	Canley Brook - source to confluence with Finham Brook	Warwickshire Avon - Coal Measures Coventry
19 – Coleshill Junction	AP ₄ -019-001 (Part of Group)	AP-C223-112 (68/73/157/160/164) (Also to include 235)	Chattle Hill Group	River Tame from Conf of the two arms to R Blythe	Tame Anker Mease - Secondary Combined
	AP ₄ -019-003	AP-C223-233	Temporary improvements to the junction of the A446 Lichfield Road and B4118 Marsh Lane to the East of Water Orton	River Tame from Conf of the two arms to R Blythe	Tame Anker Mease - Secondary Combined
23 – Balsall Common and Hampton-in-Arden	AP ₄ -023-001	AP-C224-025	A452 Kenilworth Road/Marsh Lane junction	River Blythe from Patrick Bridge to River Tame	Tame Anker Mease - Secondary Combined
18 – Stoneleigh, Kenilworth and Burton Green		CNO-137-002	National Grid (Gas Distribution) – 600mm steel high pressure main at Stoneleigh	N	Warwickshire Avon - PT Sandstone Warwick/Avon Confined
		CNO-145-008	British Pipelines Agency – 250mm fuel pipeline at Burton Green	N	Warwickshire Avon - Coal Measures Coventry
20 – Curdworth to Middleton		CNO-172-001	High-Pressure Gas Main Diversion Route and Associated Site Compound	N	Tame Anker Mease - Secondary Combined

Surface water body assessment

Presentation of findings

- 2.2.2 The assessment for each surface water body is presented in Annex A using the same matrix approach as the main ES and the SES and AP2 ES. New or different HS2 scheme elements associated with AP4 amendments are highlighted in columns.
- 2.2.3 The ten relevant AP4 amendments have the potential to affect eight surface water bodies.

No deterioration assessment

- 2.2.4 The surface water assessment results are contained in Annex A. A summary of the findings is presented in Table 2. The baseline condition for the AP4 amendments assessment includes the SES WFD survey results and AP2 amendments.
- 2.2.5 Changes arising from AP4 amendments are summarised in the final column of Table 2. All eight of the surface waterbodies potentially affected remain at the same level of risk as in the main ES.
- 2.2.6 The River Blythe had previously been assessed as being adversely affected (amber). The AP4 scheme elements have been assessed as having a minor impact individually, but contribute to the cumulative impact in combination with other scheme elements (original scheme and AP2 amendments). Subsequently, the AP4 revised scheme elements slightly increase the risk of deterioration from the previous assessment, but the risk remains amber.
- 2.2.7 For the waterbodies including the River Colne and Oxford Canal, the AP4 revised scheme elements have also been assessed as having a minor impact individually, and only making a small contribution to the cumulative impact in combination with other scheme elements (original scheme and AP2 amendments). Consequently, there is no change in the risk of deterioration from the previous assessments.
- 2.2.8 For the waterbodies including the Yeading Brook and River Tame, the AP4 revised scheme elements have been assessed as having no impact individually or cumulatively. Therefore there is no change in the risk of deterioration from the previous assessments, and in the case of the River Tame, a minor beneficial impact is still predicted.
- 2.2.9 The Canley Brook had previously been assessed as being adversely affected (amber). The AP4 revised scheme elements have been assessed as having no impact individually or cumulatively. Therefore there is no change in the risk of deterioration from the previous assessment, but the risk remains amber.

Table 2 - Summary of surface water AP4 WFD assessment changes

Surface water body name	Water body ID	Catchment	CFA (number)	SES baseline survey (Y - yes; N - no)	No. of scoped in AP4 amendments within the CFA	Risk of deterioration to overall status		
						Original assessment	Post- SES baseline survey (N/A denotes no change)	Original scheme, SES, AP2 amendments and AP4 amendments
Canley Brook - source to confluence with Finham Brook	GB109054044520	Warwickshire Avon	18	Y	1	amber	amber no change	amber no change
Colne and GUC (from confluence with Chess to Ash)	GB106039023090	Colne	7	Y	2	amber	yellow reduced risk	yellow no change
Misbourne	GB106039029830	Colne	9	N	1	yellow	N/A	yellow no change
R Blythe from Patrick Bridge to R Tame	GB104028042572	Tame Anker and Mease	23, 24	Y	1	amber	amber no change	amber no change
Stoke Brook Aylesbury	GB106039030320	Thame and South Chilterns	11	N	1	amber	N/A	amber no change
Oxford Canal, summit pound	GB70910196	N/A	16	N	1	yellow	N/A	yellow no change
Yeading Brook (West Arm)	GB106039023060	London	5, 6	N	1	green	N/A	green no change
River Tame from Conf of the two arms to R Blythe	GB104028046840	Tame Anker and Mease	19, 20, 25, 26	N	2	blue	N/A	blue no change

Groundwater body assessment

Presentation of findings

- 2.2.10 The assessment for each groundwater body is presented in Annex B of this appendix.
- 2.2.11 Seven relevant AP4 amendments and the three utilities changes have the potential to affect five groundwater bodies.

No deterioration assessment

- 2.2.12 The groundwater assessment results are contained in Annex B of this appendix.
- 2.2.13 A summary of the findings is presented in Table 3. There are no changes to the risks assessed in the main ES for the five groundwater bodies affected by the AP4 revised scheme.

Table 3: Summary of groundwater AP4 WFD assessments

Water Body ID	Groundwater Body Name	CFA (number)	WFD assessment reference	Quantitative WFD elements			Qualitative WFD elements		
				Current	Prediction with AP4 amendment	Comments	Current	Prediction with AP4 amendment	Comments
GB40602G602800	Radlett Tertiaries	5, 6, 7, 8	AP-C221-088	Poor	No significant deterioration	No changes to main ES - Local, minor or temporary effects	Poor	No significant deterioration	No changes to main ES - local, minor or temporary effects
GB40601G601200	Mid-Chilterns Chalk	7, 8, 9, 10	AP-C222-061, AP-C222-284	Poor	No significant deterioration	No changes to main ES - Local, minor or temporary effects	Poor	No significant deterioration subject to Environment Agency approval of mitigation measures	No changes to main ES - risks identified with respect to: Drinking Water Protected Areas
GB40901G300700	Warwickshire Avon - PT Sandstone Warwick/Avon Confined	17, 18	CNO-137-002	Poor	No significant deterioration	No changes to main ES - local, minor or temporary effects	Good	Remains at Good status	No changes to main ES - local, minor or temporary effects
GB40902G302200	Warwickshire Avon - Coal Measures Coventry	17, 18, 23	AP-C223-220 CNO-145-008	Poor	No significant deterioration	No changes to main ES - risks identified with respect to: surface waters and water balance	Poor	No significant deterioration	No changes to main ES - local, minor or temporary effects
GB40402G990800	Tame Anker Mease - Secondary Combined	19, 20, 21, 22, 23, 24, 25, 26	AP-C223-112, AP-C223-233 AP-C224-025 CNO-172-001	Good	Remains at Good status	No changes to main ES - risks identified with respect to: surface waters; GWDTE	Good	Remains at Good status	No changes to main ES - risks identified with respect to: surface waters; GWDTE

2.3 Additional Provision 4 Water Framework Directive assessment conclusions

Change in potential risks to water body status

Surface water

- 2.3.1 All eight surface water bodies potentially affected by AP4 amendments remain at the same level of risk as for the original scheme. The River Blythe remains at amber risk but with a slight increase in the risk of deterioration compared with the original scheme and the AP2 revised scheme. The Canley Brook also remains at amber risk, but there is no change in risk of deterioration from the original scheme and AP2 revised scheme.

Groundwater

- 2.3.2 There were no changes to the risks assessed for the five groundwater bodies affected by the AP4 revised scheme when compared to the risk of deterioration from the original scheme and the AP2 revised scheme.

Compliance

- 2.3.3 As for the main ES and SES, the WFD assessment has been undertaken on a precautionary basis given that the baseline data was not available for all the affected water bodies and tributaries, and that the design of mitigation measures is at an outline stage.
- 2.3.4 The WFD assessment provides an indication of the likely compliance of the HS2 scheme at the time the assessment was prepared. It is based on the original scheme design, incorporated mitigation measures and on the current status of 61 surface water bodies and 16 groundwater bodies.
- 2.3.5 The assessment concluded that, as for the original scheme, where the failure to prevent deterioration in the status of a body of surface water or groundwater is the result of new modifications to the physical characteristics of a surface water body or alterations to the level of bodies of groundwater, there will be no breach of the WFD where:
- all practicable steps are taken to mitigate the adverse impact on the status of the body of water;
 - the reasons for those modifications or alterations are specifically set out and explained in the RBMP;
 - the reasons for those modifications or alterations are of overriding public interest and/or the benefits to the environment and to society of achieving the objectives set out in Article 4.1 of the WFD are outweighed by the benefits of the new modifications or alterations to (among other things) sustainable development; and
 - the beneficial objectives served by those modifications or alterations of the

water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option.

2.3.6 It is concluded that:

- in light of the work carried out by HS2 Ltd in liaison with the Environment Agency, all practicable measures to mitigate any adverse impacts on surface water bodies and groundwater have been identified, and those measures will continue to be reviewed;
- the RBMP process is subject to review and any effects of the original scheme will be taken into account in future RBMP;
- there is an overriding public interest in the construction of the original scheme, and in any event the benefits of the scheme as a form of sustainable development outweigh the benefits of achieving the objectives in Article 4(1) (to the limited extent that the original scheme would hinder the attainment of those objectives); and
- there are no better environmental options to the works described which are technically feasible and proportionate in cost.

2.3.7 For those reasons, even if the original scheme does result in the deterioration in status of a body of surface water or groundwater, there would be no breach of the WFD.

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