HIGH SPEED RAIL (LONDON - WEST MIDLANDS)

Supplementary Environmental Statement and Additional Provision 2 Environmental Statement

Volume 5 | Technical appendices
CFA22 | Whittington to Handsacre

July 2015

SES and AP2 ES 3.5.1.9

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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	Topic	Code
CFA22, Whittington to Handsacre	Agriculture, forestry and soils	AG-001-022
	Air quality	AQ-001-022
	Community	CM-001-022
	Cultural heritage	CH-002-022
		CH-003-022
		CH-004-022
	Landscape and visual assessment	LV-001-022
	Sound, noise and vibration	SV-003-022 (construction)
		SV-004-022 (operational)
	Water resources and flood risk assessment	WR-002-022
		WR-003-022
		WR-004-022

Environmental topic:	Agriculture, forestry and soils	AG
Appendix name:	Data appendix	001
Community forum area:	Whittington to Handsacre	022

Contents

1 Introduction 1
2 Update on forestry 1
3 Update on the assessment of effects on holdings 2

List of tables

Table 1 - Area of woodland within the study area and construction boundary 1
Table 2 - Summary of assessment of effected holdings 2

1 Introduction

1.1.1 This appendix provides an update to Appendix AG-001-022 Agriculture, forestry and soils Data appendix from the main Environmental Statement (main ES) as a result of design changes, as part of the Additional Provision 2 Environmental Statement (AP2 ES). This update should be read in conjunction with Appendix AG-001-022 from the main ES.

1.1.2 This Agriculture, forestry and soils appendix for the Whittington to Handsacre community forum area (CFA22) comprise:

- update on forestry (Section 2); and
- update on the assessment of effects on holdings (Section 3).

1.1.3 Maps referred to throughout the agriculture, forestry and soils appendix are contained in the Volume 5 Agriculture, forestry and soils Map Book within this SES and AP2 ES.

2 Update on forestry

2.1.1 Identification of forestry resources has primarily had regard to the National Forestry Inventory[1].

2.1.2 The area of land under forestry (i.e. trees and woodland) within 2km either side of the route centre line has been determined using GIS and is shown in Table 1.

Table 1 - Area of woodland within the study area and construction boundary

	Area of forestry land (ha)	Forestry land as a % of total land area
Forestry land in study area	208.9	4
Forestry land within construction boundary	19.7	6

2.1.3 Stands of woodland include Fulfen Wood in the south, Big and Little Lyntus Woods just north of Curborough, and Brokendown Wood, Ravenshaw Wood, Black Slough and Vicar's Coppice in the north. Woodland is often situated on low ground affected by high groundwater (Blackwood association). As forestry land covers 4% of land in the study area, compared to the national average of 10%, the sensitivity of the forestry land resource in this study area is considered to be high, as set out in the SMR Addendum (see main ES Volume 5: Appendix CT-001-000/2).

[1] Forestry Commission (2001), *National Forest Inventory Woodland and Ancient Woodland (as updated)*.

3 Update on the assessment of effects on holdings

3.1.1 The assessment uses the same methodology set out in the Scope and Methodology Report (SMR) (Volume 5: Appendix CT-001-000/1) and the SMR Addendum (Volume 5, Appendix CT-001-000/2) and applies this to the assessment of the AP2 amendments on holdings. Only those holdings affected by the AP2 revised scheme are reported in this appendix.

3.1.2 The nature of impacts considered comprises the temporary and permanent land required from the holding, the temporary and permanent severance of land, the permanent loss of key farm infrastructure and the imposition of disruptive effects (particularly noise and dust) on land uses and the holding's operations. These impacts occur primarily during the construction phase of the AP2 revised scheme and are set out in Table 1.

Table 2 - Summary of assessment of effected holdings

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
CFA22-01 Fulfen Farm 71.6ha of Mainly arable Medium sensitivity to change	Land required: 16.6ha; 23% of holding required for construction. High Impact Severance: although the holding is substantially affected by construction activities, no part of it is severed. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 5.2ha; 7% of holding taken. Low Impact Severance: NE corner severed from rest of holding. Access to this parcel will be via public highway (Capper's Lane/Broad lane overbridge). Medium Impact Infrastructure: reinstatement of water supply/ drinking trough systems; restoration of drainage functionality; fencing. Negligible Impact
CFA22-02 Land off Capper's Lane A 18.7ha of Grassland Medium sensitivity to change	Land required: 6.2ha; 33% of holding required for construction. High Impact Severance: holding is severed by HS2 on both sides of Capper's Lane. Access provisions under CoCP. Medium Impact Disruptive effects: Considered to be Low Impact.	Land required: 6.1ha; 33% of holding taken. High Impact Severance: access to land to NE via Broad Lane. Access to remainder off Capper's Lane or via track provided by HS2 under Capper's Lane Viaduct. Low Impact Infrastructure: reinstatement of water supply/ drinking trough systems; restoration of drainage functionality; fencing. Low Impact
CFA22-03 Huddlesford House Farm	Land required: 16.1ha; 5% of holding required for construction. Negligible Impact	Land required: 7.0ha; 2% of holding taken. Negligible Impact Severance: land to west of line is severed from the rest of the holding. Restricted

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
323.8ha of Mixed arable and livestock (including dairy) High sensitivity to change	Severance: no severance (severed land required for construction). Negligible Impact Disruptive effects: proximity of construction to dairy herd. Low Impact	access under West Coast Main Line (3.5m high underpass) may limit agricultural access. High Impact Infrastructure: reinstatement of abstraction point, water supply / drinking trough systems and dirty water irrigation systems; restoration of drainage functionality; fencing. Negligible Impact
CFA22-04 Hill Farm Streethay 28.3ha of Mixed arable and livestock Medium sensitivity to change	Land required: 10.8ha; 38% of holding required for construction. High Impact Severance: access over HS2 to be maintained through CoCP. Low Impact Disruptive effects: none identified. Low Impact	Land required: 7.7ha; 27% of holding taken. High Impact Severance: Streethay Footpath 6 (184-S5) provides agricultural access over HS2. Low Impact Infrastructure: reinstatement of water supply / drinking trough systems; restoration of drainage functionality; fencing. Low Impact
CFA22-05 Streethay Farm* 32.5ha of Mixed arable and livestock Medium sensitivity to change	Land required: 7.7ha; 24% of holding required for construction. High Impact Severance: no severance (severed land required for construction). Negligible Impact Disruptive effects: noise likely to affect horse livery. High Impact	Land required: 5.2ha; 16% of holding taken. Medium Impact Severance: Streethay Footpath 6 (184-S5) provides agricultural access over HS2. Low Impact Infrastructure: reinstatement of water supply / drinking trough systems; restoration of drainage functionality; fencing. Low Impact
CFA22-06 Streethay House Farm* 91.7ha of Mainly arable Medium sensitivity to change	Land required: 10.4ha; 11% of holding required for construction. Medium Impact Severance: eastern part of holding is severed from the remainder. Access via public highway to be arranged under the CoCP, but this does substantially increase travel time to this part of holding. Medium Impact Disruptive effects: none identified. Low Impact	Land required: 9.7ha; 11% of holding taken. Medium Impact Severance: eastern part of holding is severed from the remainder. Access via public highway possible through Fradley Business Park and along HS2 access to Mare Brook Package Sub Station, but this does substantially increase travel time to this part of holding. Medium Impact Infrastructure: restoration of drainage functionality. Negligible Impact

Holding reference, name and description	**Construction effects**	**Residual effects post restoration of land required temporarily**
CFA22-07 Curborough House Farm* 172.0ha of Mainly arable Medium sensitivity to change	Land required: 37.5ha; 22% of holding required for construction. High Impact Severance: areas of holding are severed. Access via public highway to be arranged under the CoCP, but this does substantially increase travel time to these part of holding. Medium Impact Disruptive effects: none identified. Low Impact	Land required: 37.3ha; 22% of holding taken. High Impact Severance: areas of holding are severed. Access via public highway possible through Fradley Business Park, but this does substantially increase travel time to this part of holding. Medium Impact Infrastructure: restoration of drainage functionality; access provisions. Low Impact
CFA22-08 Curborough Farm 272.0ha of Mixed arable and livestock (sheep and cattle) High sensitivity to change	Land required: 33.8ha; 12% of holding required for construction. Medium Impact Severance: access to land not required for construction off public highway (Wood End Lane). Access to parcel adjacent to Trent and Mersey Canal provided through CoCP. Medium Impact Disruptive effects: disruption of customer access to diversified activities (e.g. tea room, fishing lakes) needs to be managed effectively under CoCP. Low Impact	Land required: 30.0ha; 11% of holding taken. Medium Impact Severance: access to land not required for ecological mitigation and permanent planting is off public highway, principally Wood End Lane. Medium Impact Infrastructure: access provisions, reinstatement of abstraction point and water supply / drinking trough systems; restoration of drainage functionality; fencing. Negligible Impact
CFA22-09 Big Lyntus Wood 6.7ha of Woodland Medium sensitivity to change	Land required: 0.8ha; 12% of holding required for construction. Medium Impact Severance: no severance (severed land required for construction). Access provided through CoCP. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 0.8ha; 12% of holding taken. Medium Impact Severance: no severance (severed land required for construction). Access along Netherstowe Lane Extension. Negligible Impact Infrastructure: restoration of drainage functionality. Negligible Impact
CFA22-10 Land around Fradley Wood 1618.8ha of Mixed arable and livestock High sensitivity to change	Land required: 1.5ha; 0% of holding required for construction. Negligible Impact Severance: access to southern parcel provided through CoCP. Negligible Impact Disruptive effects: none identified. Negligible Impact	Land required: 1.5ha; 0% of holding taken. Negligible Impact Severance: no severance. Access to southern parcel possible around northern end of Phase 1 works. Negligible Impact Infrastructure: reinstatement of irrigation mains. Negligible Impact

Holding reference, name and description	**Construction effects**	**Residual effects post restoration of land required temporarily**
CFA22-12 Ravenshaw Wood (East) 15.0ha of Woodland Low sensitivity to change	Land required: 1.7ha; 11% of holding required for construction. Medium Impact Severance: the infrequent access required to maintain wood during construction period can be arranged under CoCP. Medium Impact Disruptive effects: none identified. Low Impact	Land required: 1.7ha; 11% of holding taken. Medium Impact Severance: severed southern block accessed from CFA12-13 Black Slough Farm. Access to the northern majority of holding along alternative access route to Ravenshaw Cottages via A515. Medium Impact Infrastructure: restoration of drainage functionality; fencing. Negligible Impact
CFA22-13 Black Slough Farm 56.0ha of Mainly livestock (dairy) High sensitivity to change	Land required: 26.1ha; 47% of holding required for construction. High Impact Severance: the infrequent access required to maintain severed small area of woodland to N of holding can be arranged under CoCP. Medium impact Woodland in northern corner of holding to the north of the track can be accessed via track off the A515 - a large diversion. Medium Impact Disruptive effects: very close proximity of construction to dairy herd. Medium Impact	Land required: 20.7ha; 37% of holding taken. High Impact Severance: small severed block of woodland to N of holding can be accessed via alternative Access Route to Ravenshaw Cottage and A515. Medium Impact Infrastructure: water supply / drinking trough systems; restoration of drainage functionality; fencing; reconnection of electric ring main. Low Impact
CFA22-14 Ravenshaw Wood (West) 12.0ha of Woodland Low sensitivity to change	Land required: 1.5ha; 12% of holding required for construction. Medium Impact Severance: no severance. Access to be provided under CoCP. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 1.5ha; 12% of holding taken. Medium Impact Severance: no severance. Access to holding along Alternative Access Route to Ravenshaw Cottages via A515. Negligible Impact Infrastructure: fencing. Negligible Impact
CFA22-15 Hanchwood 121.4ha of Mixed arable and livestock High sensitivity to change	Land required: 15.4ha; 13% of holding required for construction. Medium Impact Severance: NW quadrant severed from southern part of holding. Access will be provided along Network Rail track under CoCP. Medium Impact	Land required: 11.5ha; 9% of holding taken. Low Impact Severance: NW quadrant severed from southern part of holding. New public highway between A515 and Shaw Lane will reduce travel time to this severed block. Medium Impact

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
	Disruptive effects: safety requirements of construction site will curtail commercial shoot. High Impact	Infrastructure: reinstatement of abstraction point and water supply / drinking trough systems; restoration of drainage functionality; fencing. Low Impact
CFA22-16 Brownfields Farm 283.3ha of Mixed arable and livestock High sensitivity to change	Land required: 20.1ha; 7% of holding required for construction. Low Impact Severance: the holding is severed by HS2. Southern section accessed off Wood End Lane. Access to northern block arranged through CoCP. Medium Impact Disruptive effects: none identified. Low Impact	Land required: 17.5ha; 6% of holding taken. Low Impact Severance: southern section accessed off Wood End Lane. Access to northern block via Alternative Access Route to Ravenshaw Cottages. Medium Impact Infrastructure: reinstatement of water supply / drinking trough systems; restoration of drainage functionality; fencing; access provisions. Low Impact
CFA22-17 Hunts Farm 32.4ha of Mixed arable and livestock Medium sensitivity to change	Land required: 17.7ha; 55% of holding required for construction. High Impact Severance: no severance (all land to south of HS2 now taken for construction). Negligible Impact Disruptive effects: none identified Low Impact	Land required: 4.3ha; 13% of holding taken. Medium Impact Severance: no severance (all land to south of Hs2 now taken for planting). Note access to northern block improved by new public highway between A515 and Shaw Lane. Negligible Impact Infrastructure: restoration of drainage functionality; fencing. Low Impact
CFA22-18 New Farm, Elmhurst 33.1ha of Horticulture - fruit grower High sensitivity to change	Land required: 4.4ha; 13% of holding required for construction. Medium Impact Severance: no new severance. Negligible Impact Disruptive effects: Medium Impact	Land required: 3.8ha; 11% of holding taken. Medium Impact Severance: no new severance. Negligible Impact Infrastructure: potential reinstatement of abstraction point / water mains; restoration of drainage functionality. Medium Impact
CFA22-19 Ashton Hayes Farm 16.2ha of Mixed arable and livestock Medium sensitivity to change	Land required: 4.5ha; 28% of holding required for construction. High Impact Severance: no new severance. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 4.4ha; 27% of holding taken. High Impact Severance no new severance. Negligible Impact Low Impact Infrastructure: restoration of drainage functionality.

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
CFA22-20 Tuppenhurst Field 6.9ha of General cropping (cereals and potatoes) Medium sensitivity to change	Land required: 5.5ha; 80% of holding required for construction. High Impact Severance: Although large proportion of holding required for construction, no new severance. Negligible Disruptive effects: Low Impact	Land required: 4.9ha; 71% of holding taken. High Impact Severance: no new severance because land that would have been severed is required for ecological mitigation and permanent planting. Negligible Impact Infrastructure: restoration of drainage functionality; fencing; access provision. Low Impact
CFA22-21 Tuppenhurst Farm 303.5ha of Mainly arable Medium sensitivity to change	Land required: 1.1ha; 0% of holding required for construction. Negligible Impact Severance: no new severance. Negligible Impact Disruptive effects: Low Impact	Land required: 0.0ha; 0% of holding taken. Negligible Impact Severance: no new severance. Negligible Impact Infrastructure: Note access to Farm hub improved by new public highway between A515 and Shaw Lane. Low Impact
CFA22-24 Brokendown Wood* 4.8ha of Woodland Medium sensitivity to change	Land required: 2.3ha; 47% of holding required for construction. High Impact Severance: Western corner of holding severed by HS2. The infrequent access required to maintain woodland can be arranged under CoCP Low Impact Disruptive effects: Low Impact	Land required: 2.3ha; 47% of holding taken. High Impact Severance: Western corner of holding severed by HS2. Access is possible under the Trent and Mersey Canal East Underbridge (3.5m clearance considered adequate for machinery required to manage woodland). Low Impact Infrastructure: Negligible Impact
CFA22-27 Land on NE side of Marsh Lane* 1.9ha of Mainly livestock (Sheep) Medium sensitivity to change	Land required: 0.5ha; 26% of holding required for construction. High Impact Severance: no new severance. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 0.3ha; 16% of holding taken. Medium Impact Severance: no new severance. Negligible Impact Infrastructure: reinstatement of drainage functionality. Negligible Impact

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
CFA22-28 Whittington Hill Farm 4.5ha of Equestrian (non-commercial) Low sensitivity to change	Land required: 2.7ha; 61% of holding required for construction. High Impact Severance: land severed to the east of holding. Access to be provided under CoCP. Medium Impact Disruptive effects: effect of noise on horses. Medium Impact	Land required: 2.7ha; 61% of holding taken. High Impact Severance: land severed to the east of holding. Access will be possible off the old alignment of Darnford Lane. Medium Impact Infrastructure: reinstatement of water supply / drinking trough systems; restoration of drainage functionality; fencing; access provisions. Low Impact
CFA22-29 Vicar's Coppice 7.7ha of Woodland Low sensitivity to change	Land required: 0.5ha; 6% of holding required for construction. Low Impact Severance: no new severance. Negligible Impact Disruptive effects: none identified Low Impact	Land required: 0.3ha; 3% of holding taken. Negligible Impact Severance: no new severance. Negligible Impact Infrastructure: no infrastructure issues identified. Negligible Impact
CFA22-30 Fradley Wood 43.5ha of Woodland Low sensitivity to change	Land required: 2.4ha; 6% of holding required for construction. Low Impact Severance: no new severance. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 2.4ha; 6% of holding taken. Low Impact Severance: no new severance. Negligible Impact Infrastructure: restoration of drainage functionality; fencing. Negligible Impact
CFA22-31 Land adjacent to Fulfen Farm* 3.4ha of Grassland Medium sensitivity to change	Land required: 0.3ha; 10% of holding required for construction. Low Impact Severance: no new severance. Negligible Impact Disruptive effects: none identified. Negligible Impact	Land required: 0.3ha; 9% of holding taken. Low Impact Severance: no new severance. Negligible Impact Infrastructure: reinstatement of water supply / drinking trough systems; restoration of drainage functionality; fencing. Negligible Impact
CFA22-32 Land adjacent to Easthill House* 2.5ha of Woodland Medium sensitivity to change	Land required: 0.5ha; 21% of holding required for construction. High Impact Severance: no new severance. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 0.5ha; 21% of holding taken. High Impact Severance: no new severance. Negligible Impact Disruptive effects: none identified. Low Impact

Holding reference, name and description	**Construction effects**	**Residual effects post restoration of land required temporarily**
CFA22-36 Land adjacent to Rileyhill Farm*# 23.1ha of General cropping (cereals and potatoes) Medium sensitivity to change	Land required: 0.7ha; 3% of holding required for construction. Negligible Impact Severance: if access to temporarily severed land is essential, this can be managed through CoCP. Low Impact Disruptive effects: none identified. Negligible Impact	Land required: 0.0ha; 0% of holding taken. Negligible Impact Severance: none - assume no additional ground based infrastructure is installed. Negligible Impact Infrastructure: gateways; fencing. Negligible Impact
CFA22-40 Hanch Hall Farm*# 21.0ha of Mainly livestock (cattle and sheep) Medium sensitivity to change	Land required: 3.9ha; 19% of holding required for construction. Medium Impact Severance: if access to temporarily severed land is essential, this can be managed through CoCP. Low Impact Disruptive effects: none identified. Low Impact	Land required: 0.1ha; 0% of holding taken. Negligible Impact Severance: none - assume no additional ground based infrastructure is installed. Negligible Impact Infrastructure: gateways; fencing. Negligible Impact
CFA22-41 Land off Capper's Lane B* 21.0ha of Mainly livestock (Sheep) Medium sensitivity to change	Land required: 4.8ha; 23% of holding required for construction. High Impact Severance: access will be off Broad Lane, the same as before the scheme. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 4.1ha; 20% of holding taken. Medium Impact Severance: access will be off Broad Lane, the same as before the scheme. Negligible Impact Infrastructure: reinstatement of water supply / drinking trough systems; restoration of drainage functionality; fencing; access provision Negligible Impact
CFA22-42 Land to the north and south of Mill Farm* 2.8ha of Grassland Medium sensitivity to change	Land required: 2.1ha; 75% of holding required for construction. High Impact Severance: although construction activities affect a large proportion of holding, there is no severance. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 1.7ha; 62% of holding taken. High Impact Severance: although the scheme requires a large proportion of holding, there is no severance. Negligible Impact Infrastructure: reinstatement of water supply / drinking trough systems; restoration of drainage functionality; fencing; access provision. Negligible Impact

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
CFA22-43 Land to the west of Mill Farm* 0.7ha of Grassland Medium sensitivity to change	Land required: 0.7ha; 100% of holding required for construction. High Impact Severance: whole holding required by scheme. Low Impact Disruptive effects: whole holding required by scheme. Low Impact	Land required: 0.7ha; 100% of holding taken. High Impact Severance: whole holding required by scheme. Low Impact Infrastructure: whole holding required by scheme. Negligible.
CFA22-44 Fulbrook Farm*# 22.9ha of Mainly livestock (cattle and sheep) Medium sensitivity to change	Land required: 1.4ha; 6% of holding required for construction. Low Impact Severance: if access to temporarily severed land is essential, this can be managed through CoCP. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 0.0ha; 0% of holding taken. Negligible Impact Severance: none - assume no additional ground based infrastructure is installed. Negligible Impact Infrastructure: gateways; fencing. Negligible Impact
CFA22-45 Corporation Farm*# 36.5ha of Mainly arable Medium sensitivity to change	Land required: 0.6ha; 2% of holding required for construction. Negligible Impact Severance: no severance. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 0.0ha; 0% of holding taken. Negligible Impact Severance: no severance. Negligible Impact Infrastructure: gateways; fencing. Negligible Impact
CFA22-46 Land on the east side of Lysways Lane (A)*# 5.3ha of Mainly arable Medium sensitivity to change	Land required: 0.9ha; 18% of holding required for construction. Medium Impact Severance: if access to temporarily severed land is essential, this can be managed through CoCP. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 0.0ha; 0% of holding taken. Negligible Impact Severance: none - assume no additional ground based infrastructure is installed. Negligible Impact Infrastructure: gateways; fencing. Negligible Impact
CFA22-47 Land to the east of Stafford Road (A)*# 208.8ha of Mixed arable and livestock (sheep and cattle) Medium sensitivity to change	Land required: 0.3ha; 0% of holding required for construction. Negligible Impact Severance: if access to temporarily severed land is essential, this can be managed through CoCP. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 0.0ha; 0% of holding taken. Negligible Impact Severance: none - assume no additional ground based infrastructure is installed. Negligible Impact Infrastructure: gateways; fencing. Negligible Impact

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
CFA22-48 Land to the east of Stafford Road (B)*# 3.1ha of Mainly arable Medium sensitivity to change	Land required: 0.2ha; 6% of holding required for construction. Low Impact Severance: if access to temporarily severed land is essential, this can be managed through CoCP. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 0.0ha; 0% of holding taken. Negligible Impact Severance: none - assume no additional ground based infrastructure is installed. Negligible Impact Infrastructure: gateways; fencing. Negligible Impact
CFA22-49 Land on the east side of Lysways Lane (B)*# 2.4ha of Mainly arable Medium sensitivity to change	Land required: 0.2ha; 10% of holding required for construction. Low Impact Severance: no severance. Negligible Impact Disruptive effects: none identified. Low Impact	Land required: 0.0ha; 0% of holding taken. Negligible Impact Severance: no severance. Negligible Impact Infrastructure: gateways; fencing. Negligible Impact

* No farm impact assessment interview conducted; data estimated.

Land take and severance associated with a wayleave or similar and the scale of effect is a 'worst case'.

Environmental topic:	Air quality	AQ
Appendix name:	Data appendix	001
Community forum area:	Whittington to Handsacre	022

Contents

1 Introduction 3

1.1 Structure of this air quality assessment appendix 3

1.2 Scope of this assessment 3

2 Policy Framework 4

3 Baseline air quality data 5

3.1 Existing air quality 5

3.2 Receptors 7

4 Dust impact evaluation and risk rating 9

5 Air quality assessment - road traffic 42

5.1 Overall assessment approach 42

5.2 Construction traffic 42

5.3 Operational traffic 47

6 References 51

List of tables

Table 1 - Annual mean NO2 concentrations recorded at diffusion tube monitoring sites 6

Table 2 - Summary of dust assessment at discrete locations affected by the AP2 revised scheme10

Table 3 - Summary of construction dust impacts and effects 40

Table 4 - Modelled receptors (construction phase) 43

Table 5 - Background 2017 concentrations at assessed receptors 43

Table 6 - Summary of DMRB annual mean NO2 results (construction phase) 44

Table 7 - Summary of DMRB annual mean PM10 results (construction phase) 45

Table 8 - Modelled receptors (operational phase) 47

Table 9 - Background 2026 concentrations at assessed receptors 48

Table 10 - Summary of DMRB annual mean NO2 results (operational phase) 48

Table 11 - Summary of DMRB annual mean PM10 results (operational phase) 49

1 Introduction

1.1 Structure of this air quality assessment appendix

1.1.1 This appendix provides an update of the relevant information contained in Appendix AQ-001-022 from the main Environmental Statement (ES) (Volume 5, Appendix AQ-001-022). This update should be read in conjunction with Appendix AQ-001-022 from the main ES.

1.1.2 This appendix is structured as follows:

- Policy framework (Section 2);
- Baseline air quality data (Section 3);
- Dust impact evaluation and risk rating (Section 4); and
- Air quality assessment - road traffic (Section 5).

1.1.3 Maps referred to throughout this air quality appendix are contained in the Supplementary Environmental Statement (SES) and Additional Provision 2 ES (AP2 ES) Volume 5 Air Quality Map Book.

1.2 Scope of this assessment

1.2.1 This air quality assessment considers changes to local air quality as a result of :

- corrections to Appendix AQ-001-022 from the main ES (not relevant for CFA22);
- changes to the design or construction assumptions which do not require changes to the Bill;
- changes to the design of the scheme that are outside the existing limits of the Bill (i.e. AP2 amendments); and
- updates to traffic models.

Methodology, data sources and design criteria

1.2.2 The assessment scope, key assumptions and limitations for air quality are set out in Volume 1, the Scope and Methodology Report (SMR) (Volume 5: Appendix CT-001 -000/1) and the SMR Addendum (Volume 5: Appendix CT-001-000/2) of the main ES as amended by the SMR Addendum 2 (SES and AP2 ES Volume 5: Appendix CT-001 -000/3), which was produced to specifically amend and advance the SMR for AP2. The SMR Addendum 2 focuses on updates and refinements to: the establishment of the baseline and definition of the survey; the scope of the air quality assessment; and the assessment methodology.

2 Policy Framework

2.1.1 Staffordshire County Council's (SCC) Local Transport Plan (2011)[1] outlines a number of initiatives that are aimed at reducing emissions from road transport, including the promotion of alternatives to private motor vehicles (Policy 5.1) and the promotion of low-emitting vehicles and vehicle efficiency (Policy 5.2).

2.1.2 The local planning authority for the Whittington to Handsacre area is Lichfield District Council (LDC) and the relevant adopted local plan for the Whittington to Handsacre area is the Lichfield District Local Plan Strategy 2008 - 2029[2].

2.1.3 The Lichfield District Local Plan sets out the Council's policies and proposals for development and land use.

2.1.4 A number of policies in the proposed submission of the local plan make reference to air quality. Core Policy 3: Delivering Sustainable Development highlights several issues that all new development should address in order to deliver sustainable development. Of particular relevance to air quality, the policy states that all development should protect the amenity of local residents, and reduce levels of pollution or contamination to air, land, soil or water.

2.1.5 Core Policy 5: Sustainable Transport contains a commitment to reduce the impact of travel on the environment and improve air quality. Core Policy 10: Healthy and Safe Lifestyles, states that that LDC will ensure that "the current high standard of air quality in the District is monitored and maintained and, where possible, improved with no decline in standards being deemed acceptable as a result of new development"[3].

[1] Staffordshire County Council (2011), Staffordshire Local Transport Plan 2011 – Strategy Plan.
[2] Lichfield District Council (2015), Lichfield District Local Plan 2008-2029 (adopted February 2015).
[3] Lichfield District Council (2015), Lichfield District Local Plan 2008-2029 (adopted February 2015). P67.

3 Baseline air quality data

3.1 Existing air quality

Local authority review and assessment information

3.1.1 Under Part IV of the Environment Act 1995, all local authorities are responsible for local air quality management (LAQM). Under the LAQM regime, a local authority is required to undertake regular review and assessment of local air quality, the findings of which are reviewed by the Department of Environment, Food and Rural Affairs (Defra) prior to publication. If an area is identified as being unlikely to achieve an air quality standard and there are sensitive receptors to be exposed over the relevant exposure period, then the local authority is required to designate an air quality management area (AQMA) and develop an air quality action plan (AQAP) to improve local air quality.

3.1.2 LDC has designated an AQMA at Muckley Corner which includes a roundabout on the A5 and some of the surrounding properties. The AQMA is not within the Whittington to Handsacre area.

Local air quality monitoring data

3.1.3 Monitoring sites within the Whittington to Handsacre area that are considered relevant for this assessment are shown in SES and AP2 ES Volume 5: Map AQ-01-022. The following sections provide a summary of the recorded pollutant concentrations at these sites.

3.1.4 The pollutant concentrations can be compared to the air quality standards:

- 40µg/m^3 as an annual mean for NO2 and PM10;
- 200µg/m^3 as a one-hour mean for NO2 not to be exceeded more than 18 times a year (equivalent to the 99.8th percentile of the one-hour mean);
- 50µg/m^3 as a 24-hour mean for PM10 not to be exceeded more than 35 times a year (equivalent to the 90.4th percentile of the 24-hour mean); and
- 25µg/m^3 as an annual mean for PM2.5.

Continuous monitoring

3.1.5 There are currently no permanent continuous monitoring locations in operation within the Whittington to Handsacre area.

Diffusion tubes

3.1.6 This section summarises the results from the diffusion tube sites that are considered relevant for the assessment of air quality in the Whittington to Handsacre area.

3.1.7 LDC measures annual mean NO2 concentrations using passive diffusion tubes at 22 locations across its administrative area.

3.1.8 There are three diffusion tube measurement site is located within the Whittington to Handsacre area. These are roadside sites at junctions in the A38 between Fradley and

Alrewas, approximately 2.5km east of the centre line of the AP2 revised scheme. This location is not considered to be representative of background air quality conditions in the mostly rural setting of the AP2 revised scheme in the Whittington to Handsacre area.

3.1.9 Annual mean NO2 diffusion tube measurements for the period 2008 to 2013 at the A38 sites between Fradley and Alrewas are presented below in Table 1. The concentrations recorded in 2008, 2010, 2011, 2012 and 2013 were above the annual mean air quality standard at one or more of the sites. There is no clear increasing or decreasing trend over the 2008 to 2013 period.

Table 1 - Annual mean NO2 concentrations recorded at diffusion tube monitoring sites[4]

Site	Coordinates	Annual mean NO2 concentrations ($\mu g/m^3$)					
		2008	2009	2010	2011	2012	2013
A38, Fradley (2/2(1)	416295, 313186	39	34	40	35	37	35
A38, Fradley (2A/B)	416290, 313175	Closed	Closed	Closed	43	45	43
A38, Alrewas (1)	417101, 314180	44	36	43	41	44	38

Background pollutant concentrations

3.1.10 Estimates of background air quality have been obtained from Defra for 2012 and future years (2017 and 2026)[5]. These data are estimated for 1km grid squares for nitrogen oxides (NOx), NO2, PM10 and PM2.5 and are now based on a 2011 base year. NO2 annual mean concentrations ranged from $18\mu g/m^3$ to $20\mu/m^3$ in 2012, PM10 annual mean concentrations ranged from $17\mu g/m^3$ to $19\mu g/m^3$ in 2012 and PM2.5 concentrations ranged from $11\mu g/m^3$ to $13\mu g/m^3$ in 2012. Average background pollutant concentrations are below the relevant air quality standards.

3.1.11 The diffusion tube sites described previously is not considered to be representative of the predominantly rural area through which the AP2 revised scheme would pass. The background air quality maps produced by the Defra are considered to be a more appropriate source of baseline air quality conditions along the AP2 revised scheme in the Whittington to Handsacre area. These maps indicate that the average background pollutant concentrations across the Whittington to Handsacre area are below the relevant air quality standards.

Local emission sources

3.1.12 The main source of emissions of NOx and PM10 in the Whittington to Handsacre area is road traffic on the A38[6], as well as the A51 Tamworth Road and the A515 Lichfield

[4] Notes for Table 1: Air quality standard for NO_2 is 40 $\mu g/m^3$ expressed as an annual mean.
[5] Department for Environment, Food and Rural Affairs; Background Maps with 2011 base year; http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html; accessed May2015.
[6] Lichfield District Council (2014), *Lichfield District Council LAQM Progress Report 2014*.

Road which the AP2 revised scheme would cross. There are no permitted Part A industrial processes[7].

3.2 Receptors

Human

3.2.1 Human receptors which are considered to be susceptible to changes in air quality due to construction or operation of the AP2 revised scheme have been identified.

Construction phase

3.2.2 Human receptors that could potentially be affected by the construction phase of the AP2 revised scheme are shown in SES and AP2 ES Volume 5: Map AQ-02-022-01, Map AQ-02-022-02, Map AQ-02-022-03 and Map AQ-02-022-04 for receptors relevant to the construction dust assessment and SES and AP2 ES Volume 5: Map AQ-01-022 for receptors relevant to the construction traffic emissions assessment. These include:

- properties along Darnford Lane, west of Whittington;
- properties around Capper's Lane, east of Lichfield;
- property on Broad Lane, east of Lichfield;
- properties around Ash Tree Lane, Streethay;
- Hill Farm, east of the A38, Streethay;
- Streethay Farm, Burton Road, east of Streethay;
- properties around The Manor House, Burton Road, north-east of Streethay;
- Wood End Lock Cottage, Wood End Lane, Fradley;
- properties around Wood End Farm, Wood End Lane, Curborough;
- Black Slough Farm and Woods Farm, Wood End Lane, Curborough;
- Ravenshaw Cottage, Wood End Lane, Curborough;
- properties along Shaw Lane, Hanch;
- Ashton Hayes Farm, Tuppenhurst Lane, south-east of Handsacre;
- Chestnut Close, Handsacre; and
- Hayes Meadow Primary School, Spode Avenue, Handsacre, Rugeley.

[7] Environment Agency; What's in your backyard website; http://www.environment-agency.gov.uk/default.aspx; accessed May2015. A Part A process is an industrial operation requiring a permit to operate from the Environment Agency under the Environmental Permitting regime, and as such is considered a significant source of emissions.

Operational phase

3.2.3 Human receptors that could potentially be affected by the operation of the AP2 revised scheme are shown in SES and AP2 ES Volume 5: Map AQ-01-022. These include:

- properties along Darnford Lane, west of Whittington, due to permanent realignment of Darnford Lane associated with the AP2 revised scheme;
- properties around Capper's Lane and Broad Lane, due to permanent realignment of Broad Lane and Stopping up of Capper's Lane associated with the AP2 revised scheme;
- properties around Wood End Lane, due permanent realignment of Wood End Lane associated with the AP2 revised scheme.

Ecological

Construction phase

3.2.4 No statutory designated ecological receptors that could potentially be affected by the construction of the AP2 revised scheme have been identified within the Whittington to Handsacre area. There are nine non-statutory designated sites within the Whittington to Handsacre area that could potentially be affected by changes in air quality as a result of construction of the AP2 revised scheme. These are all sites with local wildlife site (LWS) status. These sites are:

- Whittington Heath Golf Course Site of Biological Importance (SBI), north of the A51 Tamworth Road;
- Big Lyntus SBI, south of Wood End Lane, Curborough;
- Fradley Wood Biological Alert Site (BAS), north of Wood End Lane, Fradley;
- Wood End Lock (south-east of) SBI, north of Wood End Lane, Curborough;
- Ravenshaw Wood, Black Slough and Slaish SBI, north of Wood End Lane, Curborough;
- Tomhay Wood SBI, between the West Coast Main Line and Wood End Lane;
- Vicar's Coppice BAS, adjacent to the A515 Lichfield Road;
- John's Gorse SBI, west of the A515; and
- Tuppenhurst Lane (west of) SBI, south-west of Tuppenhurst Lane.

Operational phase

3.2.5 No statutory or non-statutory designated ecological receptors that could potentially be affected by the operation of the AP2 revised scheme have been identified within the Whittington to Handsacre area.

4 Dust impact evaluation and risk rating

4.1.1 This section provides details of the assessment of dust emissions during construction of the AP2 revised scheme. Since the submission of the main ES, new guidance[8] has been published by the Institute of Air Quality Management (IAQM). This assessment follows the approach described in the new guidance.

4.1.2 Where considered useful to identify receptors and their relationship to the construction activity a specific figure is provided.

4.1.3 The construction activities considered were demolition; earthworks, including the movement of materials on the haul road along the line of the AP2 revised scheme; the construction of new structures; and dust and mud deposited onto public highways from vehicles travelling to and from construction areas (referred to as trackout in the IAQM guidance).

[8] IAQM, 2014, *Guidance on the assessment of dust from demolition and construction*, London

Table 2 - Summary of dust assessment at discrete locations affected by the AP2 revised scheme

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Properties along Darnford Lane, west of Whittington								
Demolition	50m-100m	Small	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Negligible Health: Negligible	Not significant	Receptors present for extended period Properties more than 50m from demolition Total volume of demolition less than 20,000m^3 Baseline PM10 concentration 15.7µg/m3 in 2017 Duration of demolition expected to be less than 12 months
Earthworks	20m-50m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 20m from earthworks and haul road Total area of earthworks greater than 10,000m^2 More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 15.7µg/m3 in 2017 Duration of earthworks expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Construction	20m-50m	Large	Dust soiling: High Health: High	10-100 (16 total, 1 property within 50 m, 3 properties within 100m, others >100m)	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 20m from construction Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.7µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No trackout route within 50m
Around Mill Farm, Capper's Lane, east of Streethay (Mill Farm, Fulfen Cottages, Brook House, Canal Cottage)								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m
Earthworks	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptors present for extended period Properties less than 20m from earthworks and greater than 100m from haul road Total area of earthworks greater than 10,000m^2 More than 10 heavy earth moving vehicles on haul road
								Baseline PM10 concentration 16.8 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Construction	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptors present for extended period Properties less than 20m from construction Total volume of construction greater than 100,000m³ Baseline PM10 concentration 16.8 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	Less than 20m	Small	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Negligible Health: Negligible	Not significant	Receptors present for extended period Properties 12m from trackout Less than 10 outward HDV trips per day Baseline PM10 concentration 16.8 µg/m3 in 2017 Duration of trackout expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Property on Broad Lane, east of Lichfield								
Demolition	20m-50m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptor present for extended period Property more than 20m from demolition of existing road Total volume of demolition greater than 50,000m^3 Baseline PM10 concentration 16.8 µg/m3 in 2017 Duration of demolition expected to be more than 12 months
Earthworks	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptor present for extended period Property more than 20m from earthworks and haul road Total area of earthworks greater than 10,000m^2 More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 16.8 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Construction	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptor present for extended period Property less than 20m from construction Total volume of construction greater than 100,000m3 Baseline PM10 concentration 16.8 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptor present for extended period Property 5m from trackout Over 50 outward HDV trips per day Baseline PM10 concentration 16.8 µg/m3 in 2017 Duration of trackout expected to be more than 12 months
Properties around Ash Tree Lane, Streethay								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m
Earthworks	50m-100m	Large	Dust soiling: High Health: High	10-100 (1-10 within 100m)	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 50m from earthworks and more than 50m from haul road Total area of earthworks greater than 10,000m²

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
								More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months
Construction	100m-200m	Large	Dust soiling: High Health: High	10-100	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 100m from construction Total volume of construction greater than $100,000m^3$ Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	20m-50m	Large	Dust soiling: High Health: High	1-10 within 50m	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 20m from trackout Over 50 outward HDV trips per day Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of trackout expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Hill Farm, Ash Tree Lane, Streethay								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m
Earthworks	20m-50m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 20m from earthworks and more than 100m from haul road Total area of earthworks greater than 10,000m^2 More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months
Construction	50m-100m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 50m from construction Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No trackout within 50m

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Streethay Farm, Burton Road, north-east of Streethay								
Demolition	200m-350m	Small	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Negligible Health: Negligible	Not significant	Receptor present for extended period Property more than 200m from demolition Total volume of demolition <20,000m^3 Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of demolition expected to be more than 12 months
Earthworks	50m-100m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Property more than 100m from earthworks and haul road over 50m Total site area of earthworks greater than 10,000m^2 More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of earthworks expected more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Construction	50m-100m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Property more than 50m from construction Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	20m-50m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Property more than 20m from trackout More than 50 outward HDV trips per day Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of trackout expected to be more than 12 months
Properties around The Manor House, Burton Road, north-east of Streethay (The Manor House, Streethay Cottage and Elverceter)								
Demolition	20m-50m	Small	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Negligible Health: Negligible	Not significant	Receptors present for extended period Properties more than 20m from demolition Total volume of demolition less than 20,000m^3 Baseline PM10 concentration 17.8 µg/m3 in 2017

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
								Duration of demolition expected more than 12 months
Earthworks	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 50m from earthworks and 10m from haul road Total area of earthworks greater than 10,000m² More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months
Construction	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 20m from construction Total volume of construction greater than 100,000m³ Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of construction expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Trackout	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust Soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptor present for extended period Property more than 20m from trackout More than 50 outward HDV trips per day Baseline PM10 concentration 17.8 µg/m3 in 2017 Duration of trackout expected to be more than 12 months
Properties around Wood End Farm and The Cottage, Wood End Lane, Curborough								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m
Earthworks	20m-50m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 20m from earthworks and haul road Total area of earthworks greater than 10,000m² More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 15.7 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Construction	20m-50m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptors present for extended period Properties more than 20m from construction Total volume of construction greater than 100,000m[3] Baseline PM10 concentration 15.7 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptors present for extended period Properties 10m from trackout Over 50 outward HDV trips per day Baseline PM10 concentration 15.7 µg/m3 in 2017 Duration of trackout expected to be more than 12 months
Wood End Lock Cottage, Wood End Lane, Curborough								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m
Earthworks	50m-100m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Property more than 50m from earthworks and more than 100m to haul road Total site area of earthworks greater than 10,000m[2]

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
								More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 15.7 µg/m3 in 2017 Duration of earthworks expected more than 12 months
Construction	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptor present for extended period Property less than 20m from construction of new access route. 50-100m from construction associated with HS2 route. Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.7 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No trackout route within 50m
Black Slough Farm & Woods Farm, Wood End Lane								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Earthworks	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptors present for extended period Properties less than 20m from earthworks for road realignment, over 200m from HS2 route and over 200m from haul road Total area of earthworks greater than 10,000m^2 More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 15.7 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months
Construction	20-50m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptors present for extended period Properties less than 20m from construction for road realignment and over 200m from HS2 route Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.7 µg/m3 in 2017 Duration of construction expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Trackout	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptors present for extended period Properties 10m from trackout Over 50 outward HDV trips per day Baseline PM10 concentration 15.7 µg/m3 in 2017 Duration of trackout expected to be more than 12 months
Ravenshaw Cottage, Wood End Lane, Curborough								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m
Earthworks	200m-350m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Property more than 200m from earthworks and haul road Total site area of earthworks greater than 10,000m² More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 15.2 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Construction	200m-350m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Property more than 200m from construction Total volume of construction greater than 100,000m3 Baseline PM10 concentration 15.2 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No trackout route within 50m
The Elms, Shaw Lane, Hanch								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m
Earthworks	100m-200m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Property more than 100m from haul route and more than 200m from earthworks Baseline PM10 concentration 15.0 µg/m3 in 2017 Duration of construction expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Construction	200m-350m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Property more than 200m from construction Baseline PM10 concentration 15.0 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No trackout within 50m
Shaw Lane Farm, Shaw Lane, Hanch								
Demolition	100m-200m	Small	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Negligible Health: Negligible	Not significant	Receptor present for extended period Properties more than 100m from demolition Total volume of demolition less than 20,000m^3 Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of demolition expected to be less than 12 months
Earthworks	Less than 20m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Medium Health: Low	Dust soiling: Medium risk Health: Low risk	Not significant	Receptor present for extended period Properties 10m from earthworks and 100m from haul road Total site area of earthworks greater than 10,000m^2

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
								More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months
Construction	20m-50m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Properties more than from construction of Tuppenhurst Lane extension Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No trackout within 50m
Ashton Hayes Farm, Tuppenhurst Lane, south-east of Handsacre								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m
Earthworks	20m-50m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Properties more than 20m from earthworks and haul road

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
								Total site area of earthworks greater than 10,000m^2 More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months
Construction	20m-50m	Large	Dust soiling: High Health: High	1-10	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Properties more than 20m from construction Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No trackout route within 50m
Chestnut Close, Handsacre								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m
Earthworks	20m-50m	Large	Dust soiling: High Health: High	10-100	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Properties more than 20m from earthworks and haul road

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
								Total site area of earthworks greater than 10,000m^2 More than 10 heavy earth moving vehicles on haul road Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of earthworks expected to be more than 12 months
Construction	20m-50m	Large	Dust soiling: High Health: High	10-100	Dust soiling: Low Health: Low	Dust soiling: Low risk Health: Low risk	Not significant	Receptor present for extended period Properties more than 20m from construction Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No trackout route within 50m
Hayes Meadow Primary School								
Demolition	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No demolition within 350m
Earthworks	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No earthworks or haul road within 350m

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Construction	Less than 20m	Large	Dust soiling: High Health: High	>100	Dust soiling: High Health: Medium	Dust soiling: High risk Health: Medium risk	Not significant	Receptor present for extended period School building 10m from construction of access road
								Total volume of construction greater than 100,000m3 Baseline PM10 concentration 15.2 µg/m3 in 2017 Duration of construction expected to be less than 12 months
Trackout	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No trackout route within 50m
Whittington Heath Golf Course SBI								
Demolition	n/a	n/a	n/a	-	n/a	n/a	n/a	No demolition within 50m
Earthworks	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from earthworks and haul road Total volume of earthworks greater than 100,000m3 Baseline PM10 concentration 15.3 µg/m3 in 2017 Duration of construction expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Construction	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from construction Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.3 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	Less than 20m	Medium	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from trackout 10-50 outward HDV trips per day Baseline PM10 concentration 15.3 µg/m3 in 2017 Duration of trackout expected to be more than 12 months
Big Lyntus SBI								
Demolition	n/a	n/a	n/a	-	n/a	n/a	n/a	No demolition within 50m
Earthworks	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from earthworks and haul road

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
								Total volume of earthworks greater than $100,000m^3$ Baseline PM10 concentration 16.0 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Construction	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from construction Total volume of construction greater than $100,000m^3$ Baseline PM10 concentration 16.0 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from trackout Over 50 outward HDV trips per day Baseline PM10 concentration 16.0 µg/m3 in 2017 Duration of trackout expected to be more than 12 months

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Fradley Wood BAS								
Demolition	n/a	n/a	n/a	-	n/a	n/a	n/a	No demolition within 50m
Earthworks	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from earthworks Total volume of earthworks greater than 100,000m^3 Baseline PM10 concentration 15.5 μg/m3 in 2017 Duration of construction expected to be more than 12 months
Construction	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from construction Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.5 μg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	-	n/a	n/a	n/a	No trackout within 50 m

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Wood End Lock SBI								
Demolition	n/a	n/a	n/a	-	n/a	n/a	n/a	No demolition within 50m
Earthworks	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from earthworks Total volume of earthworks greater than 100,000m^3 Baseline PM10 concentration 15.5 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Construction	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from construction Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.5 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	-	n/a	n/a	n/a	No trackout within 50 m

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Ravenshaw Wood, Black Slough and Slaish SBI								
Demolition	n/a	n/a	n/a	-	n/a	n/a	n/a	No demolition within 50m
Earthworks	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from earthworks Total volume of earthworks greater than 100,000m^3 Baseline PM10 concentration 15.7 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Construction	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from construction Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.7 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	-	n/a	n/a	n/a	No trackout within 50 m

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Tomhay Wood SBI								
Demolition	n/a	n/a	n/a	-	n/a	n/a	n/a	No demolition within 50m
Earthworks	n/a	n/a	n/a	-	n/a	n/a	n/a	No earthworks within 50m
Construction	n/a	n/a	n/a	-	n/a	n/a	n/a	No construction within 50m
Trackout	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from trackout Over 50 outward HDV trips per day Baseline PM10 concentration 15.2 µg/m3 in 2017 Duration of trackout expected to be more than 12 months
Vicar's Coppice BAS								
Demolition	n/a	n/a	n/a	-	n/a	n/a	n/a	No demolition within 50m
Earthworks	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from earthworks Total volume of earthworks greater than 100,000m^3 Baseline PM10 concentration 15.2 µg/m3 in 2017

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
								Duration of construction expected to be more than 12 months
Construction	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from construction Total volume of construction greater than 100,000m^3 Baseline PM10 concentration 15.2 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	Less than 20m	Medium	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from trackout 10-50 outward HDV trips per day Baseline PM10 concentration 15.2 µg/m3 in 2017 Duration of trackout expected to be more than 12 months
John's Gorse SBI								
Demolition	n/a	n/a	n/a	-	n/a	n/a	n/a	No demolition within 50m

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Earthworks	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from earthworks Total volume of earthworks greater than 100,000m3 Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Construction	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from construction Total volume of construction greater than 100,000m3 Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	-	n/a	n/a	n/a	No trackout within 50m
Tuppenhurst Lane (west of) SBI								
Demolition	n/a	n/a	n/a	-	n/a	n/a	n/a	No demolition within 50m

Activity	Distance to nearest receptor	Dust emission class	Sensitivity of Receptor	No properties	Sensitivity of surrounding area	Dust Risk	Significance (with CoCP mitigation measures)	Principal justifications
Earthworks	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from earthworks Total volume of earthworks greater than 100,000m3 Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Construction	Less than 20m	Large	Low	-	Low	Low risk	Not significant	Locally important ecological site Ecological receptor less than 20m from construction Total volume of construction greater than 100,000m3 Baseline PM10 concentration 15.4 µg/m3 in 2017 Duration of construction expected to be more than 12 months
Trackout	n/a	n/a	n/a	-	n/a	n/a	n/a	No trackout within 50m

Table 3 - Summary of construction dust impacts and effects

Location	Risk of impact	Additional Mitigation	Effect of dust-generating activities (with CoCP mitigation measures)
Properties along Darnford Lane, west of Whittington	Dust soiling: Low risk Health: Low risk	None required	Not significant
Around Mill Farm, Capper's Lane, east of Lichfield	Dust soiling: Medium risk Health: Low risk	None required	Not significant
Property on Broad Lane, Huddlesford	Dust soiling: Medium risk Health: Low risk	None required	Not significant
Properties on Ash Tree Lane, Streethay	Dust soiling: Low risk Health: Low risk	None required	Not significant
Hill Farm, Ash Tree Lane, Streethay	Dust soiling: Low risk Health: Low risk	None required	Not significant
Streethay Farm, Burton Road, north-east of Streethay	Dust soiling: Low risk Health: Low risk	None required	Not significant
Around The Manor, Burton Road, north-east of Streethay	Dust soiling: Medium risk Health: Low risk	None required	Not significant
Properties around Wood End Farm, Wood End Lane, Curborough	Dust soiling: Medium risk Health: Low risk	None required	Not significant
Wood End Lock Cottage, Wood End Lane, Fradley	Dust soiling: Medium risk Health: Low risk	None required	Not significant
Black Slough Farm & Woods Farm, Wood End Lane	Dust soiling: Medium risk Health: Low risk	None required	Not significant
Ravenshaw Cottage, Wood End Lane, Curborough	Dust soiling: Low risk Health: Low risk	None required	Not significant
The Elms, Shaw Lane, Handsacre	Dust soiling: Low risk Health: Low risk	None required	Not significant
Shaw Lane Farm, Shaw Lane, Handsacre	Dust soiling: Medium risk Health: Low risk	None required	Not significant

Location	Risk of impact	Additional Mitigation	Effect of dust-generating activities (with CoCP mitigation measures)
Ashton Hayes Farm, Tuppenhurst Lane, south-east of Handsacre	Dust soiling: Low risk Health: Low risk	None required	Not significant
Chestnut Close, Handsacre	Dust soiling: Low risk Health: Low risk	None required	Not significant
Hayes Meadow Primary School	Dust soiling: High risk Health: Medium risk	None required	Not significant
Whittington Heath Golf Course SBI	Low risk	None required	Not significant
Big Lyntus SBI	Low risk	None required	Not significant
Fradley Wood BAS	Low risk	None required	Not significant
Wood End Lock (south-east of) SBI	Low risk	None required	Not significant
Ravenshaw Wood, Black Slough and Slaish SBI	Low risk	None required	Not significant
Tomhay Wood SBI	Low risk	None required	Not significant
Vicar's Coppice BAS	Low risk	None required	Not significant
John's Gorse SBI	Low risk	None required	Not significant
Tuppenhurst Lane (west of) SBI	Low risk	None required	Not significant

5 Air quality assessment - road traffic

5.1 Overall assessment approach

5.1.1 The overall assessment approach remains the same as described in Appendix AQ-001-022 of the main ES.

5.1.2 The air quality assessment for road related emissions has used three different approaches based on the scale of changes in traffic and road alignment. Where the Design Manual for Roads and Bridges (DMRB) thresholds detailed in the SMR (Volume 5: Appendix CT-001-000/1) will not be exceeded, any additional assessment is not required as the air quality impacts will be minimal. If these thresholds are breached, then an assessment has been carried out.

5.1.3 If it is considered unlikely that air quality standards will be exceeded and the road configuration is a simple one, then the DMRB screening method has been used to predict changes in air quality. Where there will be a risk of standards being exceeded, where the road layout is considered to be complex or where the use of the DMRB screening method has indicated that there will be a potential exceedance of air quality standards, then the atmospheric dispersion model ADMS-Roads has been used for the assessment. Professional judgment has been used to select the appropriate tool for each area.

5.1.4 In this study area the DMRB screening method was considered to be a suitable tool for the assessment as baseline air quality will be below air quality standards, there is a simple road layout and there are limited numbers of receptors close to roads affected during construction and operation of the AP2 revised scheme.

5.2 Construction traffic

5.2.1 Construction traffic data used in this assessment are detailed in SES and AP2 ES Appendix TR-001-000. The construction scenario used traffic data from the year of maximum intensity of construction (2021) but assumed this would occur in the first possible year of construction (2017).

5.2.2 Screening using the DMRB traffic and road alignment change criteria was undertaken to determine locations requiring assessment. Two locations within the Whittington to Handsacre area met the criteria for assessment of change in traffic emissions during the construction phase. These locations are around Broad Lane and Capper's Lane, east of Lichfield; and around the A38 in Streethay. At both all of these locations, the increase in construction traffic was sufficient to require an assessment and there will also be temporary road realignments. No locations were identified as requiring assessment due to construction traffic movements on the haul road.

Receptors assessed

5.2.3 For locations where DMRB traffic and road alignment change criteria for local air quality were met, a number of receptors representative of worst-case exposure locations were selected for quantitative assessment. These included locations representative of highest concentrations along the roads, including closest to junctions or to the road itself. Receptors assessed are listed in Table 4 and shown in SES and AP2 ES Volume 5: Map AQ-01-022.

Table 4 - Modelled receptors (construction phase)

Receptor	Description/Location	Ordnance Survey coordinates
22-1	39 Darnford Lane, Lichfield (along A38)	413568, 308836
22-2	West Farm House, Capper's Lane, Lichfield (along A38)	414050, 309201
22-3	Mill Farm, Capper's Lane, Lichfield	414854, 309065
22-4	Brook House, Capper's Lane, Lichfield	414918, 309101
22-5	1 Fulfen Cottages, Capper's Lane, Lichfield	414518, 309207
22-6	New Fulfen Cottage, Capper's Lane, Lichfield	414322, 309218
22-7	Ivy Cottage, Broad Lane, Huddlesford	414652, 309427
22-8	Poplars, Ash Tree Lane, Lichfield	414285, 310356
22-9	9 Ash Tree Lane, Lichfield	414313, 310410
22-10	141 Burton Road, Streethay, Lichfield	414247, 310471
22-11	1 Holland Close, Streethay, Lichfield	414194, 310422
22-12	Streethay Farm, Burton, Streethay, Lichfield	414578, 310795
22-13	Streethay Farm House, Burton, Streethay, Lichfield	414631, 310778
22-14	The Manor, Burton Road, Streethay, Lichfield	414371, 310835

Background concentrations

5.2.4 The background concentrations used in the assessment are shown in Table 5 taken from the Defra Maps.

Table 5 - Background 2017 concentrations at assessed receptors

Receptor (or zone of receptors)	Concentrations (µg/m3)		
	NOx	NO2	PM10
22-1 (39 Darnford Lane)	21.5	15.5	17.2
22-2 (West Farm House)	20.5	14.8	16.9
22-3 (Mill Farm)	20.5	14.8	16.9
22-4 (Brook House)	20.5	14.8	16.9

Receptor (or zone of receptors)	Concentrations (µg/m3)		
	NOx	NO_2	PM_{10}
22-5 (1 Fulfen Cottages)	20.5	14.8	16.9
22-6 (New Fulfen Cottage)	20.5	14.8	16.9
22-7 (Ivy Cottage)	20.5	14.8	16.9
22-8 (Poplars)	22.3	16.0	17.8
22-9 (9 Ash Tree)	22.3	16.0	17.8
22-10 (141 Burton Road)	22.3	16.0	17.8
22-11 (1 Holland Close)	22.3	16.0	17.8
22-12 (Streethay Farm)	22.3	16.0	17.8
22-13 (Streethay Farm House)	22.3	16.0	17.8
22-14 (The Manor)	22.3	16.0	17.8

DMRB model results

5.2.5 This section provides the summary of the modelled pollutant concentrations for the assessed receptors. The magnitude of change and impact descriptor are also derived following the Environmental Protection UK (EPUK) methodology[9].

Table 6 - Summary of DMRB annual mean NO_2 results (construction phase)

Receptor	Concentrations (µg/m3)			Change in concentrations (µg/m3)	Magnitude of change	Impact descriptor
	2012 baseline	2017 without scheme	2017 with AP2 revised scheme			
22-1 (39 Darnford Lane)	23.1	18.6	18.9	0.3	imperceptible	negligible
22-2 (West Farm House)	19.1	15.7	15.8	0.1	imperceptible	negligible
22-3 (Mill Farm)	18.4	15.2	15.2	0.0	imperceptible	negligible
22-4 (Brook House)	18.8	15.6	15.6	0.0	imperceptible	negligible
22-5 (1 Fulfen Cottages)	19	15.8	15.8	0.0	imperceptible	negligible
22-6 (New Fulfen Cottage)	18.1	14.9	14.9	0.0	imperceptible	negligible

[9] Environmental Protection UK (EPUK) (2010), *Development Control: Planning for Air Quality*.

Receptor	Concentrations (µg/m3)			Change in concentrations (µg/m3)	Magnitude of change	Impact descriptor
	2012 baseline	2017 without scheme	2017 with AP2 revised scheme			
22-7 (Ivy Cottage)	18.4	15.2	15.2	0.0	imperceptible	negligible
22-8 (Poplars)	30.1	24.8	25.5	0.7	small	negligible
22-9 (9 Ash Tree)	32.7	27.0	27.9	0.9	small	negligible
22-10 (141 Burton Road)	26.8	22.4	22.6	0.2	imperceptible	negligible
22-11 (1 Holland Close)	25.5	21.3	21.3	0.0	imperceptible	negligible
22-12 (Streethay Farm)	31.0	25.5	26.3	0.8	small	negligible
22-13 (Streethay Farm House)	23	18.8	19.0	0.2	imperceptible	negligible
22-14 (The Manor)	20.7	16.9	16.9	0.0	imperceptible	negligible

Table 7 - Summary of DMRB annual mean PM10 results (construction phase)

Receptor	Concentrations (µg/m3)			Change in concentrations (µg/m3)	Magnitude of change	Impact descriptor
	2012 baseline	2017 without scheme	2017 with AP2 revised scheme			
22-1 (39 Darnford Lane)	18.9	17.7	17.7	0.0	imperceptible	negligible
22-2 (West Farm House)	18.0	17.0	17.0	0.0	imperceptible	negligible
22-3 (Mill Farm)	17.9	16.9	16.9	0.0	imperceptible	negligible
22-4 (Brook House)	18.0	17.0	17.0	0.0	imperceptible	negligible
22-5 (1 Fulfen Cottages)	18.0	17.0	17.0	0.0	imperceptible	negligible
22-6 (New Fulfen Cottage)	17.9	16.9	16.9	0.0	imperceptible	negligible
22-7 (Ivy Cottage)	17.9	16.9	16.9	0.0	imperceptible	negligible
22-8 (Poplars)	20.7	19.3	19.3	0.0	imperceptible	negligible
22-9 (9 Ash Tree)	21.2	19.7	19.7	0.0	imperceptible	negligible
22-10 (141 Burton Road)	20.1	18.9	18.9	0.0	imperceptible	negligible

Receptor	Concentrations (µg/m³)			Change in concentrations (µg/m³)	Magnitude of change	Impact descriptor
	2012 baseline	2017 without scheme	2017 with AP2 revised scheme			
22-11 (1 Holland Close)	19.9	18.7	18.7	0.0	imperceptible	negligible
22-12 (Streethay Farm)	20.8	19.4	19.5	0.1	imperceptible	negligible
22-13 (Streethay Farm House)	19.4	18.2	18.2	0.0	imperceptible	negligible
22-14 (The Manor)	19.0	17.9	17.9	0.0	imperceptible	negligible

5.2.6 Annual mean NO2 and PM10 concentrations will be below the air quality standards both with the AP2 revised scheme and without the scheme for the construction phase. The hourly mean NO2 air quality standard will also be met as annual mean NO2 concentrations will be well below 60µg/m³. In addition the daily mean PM10 air quality standard will also be met. It is not possible to model PM2.5 using the DMRB screening model, but given the PM10 concentrations, the annual mean PM2.5 concentrations will be below the air quality standard.

5.2.7 Changes in modelled concentrations with the AP2 revised scheme and without the scheme have been calculated to determine the impact to local air quality. There will be a small increase in annual mean NO2 concentrations at the receptors closest to the A38 due to increases in traffic on this road as a result of construction traffic movements. The change in annual mean NO2 concentrations is imperceptible at all other receptors. The change in annual mean PM10 concentrations is imperceptible at all receptors.

5.2.8 The magnitude of impact for NO2 will be negligible for all receptors as the change in concentrations is imperceptible to small and concentrations are well below air quality standards. For PM10 the magnitude of impact will be negligible for all receptors assessed as the change in concentrations is imperceptible and concentrations are well below air quality standards.

Assessment of significance

5.2.9 Considering the significance of the air quality impacts according to the criteria set in the EPUK methodology[9], the following points are noted:

- the magnitude of impact is negligible for NO2 and PM10 at receptors;
- pollutant concentrations are well below the air quality standards for both NO2 and PM10 with the AP2 revised scheme and without the scheme.

5.2.10 Based on the above, the effect on air quality due to construction traffic emission will not be significant

5.3 Operational traffic

5.3.1 Operational traffic data used in this assessment are detailed in SES and AP2 ES Volume 5: Appendix TR-001-000. The operational scenario used traffic data from the first year of opening of the AP2 revised scheme (2026).

5.3.2 Screening using the DMRB traffic and road alignment change criteria was undertaken to determine locations requiring assessment. Four locations within the Whittington to Handsacre area met the criteria for an assessment of emissions from traffic during the operational stage, following completion of the AP2 revised scheme. These locations are Darnford Lane, west of Whittington, due to permanent realignment of Darnford Lane; around Broad Lane and Capper's Lane, east of Lichfield, due to permanent realignment of Broad Lane and stopping up of Capper's Lane and Wood End Lane, Curborough, due to permanent realignment of Wood End Lane.

Receptors assessed

5.3.3 For locations where DMRB traffic and road alignment change criteria for local air quality were met, a number of receptors representative of worst-case exposure locations were selected for quantitative assessment. These included locations representative of highest concentrations along the roads, including closest to junctions or to the road itself. Receptors assessed are listed in Table 8 and shown in SES and AP2 ES Volume 5: Map AQ-01-022.

Table 8 - Modelled receptors (operational phase)

Receptor	Description/Location	Ordnance Survey coordinates
22-15	Whittington Hill Farm, Darnford Lane, Lichfield	414656, 308405
22-3	Mill Farm, Capper's Lane, Lichfield	414854, 309065
22-4	Brook House, Capper's Lane, Lichfield	414918, 309101
22-5	1 Fulfen Cottages, Capper's Lane, Lichfield	414518, 309207
22-6	New Fulfen Cottage, Capper's Lane	414322, 309218
22-7	Ivy Cottage, Broad Lane, Huddlesford	414652, 309427
22-16	The Cottage, Wood End Lane, Curborough	412793, 313234
22-17	Wood End Lock Cottage, Wood End Lane, Curborough	412776, 313518

Background concentrations

5.3.4 The background concentrations used in the assessment are shown in Table 9 taken from the Defra maps.

Table 9 - Background 2026 concentrations at assessed receptors

Receptor (or zone of receptors)	Concentrations (µg/m3)		
	NOx	NO2	PM10
22-15 (Whittington Hill Farm)	13.2	9.9	15.1
22-3 (Mill Farm)	16.4	12.1	16.2
22-4 (Brook House)	16.4	12.1	16.2
22-5 (1 Fulfen Cottages)	16.4	12.1	16.2
22-6 (New Fulfen Cottage)	16.4	12.1	16.2
22-7 (Ivy Cottage)	16.4	12.1	16.2
22-16 (The Cottage)	14.3	10.6	15.1
22-17 (Wood End Lock Cottage)	14.3	10.6	15.1

DMRB model results

5.3.5 This section provides the summary of the modelled pollutant concentrations for the assessed receptors. The magnitude of change and impact descriptor is also derived following the EPUK methodology[9].

Table 10 - Summary of DMRB annual mean NO2 results (operational phase)

Receptor	Concentrations (µg/m3)		Change in concentrations (µg/m3)	Magnitude of change	Impact descriptor
	2026 without scheme	2026 with AP2 revised scheme			
22-15 (Whittington Hill Farm)	9.9	9.9	0.0	imperceptible	negligible
22-3 (Mill Farm)	12.4	12.4	0.0	imperceptible	negligible
22-4 (Brook House)	12.8	12.8	0.0	imperceptible	negligible
22-5 (1 Fulfen Cottages)	13.0	12.1	-0.9	small	negligible
22-6 (New Fulfen Cottage)	12.2	12.2	0.0	imperceptible	negligible
22-7 (Ivy Cottage)	12.5	12.6	0.1	imperceptible	negligible
22-16 (The Cottage)	12.5	10.8	-1.7	small	negligible
22-17 (Wood End Lock Cottage)	10.6	10.8	0.2	imperceptible	negligible

Table 11 - Summary of DMRB annual mean PM10 results (operational phase)

Receptor	Concentrations (µg/m3)		Change in concentrations (µg/m3)	Magnitude of change	Impact descriptor
	2026 without scheme	2026 with AP2 revised scheme			
22-3 (Mill Farm)	15.1	15.1	0.0	imperceptible	negligible
22-4 (Brook House)	16.3	16.3	0.0	imperceptible	negligible
22-5 (1 Fulfen Cottages)	16.4	16.4	0.0	imperceptible	negligible
22-6 (New Fulfen Cottage)	16.4	16.3	-0.2	imperceptible	negligible
22-7 (Ivy Cottage)	16.3	16.3	0.0	imperceptible	negligible
22-16 (The Cottage)	16.3	16.4	0.0	imperceptible	negligible
22-17 (Wood End Lock Cottage)	15.4	15.1	-0.3	imperceptible	negligible

5.3.6 Annual mean NO2 and PM10 concentrations will be below the air quality standards both with the AP2 revised scheme and without the scheme for the operation phase. The hourly mean NO2 air quality standard will also be met as annual mean NO2 concentrations will be well below 60µg/m^3. In addition the daily mean PM10 air quality standard will also be met. It is not possible to model PM2.5 using the DMRB screening model, but given the PM10 concentrations, the annual mean PM2.5 concentrations will be below the air quality standard.

5.3.7 Changes in modelled concentrations with the AP2 revised scheme and without the scheme have been calculated to determine the impact to local air quality. There will be a small decrease in annual mean NO2 concentrations at Fulfen Cottages due to the stopping up of Capper's Lane which removes the traffic emission source adjacent to this receptor. There will also a small decrease in annual mean NO2 concentrations at The Cottage due to the permanent realignment of Wood End Lane which moves the road alignment further away from the receptor. The change in annual mean NO2 concentrations is imperceptible at all other receptors. The change in annual mean PM10 concentrations is imperceptible at all receptors.

5.3.8 The magnitude of impact for NO2 will be negligible for all receptors as the change in concentrations is imperceptible to small and concentrations are well below air quality standards. For PM10 the magnitude of impact will be negligible for all receptors assessed as the change in concentrations is imperceptible and concentrations are well below air quality standards.

Assessment of significance

5.3.9 Considering the significance of the air quality impacts according to the criteria set in the EPUK methodology[9], the following points are noted:

- the magnitude of impact is negligible for NO2 and PM10 at all receptors; and
- pollutant concentrations are well below the air quality standards for both NO2 and PM10 with the AP2 revised scheme and without the scheme.

5.3.10 Based on the above, the effect on air quality due to operational traffic emissions will not be significant.

6 References

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Environmental topic:	Community	CM
Appendix name:	Community assessment	001
Community forum area:	Whittington to Handsacre	022

Contents

1 Introduction 1

Part 1: Supplementary Environmental Statement 2

2 Community impact assessment record sheets - construction 3

2.1 Residents of Fradley 3

3 Community impact assessment record sheets - operation 1

3.1 [Tables in section 3 not required as no SES assessments] 1

Part 2: Additional Provision 2 Environmental Statement 2

4 Community impact assessment record sheets - construction 3

4.1 Ellfield House, Lichfield Road 3

4.2 Residential properties at Fulfen Farm, Capper's Lane 5

4.3 Mill Farm and Mill House, Darnford Lane 6

4.4 Mill Farm, The Watermill and Brook House, Capper's Lane 7

4.5 Canal Cottage, Capper's Lane 8

4.6 Barn Farm, Broad Lane 9

4.7 Darnford Moors Golf Club 10

4.8 Lichfield Cruising Club 11

4.9 Residents of Huddlesford 13

4.10 Users of the Coventry Canal and towpath 14

4.11 Kings Orchard Marina, Streethay 15

4.12 Horsepower Equestrian Centre, Streethay 16

4.13 Six residential properties at Streethay 18

4.14 Field Cottage, Burton Road, Streethay 19

4.15 Three residential properties at Burton Road, Streethay 20

4.16 Sustrans National Cycle Route No. 54 21

4.17 Moorings on the Trent and Mersey Canal at Wood End Lock 22

4.18 Three residential properties at Wood End Lane, Curborough 23

4.19 Ravenshaw House, Wood End Lane, Curborough 24

4.20 Birch Ridings, Wood End Lane, Elmhurst 25

4.21 Kings Bromley Marina 26

4.22 Hanch Hall Farm, Lichfield Road, Hanch 27

4.23 Shaw House and Shaw Lane Farm, Shaw Lane, Hanch 28

5 Community impact assessment record sheets - operation 29

5.1 Residential properties at Lichfield Road and Darnford Lane, west of Whittington 29

List of tables

Table 1 - Residents of Fradley community impact assessment record sheet 3
Table 2 - Ellfield House, Lichfield Road community impact assessment record sheet 3
Table 3 - Residential properties at Fulfen Farm, Capper's Lane community impact assessment record sheet 5
Table 4 - Mill Farm and Mill House, Darnford Lane community impact assessment record sheet 6
Table 5 - Mill Farm, The Watermill and Brook House, Capper's Lane community impact assessment record sheet 7
Table 6 - Canal Cottage, Capper's Lane community impact assessment record sheet 8
Table 7 - Barn Farm, Broad Lane community impact assessment record sheet 9
Table 8 - Darnford Moors Golf Club community impact assessment record sheet 10
Table 9 - Lichfield Cruising Club community impact assessment record sheet 11
Table 10 - Residents of Huddlesford community impact assessment record sheet 13
Table 11 - Users of the Coventry Canal and towpath community impact assessment record sheet 14
Table 12 - Kings Orchard Marina, Streethay community impact assessment record sheet 15
Table 13 - Horsepower Equestrian Centre community impact assessment record sheet 16
Table 14 - Six residential properties at Streethay community impact assessment record sheet 18
Table 15 - Field Cottage, Burton Road, Streethay community impact assessment record sheet 19
Table 16 - Three residential properties at Burton Road, Streethay community impact assessment record sheet 20
Table 17 - Sustrans National Cycle Route No. 54 community impact assessment record sheet 21
Table 18 - Moorings on the Trent and Mersey Canal at Wood End Lock community impact assessment record sheet 22
Table 19 - Three residential properties at Wood End Lane, Curborough community impact assessment record sheet 23
Table 20 - Ravenshaw House, Wood End Lane, Curborough community impact assessment record sheet 24
Table 21 - Birch Ridings, Wood End Lane, Elmhurst community impact assessment record sheet 25
Table 22 - Kings Bromley Marina community impact assessment record sheet 26
Table 23 - Hanch Hall Farm, Lichfield Road, Hanch Community impact assessment record sheet 27
Table 24 - Shaw House and Shaw Lane Farm, Shaw Lane, Hanch community impact assessment record sheet 28
Table 25 - Residential properties at Lichfield Road and Darnford Lane, west of Whittington community impact assessment record sheet 29

1 Introduction

1.1.1 This appendix provides an update to the Appendix CM-001-022 Community assessment from the main Environmental Statement (ES) as a result of design changes in AP2, assessed as part of the Additional Provision 2 Environmental Statement (AP2ES). This update should be read in conjunction with Appendix CM-001-022 Community assessment from the main ES.

1.1.2 This appendix is structured as followed:

- Part 1: Supplementary Environmental Statement
  - Community impact assessment record sheets - construction; and
  - Community impact assessment record sheets - operation.
- Part 2: Additional Provision 2 Environmental Statement
  - Community impact assessment record sheets - construction; and
  - Community impact assessment record sheets - operation

Part 1: Supplementary Environmental Statement

2 Community impact assessment record sheets - construction

2.1 Residents of Fradley

Table 1 - Residents of Fradley community impact assessment record sheet

Resource name	Residents of Fradley
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residents
Resource description/profile	Residents of Fradley dependent upon access to facilities at Lichfield, including the Friary School (Secondary) and health care facilities.
Assessment year	Construction phase (2017+)
Impact: Temporary isolation	Impact: Potential disruption to journeys to access community facilities at Lichfield, including secondary schools and health care facilities, due to major adverse congestion effect at the Wood End Lane/A38 junction caused by construction traffic. This impact has been identified as a correction in the SES and AP2 ES Volume 2 report for CFA22. Previously, no impact on journeys for residents was identified in the main ES. Duration: Approximately two years during construction.
Assessment of magnitude	The traffic and transport assessment has predicted a major adverse and significant congestion/delay effect at the A38/Wood End Lane junction which is likely to last for a period of up to approximately two years. This will affect journeys made to access secondary schools and other community facilities on a day to day basis. Traffic management measures are also proposed on the A38 but no significant delays are predicted associated with the works at Streethay. The magnitude of impact is assessed as medium, based on the results of the traffic and transport assessment. This is a change in the assessment from that reported in the main ES for the original scheme and has been identified as a result of a correction to the traffic and transport assessment.
Relevant receptors	Secondary school pupils residing in Whittington
Assessment of sensitivity of receptors (s) to impact	Trips are made on a daily basis and all families with children of secondary age will be affected. Limited alternative routes to Lichfield via Wood End Lane will also be affected during construction, albeit no significant congestion or delays are predicted. Sensitivity Rating: Medium
Significance rating of effect	Moderate adverse effect - significant. This is a new temporary significant effect not previously reported in the main ES and has been identified as a result of a correction to the traffic

Resource name	Residents of Fradley
	and transport assessment for the original scheme. Previously, the construction of the Proposed Scheme was assessed as having a negligible isolation effect on the community of Fradley.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Moderate adverse effect – significant. This is a new temporary significant effect not previously reported in the main ES, as the original scheme was assessed as having a negligible effect on the community of Fradley. This effect has been identified as a result of a correction made to the traffic and transport assessment, which is reported in the Volume 2 CFA18 report of the SES and AP2 ES.

3 Community impact assessment record sheets - operation

3.1 [Tables in section 3 not required as no SES assessments]

Part 2: Additional Provision 2 Environmental Statement

4 Community impact assessment record sheets - construction

4.1 Ellfield House, Lichfield Road

Table 2 - Ellfield House, Lichfield Road community impact assessment record sheet

Resource name	Ellfield House
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	Residential property with a two bedroom annex in the rear courtyard and a separate outbuilding (referred to as The Bothy) which is being converted to a three bedroom dwelling.
Assessment year	Construction phase (2017+)
Impact 1: Demolition of dwelling house	Impact: No demolition of dwelling required under the AP2 revised scheme. The original scheme required the demolition of an outbuilding being converted to residential use (referred to as The Bothy).
Assessment of magnitude	N/A
Relevant receptors	Residents and owners.
Assessment of sensitivity of receptors (s) to impact	N/A
Significance rating of effect	No effect under the AP2 revised scheme. This removes a minor adverse effect reported in the main ES.
Impact 2: Permanent loss of land	Permanent loss of a small area of garden land adjacent to The Bothy, including the demolition of an outbuilding.
Assessment of magnitude	Negligible as a single property affected.
Relevant receptors	Residents and owners.
Assessment of sensitivity of receptors (s) to impact	Residential therefore sensitivity rating is high.
Significance rating of effect	Minor adverse – not significant
Proposed mitigation options for significant effects	No further mitigation practicable.

Resource name	Ellfield House
Residual effects significance rating	Impact 1: N/A under the AP2 revised scheme (this removes a minor adverse demolition effect reported in the main ES). Impact 2: Minor adverse – not significant this effect would also arise with construction of the original scheme.

4.2 Residential properties at Fulfen Farm, Capper's Lane

Table 3 - Residential properties at Fulfen Farm, Capper's Lane community impact assessment record sheet

Resource name	**Residential properties at Fulfen Farm, Capper's Lane**
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential properties
Resource description/profile	The Barn, Linden Byre and The Bungalow at Fulfen Farm, Capper's Lane
Assessment year	Construction phase (2017+)
Impact: Temporary loss of land	The properties were included within the boundary of land required temporarily during construction of the original scheme for overhead powerline works. The same properties together with an additional property, Squirrels Dray, were situated within the boundary of the AP1 revised scheme. There would be no impact on any of these properties with the AP2 revised scheme.
Assessment of magnitude	Negligible for the original and AP1 revised scheme. No impact for the AP2 revised scheme.
Relevant receptors	Residents and owners.
Assessment of sensitivity of receptors (s) to impact	N/A
Significance rating of effect	No effect arising during construction of the AP2 revised scheme. The changes incorporated within the AP2 revised scheme therefore avoid any effect on these properties.
Proposed mitigation options for significant effects	N/A
Residual effects significance rating	No effect arising during construction of the AP2 revised scheme.

4.3 Mill Farm and Mill House, Darnford Lane

Table 4 - Mill Farm and Mill House, Darnford Lane community impact assessment record sheet

Resource name	Mill Farm and Mill House
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	Mill Farm and Mill House, which are situated on the south side of Darnford Lane, just east of the A38.
Assessment year	Construction phase (2017+)
Impact: Temporary loss of land	No impact with the AP2 revised scheme. These properties were included within the boundary of land required temporarily for the construction of the original scheme.
Assessment of magnitude	N/A
Relevant receptors	Residents
Assessment of sensitivity of receptors (s) to impact	N/A
Significance rating of effect	No effect. The properties are outside of the boundary of land required for the construction of the AP2 revised scheme. Previously, these properties were within an area required temporarily for the construction of the original scheme, which was assessed as a negligible effect.
Proposed mitigation options for significant effects	N/A
Residual effects significance rating	No effect. The original scheme was assessed as giving rise to a negligible effect on these properties.

4.4 Mill Farm, The Watermill and Brook House, Capper's Lane

Table 5 - Mill Farm, The Watermill and Brook House, Capper's Lane community impact assessment record sheet

Resource name	**Mill Farm, The Watermill and Brook House, Capper's Lane.**
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	A group of three residential properties situated on both sides of Capper's Lane to the east of the route of the AP2 revised scheme.
Assessment year	Construction phase (2017+)
Impact: Permanent loss of land	Impact: Slight permanent loss of land due to works to realign Capper's Lane and to amend access to Mill Farm and The Watermill. Duration: Permanent
Assessment of magnitude	Negligible as fewer than five properties affected.
Relevant receptors	Residents/property owners
Assessment of sensitivity of receptors (s) to impact	Residential dwellings therefore sensitivity rating is high
Significance rating of effect	Minor adverse effect – not significant. This is a new effect associated with the AP2 revised scheme which would not occur with the original scheme.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Minor adverse – not significant. This is a new effect arising due to construction of the AP2 revised scheme.

4.5 Canal Cottage, Capper's Lane

Table 6 - Canal Cottage, Capper's Lane community impact assessment record sheet

Resource name	Canal Cottage, Capper's Lane
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	Dwelling situated on the banks of a disused section of the Wyrley and Essington Canal, to the south of Capper's Lane.
Assessment year	Construction phase (2017+)
Impact: Temporary loss of land	Impact: Very slight loss of land from the edge of the property along the banks of the canal during works to realign the canal. It is assumed that any requirement for land during the works would be temporary only. Works to modify access to Canal Cottage from Capper's Lane will also be required. Duration: Approximately six months for canal diversion works.
Assessment of magnitude	Negligible as less than five properties affected by temporary loss of land in this location.
Relevant receptors	Residents
Assessment of sensitivity of receptors (s) to impact	Residential dwelling therefore sensitivity rating is high.
Significance rating of effect	Minor adverse effect –not significant. This is a new effect arising from the construction of the AP2 revised scheme not previously reported in the main ES.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Minor adverse effect – not significant. This is a new effect arising from construction of the AP2 revised scheme and has not been previously reported in the main ES.

4.6 Barn Farm, Broad Lane

Table 7 - Barn Farm, Broad Lane community impact assessment record sheet

Resource name	**The Barn, Broad Lane**
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	The Barn, Broad Lane
Assessment year	Construction phase (2017+)
Impact: Temporary loss of land	No impact arising with construction of the AP2 revised scheme. The boundary of land required temporarily for the construction of the original scheme included land belonging to Barn Farm at Broad Lane. The boundary of land for the AP2 revised scheme now excludes Barn Farm.
Assessment of magnitude	Negligible impact for the original scheme and no impact for the AP2 revised scheme.
Relevant receptors	Residents and owners.
Assessment of sensitivity of receptors (s) to impact	High
Significance rating of effect	Negligible effect on property for the original scheme and no effect for the AP2 revised scheme.
Proposed mitigation options for significant effects	Not applicable.
Residual effects significance rating	No effect under the AP2 revised scheme. The negligible effect assessed for the original scheme will be avoided by the AP2 revised scheme.

4.7 Darnford Moors Golf Club

Table 8 - Darnford Moors Golf Club community impact assessment record sheet

Resource name	**Darnford Moors Golf Club**
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Recreational Infrastructure
Resource description/profile	Darnford Moors Golf Club has two nine hole courses, a short play Academy Course, together with the nine hole par 34 Moors course. There is a club house and restaurant included as part of the facilities. A driving range belonging to the golf club is situated on land on the south side of Darnford Lane.
Assessment year	Construction phase (2017+)
Impact: Temporary loss of land	Impact: No impact arising under the AP2 revised scheme. Under the original scheme access to approximately 4.5 hectares of land would be required temporarily for the tensioning and reinforcement of overhead power cables. This would be required for two periods totalling 2 months over a period of one year and three months. There would be no impact on the golf club under the AP2 revised scheme.
Assessment of magnitude	No impact due to construction of the AP2 revised scheme. The magnitude of impact for the original scheme was assessed as medium as it would require partial closure of some facilities at the Golf Club for a temporary period of time. The AP2 revised scheme would not require any temporary loss of land from the golf club or closure of any of its facilities.
Relevant receptors	Golf club members and members of the public
Assessment of sensitivity of receptors (s) to impact	Sensitivity Rating: Medium
Significance rating of effect	No effect due to construction of the AP2 revised scheme. The original scheme was assessed as giving rise to a moderate adverse and significant effect on the golf club. This would be avoided by the AP2 revised scheme which would have no effect on the golf club.
Proposed mitigation options for significant effects	Not applicable
Residual effects significance rating	No effect. The AP2 revised scheme avoids the moderate adverse and significant effect reported in the main ES for the original scheme.

4.8 Lichfield Cruising Club

Table 9 - Lichfield Cruising Club community impact assessment record sheet

Resource name	Lichfield Cruising Club
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Recreation
Resource description/profile	Lichfield Cruising Club is a recreational club for boat owners. The club has 67 moorings along both the Wyrley and Essington Canal and the Coventry Canal and has approximately 165 members. Demand for moorings is strong and in recent years there has been a waiting list for new members. There is a slipway and an area at Capper's Lane which is used for parking and maintenance of boats by members. A winding arm allows members to lift boats out of the water for essential maintenance and repairs. There is a club house in the converted canal cottage which is used for a range of regular social events. Events are also held on leased land adjacent to moorings, e.g. Huddlesford Gathering, which is a popular and well attended canal heritage event which is held on alternate years. Moorings are recreational with occupation limited to up to two weeks at a time
Assessment year	Construction phase (2017+)
Impact 1: Temporary Loss of Moorings	Impact: Closure of approximately 12 moorings required during works to realign the Wyrley and Essington Canal and Capper's Lane and works to build the Capper's Lane Viaduct. Duration: Approximately two years and five months. This impact differs from that reported for the original scheme, which also resulted in the temporary closure of the boat maintenance area as well as the temporary closure of moorings between Watery Lane Bridge and Capper's Lane.
Assessment of magnitude	The magnitude of impact is medium as the moorings will be unusable and the resource is therefore partially closed for a duration of approximately two years and five months. The overall magnitude of temporary impact is unchanged from the original assessment.
Relevant receptors	Members of the club and canal users
Assessment of sensitivity of receptors (s) to impact	Sensitivity Rating: Medium, as this is a well used and valued resource and demand for moorings is high, but with the recently opened Kings Orchard Marina at Streethay there are some alternative mooring facilities available nearby. However, the availability of alternative moorings nearby offering comparable boat maintenance facilities is more limited and other sites would not necessarily offer the same social opportunities for club members that is available at Huddlesford.
Significance rating of effect	Moderate adverse – significant. The rating of significance is unchanged from the original scheme, although the nature of the impact has varied slightly.

Resource name	**Lichfield Cruising Club**
Impact 2: Permanent loss of land	Impact: 520 square metres of land is permanently required for construction of the railway and proposed Capper's Lane viaduct. Duration: Permanent The impact under the AP2 revised scheme has changed from that reported for the original scheme. The original scheme would not result in the complete loss of the boat maintenance area but the siting of a viaduct pier in this area was assessed as being likely to significantly impair use of the boat maintenance area.
Assessment of magnitude	The limits of land required permanently now include all of the car park and an area used for boat maintenance, together with a winding arm and slipway, located immediately north of Capper's Lane. These facilities are important for the functioning of the club and they allow members to remove boats from the water to carry out essential repairs. The magnitude of impact is medium as the club's resource is partially compromised on a permanent basis. Whilst the impact differs from that reported for the original scheme, the overall magnitude of impact is unchanged because only part of the total resource is affected.
Relevant receptors	Members of the club and canal users
Assessment of sensitivity of receptors (s) to impact	Medium as there are limited alternative facilities available for lifting boats for maintenance works in the local area. There are limited areas where the boat maintenance area could be relocated to due to the requirement for canal access. Significant Rating: Medium
Significance rating of effect	Moderate adverse – significant effect. The overall rating of significance is unchanged from that reported in the main ES.
Proposed mitigation options for significant effects	Impact 1: No further mitigation identified. Impact 2: No further mitigation identified.
Residual effects significance rating	Impact 1: Moderate adverse - significant Impact 2: Moderate adverse – significant Despite the variation in impacts compared with the original scheme, the levels of significance of the effects on the Lichfield Cruising Club remain unchanged from those reported in the main ES.

4.9 Residents of Huddlesford

Table 10 - Residents of Huddlesford community impact assessment record sheet

Resource name	Residents of Huddlesford
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residents
Resource description/profile	Residents of Huddlesford dependent upon access to facilities at Lichfield, including secondary schooling.
Assessment year	Construction phase (2017+)
Impact: Temporary Isolation	Impact: Slight disruption to journeys to access community facilities at Lichfield, caused by works at Broad Lane, including the realignment of the junction with Capper's Lane and the provision of a localised temporary diversion and the use of part of Broad Lane by construction vehicles. No significant congestion effects are predicted as a result of the works. Duration: Two years and eight months.
Assessment of magnitude	The magnitude of impact is assessed as low.
Relevant receptors	Residents of Huddlesford, particularly those with children of secondary school age who are within the catchment for schools at Lichfield.
Assessment of sensitivity of receptors (s) to impact	Sensitivity rating: Medium as Broad Lane is the principal route for residents travelling from Huddlesford to Lichfield for access to day to day facilities including secondary schooling. These trips are made on a daily basis. There are no convenient alternative routes which residents can use if they wish to avoid Broad Lane without significant diversion, with the most likely alternative being via Whittington and Capper's Lane, which is also crossed by the route of the AP2 revised scheme. Access to the primary school and GP branch surgery at Whittington will be unaffected.
Significance rating of effect	Minor adverse effect – not significant. The significance of the effect is unchanged from the original scheme.
Proposed mitigation options for significant effects	No further mitigation proposed.
Residual effects significance rating	Minor adverse effect – not significant. The significance of the effect is unchanged from the original scheme.

4.10 Users of the Coventry Canal and towpath

Table 11 - Users of the Coventry Canal and towpath community impact assessment record sheet

Resource name	Users of the Coventry Canal and towpath
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Recreational route
Resource description/profile	Canal and towpath
Assessment year	Construction phase (2017+)
Impact: Loss of land	No impact: The canal and towpath are beyond the boundary or limits for the AP2 revised scheme and there would therefore be no impact. Under the original scheme, two sections of the canal and towpath, each approximately 100m in length, would have been within the area required temporarily for construction. However only overnight closures of the route were envisaged.
Assessment of magnitude	The magnitude of impact associated with the original scheme was assessed as being negligible. There would be no such impact under the AP2 revised scheme.
Relevant receptors	Users of the canal and towpath.
Assessment of sensitivity of receptors (s) to impact	Sensitivity rating: medium
Significance rating of effect	For the original scheme the effect was assessed as being negligible - not significant For the AP2 revised scheme there would be no loss of land effect.
Proposed mitigation options for significant effects	No further mitigation required.
Residual effects significance rating	Negligible effect for the original scheme and no effect for the AP2 revised scheme.

4.11 Kings Orchard Marina, Streethay

Table 12 - Kings Orchard Marina, Streethay community impact assessment record sheet

Resource name	**Kings Orchard Marina, Streethay**
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Recreation
Resource description/profile	Newly built Marina, originally with moorings for 45 boats but recently expanded to provide 89 berths. The extant planning permission allows for the formation of up to 130 berths in total. The Marina is equipped with showering facilities and water and electricity connections for boats. There are no facilities for boat maintenance operations at the Marina.
Assessment year	Construction phase (2017+)
Impact: Isolation	Impact: No impact under the AP2 revised scheme. The original scheme required use of the access track to the marina for construction traffic associated with the diversion of overhead power cables. Duration: Six years
Assessment of magnitude	N/A for the AP2 revised scheme. With the original scheme the magnitude of impact was considered to be low because the marina would be able to continue operating and access would be maintained.
Relevant receptors	Users of the marina
Assessment of sensitivity of receptors (s) to impact	N/A for the AP2 revised scheme as no impact. Sensitivity Rating for original scheme assessed as medium.
Significance rating of effect	No effect with the AP2 revised scheme. The original scheme was assessed as giving rise to a minor adverse effect which was not significant.
Proposed mitigation options for significant effects	N/A.
Residual effects significance rating	No effect with the AP2 revised scheme. The original scheme was assessed as giving rise to a minor adverse effect, which was not significant

4.12 Horsepower Equestrian Centre, Streethay

Table 13 - Horsepower Equestrian Centre community impact assessment record sheet

Resource name	Horsepower Equestrian Centre (riding school)
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Recreational infrastructure – sports
Resource description/profile	Riding school and livery yard catering for all ages and also a pony club centre. Offers pony parties and school holiday events. Indoor and outdoor school facilities.
Assessment year	Construction phase (2017+)
Impact 1: Permanent loss of land	Impact: Approximately 0.9ha of land would be required for landscaping, realignment of the A38 Rykneld Street/A5127 Burton Road connecting road and the Streethay Cutting. Duration: Permanent
Assessment of magnitude	The magnitude of impact would be low, as only a small proportion of the overall grazing land would be lost permanently. It would impair use of the resource but would be unlikely to compromise its overall functioning. The magnitude of impact is unchanged from that assessed for the original scheme, as the amount of land required permanently is comparable.
Relevant receptors	Users of the facility, pupils, pony club members, visitors and horse owners.
Assessment of sensitivity of receptors (s) to impact	This is a well used resource with a regular programme of events and activities. Limited comparable alternatives available locally. Sensitivity rating: Medium
Significance rating of effect	Minor adverse effect – not significant. This rating of significance is unchanged from that reported for the original scheme.
Impact 2: Temporary loss of land	Impact: A further 0.3ha of land is required temporarily for construction of the AP2 revised scheme, including grazing land between the South Staffordshire Railway Line (SSL) and the A38 Rykneld Street to west of the Equestrian Centre buildings and use of the SSL railway crossing will also be required to allow access to the A38 Overbridge (Southeast) Satellite construction compound for construction vehicles.
Assessment of magnitude	The magnitude of impact would be low, as only a small proportion of the overall grazing land would be affected and use of facilities to the south of the SSL will be unaffected. This is a change from the assessment of the original scheme which required a much greater area of land and was assessed as a high magnitude of impact.
Relevant receptors	Users of the facility

Resource name	Horsepower Equestrian Centre (riding school)
Assessment of sensitivity of receptors (s) to impact	Medium, as this is a well used resource with a regular programme of events and activities. Limited comparable alternatives available locally.
Significance rating of effect	Minor adverse effect – not significant. This is a change in effect from that reported in the main ES. The AP2 revised scheme avoids the major adverse effect that was assessed for the original scheme.
Proposed mitigation options for significant effects	Impact 1: No further mitigation identified. Impact 2: No further mitigation identified.
Residual effects significance rating	Impact 1: Minor adverse – not significant. No change from the assessment of the original scheme. Impact 2: Minor adverse – not significant. The AP2 revised scheme avoids giving rise to the major adverse temporary effect on the Equestrian Centre which was reported in the main ES.

4.13 Six residential properties at Streethay

Table 14 - Six residential properties at Streethay community impact assessment record sheet

Resource name	Six dwellings at Streethay
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	Six dwellings at Streethay, namely Field Cottage, Streethay Cottage, Elverceter, Rough Stockings, Hill Farm and the extant planning permission for a new dwelling at Hill Farm. Since the original assessment was undertaken, planning permission has been granted for the conversion of a further building at Hill Farm to form two additional residential properties at the farm. This has yet to be implemented but is assumed to form part of the baseline for the assessment of the AP2 revised scheme.
Assessment year	Construction phase (2017+)
Impact: Demolition of residential properties	Impact: The AP2 revised scheme would require the demolition of one dwelling house, namely Field Cottage, Streethay. This is a permanent impact. The original scheme would have resulted in the total and permanent loss of the six dwellings and residential plots (now eight in total with the updated future baseline). Under the AP2 revised scheme, the demolition of all but one of these properties, namely Field Cottage, would be avoided.
Assessment of magnitude	The magnitude of impact for the AP2 revised scheme is negligible as less than five properties are affected. The original scheme was assessed as low based on the number of dwellings affected.
Relevant receptors	Residents
Assessment of sensitivity of receptors (s) to impact	Residential dwelling therefore sensitivity rating is high
Significance rating of effect	Minor adverse – not significant. The AP2 revised scheme therefore avoids the significant moderate adverse effect which was reported for the original scheme.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Minor adverse effect – not significant. The AP2 revised scheme would avoid the moderate adverse significant effect that would arise with construction of the original scheme.

4.14 Field Cottage, Burton Road, Streethay

Table 15 - Field Cottage, Burton Road, Streethay community impact assessment record sheet

Resource name	Field Cottage, Burton Road, Streethay
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential property
Resource description/profile	Residential property situated just off the A38 Burton Road and within the boundary of land required for the construction and operation of the AP2 revised scheme.
Assessment year	Construction phase (2017+)
Impact: Demolition	The AP2 revised scheme will require the demolition of Field Cottage. The original scheme also required the demolition of this property, along with five others in the Streethay area.
Assessment of magnitude	The magnitude of impact is negligible based on the number of properties affected. Previously for the original scheme, the magnitude of impact was low as six properties were affected.
Relevant receptors	Residents and owners.
Assessment of sensitivity of receptors (s) to impact	Residential dwelling therefore sensitivity rating is high.
Significance rating of effect	Minor adverse effect – not significant. This is a different effect from that reported in the main ES, which identified a moderate adverse effect due to the demolition of Field Cottage and five other properties at Streethay.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Minor adverse effect – not significant. This is a different effect from that reported in the main ES, which identified a moderate adverse effect due to the demolition of Field Cottage and five other properties at Streethay.

4.15 Three residential properties at Burton Road, Streethay

Table 16 - Three residential properties at Burton Road, Streethay community impact assessment record sheet

Resource name	Three residential properties at Burton Road, Streethay
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	Three residential properties situated just off Burton Road at Streethay, namely Streethay Cottage, Elverceter and The Manor.
Assessment year	Construction phase (2017+)
Impact: Permanent loss of land	Slight permanent loss of land from the boundary of Streethay Cottage and Elverceter and permanent loss of land and realignment of the access to The Manor.
Assessment of magnitude	The magnitude is assessed as negligible based on the number of properties affected.
Relevant receptors	Residents and owners.
Assessment of sensitivity of receptors (s) to impact	Residential dwellings and therefore the sensitivity is rated as high.
Significance rating of effect	Minor adverse effect – not significant. This is a different effect from that reported for the original scheme in the main ES, which identified a moderate adverse and significant effect due to the demolition of two of these properties and four others in the Streethay area.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Minor adverse effect – not significant. This is a different effect from that reported for the original scheme in the main ES, which identified a moderate adverse and significant effect due to the demolition of two of these properties and four others in the Streethay area.

4.16 Sustrans National Cycle Route No. 54

Table 17 - Sustrans National Cycle Route No. 54 community impact assessment record sheet

Resource name	**Sustrans Route 54**
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Cycle route and recreational named route.
Resource description/profile	National Cycle Route, which runs along the highways of Netherstowe Lane and Wood End Lane.
Assessment year	Construction phase (2017+)
Impact: Loss of land/permanent diversion of route	Impact: The boundary of land required for the construction and operation of the AP2 revised scheme incorporates a section of both Netherstowe Lane and Wood End Lane at Fradley, which is used for the Sustrans NCR No. 54. The AP2 revised scheme makes provision to permanently divert Netherstowe Lane via a realigned Wood End Lane and to divert the cycleway, to pass beneath the proposed Curborough Brook Viaduct, with a new dedicated cycleway within the landscaping area to the north of Wood End Lane to connect back to Wood End Lane approximately 150m west of the current junction between Netherstowe Lane and Wood End Lane. This permanent diversion will add approximately 1km to the cycle route. The cycle route will be operational during construction. Duration: Permanent
Assessment of magnitude	The magnitude of impact is low, as the additional distance is unlikely to affect recreational users of this cycle route, although it is recognised that the diversion will be less convenient for people using this route for commuting between Fradley and Lichfield. Approximately 500m of the route will be off-road which will offer some benefit for users as this section of the route is currently along the road at present. This is a change in magnitude of impact compared with that assessed for the original scheme, reflecting the changes in the AP2 revised scheme which now divert the cycleway by approximately 1km.
Relevant receptors	Cyclists
Assessment of sensitivity of receptors (s) to impact	Sensitivity Rating: Medium as this is a well used route with no comparable alternatives linking Fradley and Lichfield directly.
Significance rating of effect	Minor adverse effect - not significant. This is a change in effect from that reported in the main ES, which was negligible for the original scheme.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Minor adverse effect - not significant. This effect is different from the negligible effect reported in the main ES for the original scheme.

4.17 Moorings on the Trent and Mersey Canal at Wood End Lock

Table 18 - Moorings on the Trent and Mersey Canal at Wood End Lock community impact assessment record sheet

Resource name	Moorings on the Trent and Mersey Canal at Wood End Lock
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Recreational moorings
Resource description/profile	Recreational moorings for approximately 15 boats located adjacent to Wood End Lock Cottage
Assessment year	Construction phase (2017+)
Impact: Temporary closure of moorings	No impact under the AP2 revised scheme. The original scheme required some of the moorings to be closed temporarily during construction for a period of approximately one year and one month. The boundary of works for the construction of the AP2 revised scheme will not encompass the moorings and no construction work will take place above the moorings which might otherwise have necessitated their temporary closure.
Assessment of magnitude	No impact under the AP2 revised scheme.
Relevant receptors	Canal users mooring in this location
Assessment of sensitivity of receptors (s) to impact	N/A
Significance rating of effect	No effect under the AP2 revised scheme. The AP2 revised scheme therefore avoids the major adverse effect reported in the main ES due to the temporary closure of the moorings at Wood End Lock during construction of the original scheme.
Proposed mitigation options for significant effects	N/A
Residual effects significance rating	No effect. The AP2 revised scheme avoids the major adverse effect reported in the main ES due to the temporary closure of moorings.

4.18 Three residential properties at Wood End Lane, Curborough

Table 19 - Three residential properties at Wood End Lane, Curborough community impact assessment record sheet

Resource name	Three residential properties at Wood End Lane, Curborough
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	Three residential properties situated on the north side of Wood End Lane, namely The Cottage, Wood End Lock Cottage and Black Slough Farm.
Assessment year	Construction phase (2017+)
Impact: Permanent loss of land	Impact: slight permanent loss of land from the edge of these properties (gardens) due to construction of the AP2 revised scheme.
Assessment of magnitude	The magnitude of impact is negligible based on the number of properties affected.
Relevant receptors	Residents/owners.
Assessment of sensitivity of receptors (s) to impact	Residential properties therefore sensitivity rating is high.
Significance rating of effect	Minor adverse effect – not significant. This is a new effect due to the AP2 revised scheme and has not been previously identified or reported in the main ES.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Minor adverse effect – not significant. This is a new effect due to the AP2 revised scheme and has not been previously identified or reported in the main ES.

4.19 Ravenshaw House, Wood End Lane, Curborough

Table 20 - Ravenshaw House, Wood End Lane, Curborough community impact assessment record sheet

Resource name	Ravenshaw House, Wood End Lane, Curborough
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	Isolated residential property situated within Ravenshaw Wood with access currently from Wood End Lane.
Assessment year	Construction phase (2017+)
Impact: Loss of land	No loss of private garden land or outbuildings with the AP2 revised scheme. The AP2 revised scheme diverts access to the property to a new route from the A515 Lichfield Road. The original scheme was assessed as resulting in the loss of some private garden land belonging to this property and would have required the demolition of two outbuildings.
Assessment of magnitude	No loss of residential land with the AP2 revised scheme. No impact.
Relevant receptors	Residents/owners.
Assessment of sensitivity of receptors (s) to impact	N/A
Significance rating of effect	N/A Previously the loss of garden land that would have resulted due to the construction of the original scheme was assessed as a minor adverse effect.
Proposed mitigation options for significant effects	N/A
Residual effects significance rating	N/A Previously the loss of garden land that would have resulted due to the construction of the original scheme was assessed as a minor adverse effect.

4.20 Birch Ridings, Wood End Lane, Elmhurst

Table 21 - Birch Ridings, Wood End Lane, Elmhurst community impact assessment record sheet

Resource name	**Birch Ridings, Wood End Lane, Elmhurst**
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	Residential property situated adjacent to Wood End Lane in the vicinity of Vicars Coppice.
Assessment year	Construction phase (2017+)
Impact: Temporary loss of land	Impact: slight temporary loss of land from edge of garden along the boundary with Wood End Lane, required for utility diversion works.
Assessment of magnitude	The magnitude is negligible given that only a single property is affected.
Relevant receptors	Residents/owners.
Assessment of sensitivity of receptors (s) to impact	Residential dwelling therefore sensitivity rating is high.
Significance rating of effect	Minor adverse effect – not significant. This is a new effect due to the AP2 revised scheme and has not therefore been reported previously in the main ES.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Minor adverse effect – not significant. This is a new effect due to the AP2 revised scheme and has not therefore been reported previously in the main ES.

4.21 Kings Bromley Marina

Table 22 - Kings Bromley Marina community impact assessment record sheet

Resource name	**Kings Bromley Marina**
Community forum area (CFA)	CFA22- Whittington to Handsacre
Resource type	Recreation
Resource description/profile	A marina with capacity for 275 narrow boats and associated facilities with access to the Trent and Mersey Canal. The facility is approximately 90% occupied.
Assessment year	Construction phase (2017+)
Impact: Loss of land	No impact under the AP2 revised scheme. The original scheme required a small temporary loss of land along the boundary of the Kings Bromley Marina during construction. This land is not required under the AP2 revised scheme.
Assessment of magnitude	No impact.
Relevant receptors	Users of the Marina and staff
Assessment of sensitivity of receptors (s) to impact	N/A as no impact under the AP2 revised scheme.
Significance rating of effect	No effect under AP2 revised scheme. The original scheme was assessed as giving rise to a negligible temporary effect.
Proposed mitigation options for significant effects	N/A
Residual effects significance rating	No effect under AP2 revised scheme. The original scheme was assessed as giving rise to a negligible temporary effect.

4.22 Hanch Hall Farm, Lichfield Road, Hanch

Table 23 - Hanch Hall Farm, Lichfield Road, Hanch Community impact assessment record sheet

Resource name	Hanch Hall Farm, Lichfield Road, Hanch
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	Residential dwelling associated with Farm, situated to the west of Lichfield Road at Hanch.
Assessment year	Construction phase (2017+)
Impact: Temporary loss of land	Impact: the boundary of land required temporarily for the construction of the AP2 revised scheme and specifically for works to retention cables in the overhead power lines, includes the dwelling at Hanch Hall Farm. In practice, it is assumed that there will be no direct encroachment in to the residential garden area and that it will be possible to implement protective measures to avoid impacting upon this property.
Assessment of magnitude	The magnitude of impact is assessed as negligible on the basis that a single property is affected and the potential to implement measures which will avoid direct encroachment.
Relevant receptors	Residents/owners
Assessment of sensitivity of receptors (s) to impact	Residential dwelling so sensitivity is assessed as high.
Significance rating of effect	Negligible on the assumption that no direct encroachment into the garden area will be required by these works and that suitable protective measures will be implemented. This is a new effect due to the AP2 revised scheme and has not been reported previously in the main ES.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Negligible on the assumption that no direct encroachment into the garden area will be required by these works and that suitable protective measures will be implemented. This is a new effect due to the AP2 revised scheme and has not been reported previously in the main ES.

4.23 Shaw House and Shaw Lane Farm, Shaw Lane, Hanch

Table 24 - Shaw House and Shaw Lane Farm, Shaw Lane, Hanch community impact assessment record sheet

Resource name	Shaw House and Shaw Lane Farm, Shaw Lane, Hanch
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential properties
Resource description/profile	Two residential properties situated at the junction between Shaw Lane and Tuppenhurst Lane, Hanch.
Assessment year	Construction phase (2017+)
Impact: Temporary loss of land	Impact: Slight loss of land (assumed temporarily) during works to modify the junction at Shaw Lane and construct a permanent diversion of Shaw Lane to connect with the A515 Lichfield Road to the south-east. The land affected comprises verges along the highway which appears to be maintained as part of the residential garden land.
Assessment of magnitude	The magnitude of impact is assessed as negligible based on two properties being affected.
Relevant receptors	Residents and owners
Assessment of sensitivity of receptors (s) to impact	Residential properties therefore the sensitivity rating is high.
Significance rating of effect	Minor adverse effect – not significant. This is a new effect due to the construction of the AP2 revised scheme and has not been reported previously in the main ES.
Proposed mitigation options for significant effects	No further mitigation identified.
Residual effects significance rating	Minor adverse effect – not significant. This is a new effect due to the construction of the AP2 revised scheme and has not been reported previously in the main ES.

5 Community impact assessment record sheets - operation

5.1 Residential properties at Lichfield Road and Darnford Lane, west of Whittington

Table 25 - Residential properties at Lichfield Road and Darnford Lane, west of Whittington community impact assessment record sheet

Resource name	**Residential properties at Lichfield Road and Darnford Lane, situated to the west of Whittington.**
Community forum area (CFA)	CFA22 – Whittington to Handsacre
Resource type	Residential
Resource description/profile	Ten residential properties, namely: Ellfield Lodge, Ellfield House, Ellfield Cottage and The Bothy, which are situated to the east of the AP2 revised scheme at Lichfield Road; Marsh Cottage which is situated to the west of the AP2 revised scheme at Marsh Lane; and Marsh Farm, Whittington Hill House, Whittington Hill Farm, Rodrest and High View, which are situated on either side of the AP2 revised scheme at Darnford Lane. The number of receptors affected has increased in comparison with those reported in the main ES, as the AP2 revised scheme would not require the demolition of The Bothy at Ellfield House. This is now assumed to be an additional receptor in the area for the operational assessment of the AP2 revised scheme.
Assessment year	Operational phase (2026+)
Impact: Change in amenity	Impact: A combination of significant visual impacts and significant noise effects due to the operation of high speed trains and views to the earthworks for the AP2 revised scheme. As landscape mitigation matures, the visual effects on some of these properties will reduce over time. By year 15 of operation, some properties in this group will not be significantly affected. Duration: Permanent
Assessment of magnitude	The magnitude of impact is medium, given a combination of two significant residual effects.
Relevant receptors	Residents and visitors
Assessment of sensitivity of receptors (s) to impact	High, as residential property.
Significance rating of effect	Major adverse effect – significant. The significance of the effect remains as reported in the main ES.
Proposed mitigation options for significant effects	No further mitigation identified.

Resource name	Residential properties at Lichfield Road and Darnford Lane, situated to the west of Whittington.
Residual effects significance rating	Major adverse effect – significant The significance of the effect remains as reported in the main ES.

Environmental topic:	Cultural heritage	CH
Appendix name:	Gazetteer of heritage assets	002
Community forum area:	Whittington to Handsacre	022

Contents

1 Introduction 1
2 Gazetteer 2

List of tables

Table 1 - Gazetteer of heritage assets for CFA22 2

1 Introduction

1.1.1 This appendix provides an update to Appendix CH-002-022 Cultural heritage gazetteer of heritage assets to the main Environmental Statement (ES) as a result of new geophysical surveys undertaken; and potential new areas of ancient woodland identified which may be added onto the ancient woodland inventory assessed as part of the Supplementary Environmental Statement (SES) and design changes assessed as part of the Additional Provision 2 Environmental Statement (AP2ES). This update should be read in conjunction with Appendix CH-002-022 Cultural heritage gazetteer of heritage assets from the main ES.

2 Gazetteer

Table 1 - Gazetteer of heritage assets for CFA22

Unique ID	Map reference	Asset type	Name	Description	Period	Designation	Grade	Significance/ value	NHL reference	HER reference
WHA377	CH-01-xx	Archaeology	Archaeology at Fulfen Wood	Pit like features and curvilinear ditches just north of the woodland, identified through geophysical survey CN045 (WSI-CFA22-005; Appendix CH-004-022).	undated	None	None	Low	None	n/a
WHA378	CH-01-xx	Archaeology	Archaeology at Vicar's Coppice	Linear features and pits west of Ravenshaw Wood, identified through geophysical survey CN053 (WSI-CFA22-005; Appendix CH-004-022).	undated	None	None	Not significant	None	n/a
WHA379	CH-01-xx	Ancient Woodland	Fulfen Wood	Area of woodland (about 3.5ha) adjacent to and north of the West Coast Main Line at Huddlesford. The woodland is in two main blocks, just south of a brook, in a rural setting within land surrounding Hill Farm.	post medieval	likely to be added to the ancient woodland inventory.	None	High	None	n/a
WHA380	CH-01-xx	Ancient Woodland	Little Lyntus	Area of woodland (about 1ha) south of Woodend Lane at Fradley. The wood is part of a network of probably former contiguous woodland including Big Lyntus and Fradley Wood. It is in a quiet setting within agricultural land.	post medieval	likely to be added to the ancient woodland inventory.	None	High	None	n/a

Environmental topic:	Cultural heritage	CH
Appendix name:	Impact assessment table	003
Community forum area:	Whittington to Handsacre	CFA22

Contents

1 Introduction 1
2 Impact assessment 2

List of tables

Table 1 - Impact assessment for CFA22 2

1 Introduction

1.1.1 This appendix provides an update to Appendix CH-003-022 Cultural heritage impact assessment to the main Environmental Statement (ES) as a result of new geophysical surveys undertaken; and potential new areas of ancient woodland identified which may be added onto the ancient woodland inventory, assessed as part of the Supplementary Environmental Statement (SES) and design changes assessed as part of the Additional Provision 2 Environmental Statement (AP2ES). This update should be read in conjunction with Appendix CH-003-022 Cultural heritage impact assessment from the main ES.

2 Impact assessment

Table 1 - Impact assessment for CFA22

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
WHA377	Archaeology at Fulfen Wood	None	Low	The AP2 revised scheme will involve removal of all below ground features.	Permanent High adverse	Moderate adverse	No impact on significance.	No change	Neutral	This is a new asset resulting in a new effect
WHA379	Fulfen Wood	Likely to be added to the ancient woodland inventory	High	Half of the ancient woodland will be removed for construction of the main alignment. This will constitute a temporary mediumadverse impact and major adverse effect. Remaining ancient woodland will be immediately adjacent to the AP2 revised scheme, altering the ability to appreciate the woodland within its historic landscape setting. The remaining woodland will be affected during construction by the presence of the WCML overbridge (south) satellite compound for approximately two years,	Temporary medium adverse Permanent high adverse.	Temporary Major Adverse adverse Permanent Major adverse	There will be an increase in noise audible from within the wood. This will result in a high adverse impact.	Medium adverse	Major adverse	This is a new asset resullting in a new effect at SES (no further change of effect at AP2)

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
				which will alter the experience of approaching and entering the woodland. There will be disturbance during removal of part of the woodland itself, and there will also be construction related noise within the woodland. This will constitute a major adverse effect.						
WHA380	Little Lyntus	Likely to be added to the ancient woodland inventory	High	All of the ancient woodland will be removed for construction of the main alignment. This will constitute a high adverse impact and major adverse effect.	Permanent high adverse	Permanent Major adverse	No impact on significance.	No change	Neutral	This is a new asset resulting in a new effect
WHA064	Willow Cottage	N/A	Low	The cottage will experience temporary disruption of its setting during earth moving for construction of the mainline along the boundary of the asset, and there will be a noise impact for approximately two years. This will constitute a high adverse impact and moderate adverse effect. The asset will be within	Temporary high adverse Permanent high adverse	Temporary moderate adverse Permanent moderate adverse	There will be an increase in noise. This will result in a medium adverse impact. The combined permanent construction and operational impacts will adversely alter key characteristics of the setting of this asset resulting in a	Medium adverse	Moderate adverse	This is a new effect

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
				50m of the main alignment, and its setting will be altered considerably by the scheme landscaping and infrastructure.			medium adverse impact.			
WHA319	Boundary bank and earthworks	N/A	Low	This asset will be removed for construction of the main alignment. This will constitute a high adverse impact and moderate adverse effect	Permanent high adverse	Permanent moderate adverse	No impact on significance.	No change	Neutral	This is a new effect
WHA221	Big Lyntus	Ancient woodland	High	Part of the ancient woodland at Big Lyntus (WHA221)), an asset of high value, will be removed for construction of the main alignment. Remaining woodland will be affected during construction by the presence of the adjacent Curborough Brook viaduct satellite compound for approximately two years and a large material storage area, which will alter the experience of approaching and entering the woodland. There will be disturbance during	Temporary Medium adverse Permanent low adverse	Temporary Major adverse Permanent Moderate adverse	There will be an increase in noise audible from within the wood. The combined permanent construction and operational impacts will result in a medium adverse impact.	Medium adverse	Major adverse	This is a new effect

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
				removal of part of the woodland itself, and there will also be construction related noise within the woodland. This will constitute a medium adverse impact and major adverse effect. The asset will be adjacent to the constructed AP2 revised scheme, altering the ability to appreciate the woodland within its historic landscape setting. This will constitute a low adverse impact and moderate adverse effect.						
WHA132	Streethay Manor and moated site	Listed buildings and Scheduled Monument	High	The asset will experience disruption to its historic access and setting during construction. There will be noise during construction of the scheme cutting and during construction of the A38 overbridge for approximately one year and six months. This will constitute a high adverse impact and major adverse effect.	Temporary High adverse Permanent medium adverse	Temporary Major adverse Permanent Major adverse	There will be an increase in noise. The combined permanent construction and operational impacts will adversely alter key characteristics of the setting of this asset resulting in a high adverse impact and major adverse effect.	High adverse	Major adverse	Change to permanent impact at construction, but not change to major adverse effect. Still a significant effect.

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
				The AP2 revised scheme will be constructed in cutting approximately 20m from the asset through what were historically open fields. Historic views towards Rough Stockings will be altered by the scheme landscaping and connection with other parts of medieval Streethay will be severed, with some archaeological context lost. There will also be a change to the historic access to the site. Overall there will be a medium adverse impact and major adverse effect.						
WHA340	Trent and Mersey Canal	Conservation area	Moderate	The asset will experience noise during construction. This will constitute a low adverse impact and minor adverse effect. The asset will be subject to a permanent change in its setting: the AP2 revised scheme will be 150m away through previously rural land. This will constitute a	Temporary low Adverse Permanent low adverse	Minor adverse Permanent Minor adverse	There will be an increase in noise affecting the asset's rural setting. This will result in a low adverse impact. The combined permanent construction and operational impacts will result in a	Medium adverse	Moderate adverse	No longer significantly affected at construction. Operational impact and effect remains the same

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
				low adverse impact and minor adverse effect.			medium adverse impact.			
WHA338	Trent and Mersey Canal – Bridge 53 and Wood End Lock	Listed building	Moderate	The asset will experience noise during landscaping and construction for approximately one year and three months and loss of the ability to appreciate the asset in its historic landscape setting. This will constitute a medium adverse impact and moderate adverse effect. The asset will be subject to a permanent change in its setting: the AP2 revised scheme will be 150m away. This will constitute a low adverse impact and minor adverse effect.	Temporary Medium adverse Permanent low adverse	Temporary Moderate adverse Permanent Minor adverse	There will be an increase in noise affecting the asset's rural setting. The combined permanent construction and operational impacts will result in a medium adverse impact.	Medium adverse	Moderate adverse	No longer permanently significantly affected at construction. Operational impacts and effects remain the same.
WHA339	Trent and Mersey Canal – Wood End Lock Cottage	Listed building	Moderate	The cottage will experience noise during construction and loss of the ability to appreciate the building in its historic setting. Historic access will be disrupted by landscaping adjacent to the asset and use of its access road for	Temporary Medium Adverse Permanent Medium adverse	Temporary Moderate adverse Permanent Moderate adverse	There will be an increase in noise affecting the asset's rural setting. This will result in a mediumadverse impact. The combined permanent construction and	Mediumadv erse	Moderate adverse	Change in temporary effect at construction from major to moderate. This is changed but not a new significant effect.

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
				approximately one year and six months. This will constitute a medium adverse impact and moderate adverse effect. The asset will be subject to a change in setting: the AP2 revised scheme will be 150m away, but the historic approach to the cottage will be very different, through a planted landscape, not open fields, and via a different access road which will cross the constructed scheme. This will constitute a medium adverse impact and moderate adverse effect.			operational impacts will result in a medium adverse impact.			
WHA046	Rough Stockings	N/A	Low	The AP2 revised scheme will be constructed 100m from this asset. There will be temporary disruption to its setting during construction, causing a medium adverse impact. The setting of the asset will be permanently affected by the existence of the	Temporary High adverse Permanent medium adverse	Temporary Moderate adverse Permanent Moderate adverse	There will be an increase in noise affecting the asset's rural setting. This will result in a low adverse impact. The combined permanent construction and operational impacts	Low adverse	Minor adverse	This is a new temporary effect, and a reduced permanent impact

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
				scheme landscaping to its south through previously open fields. This will constitute a medium adverse impact.			will result in a low adverse impact.			
WHA090	Hill Farm, Streethay	N/A	Low	The farm will experience temporary disruption of its setting during earth moving for construction of the mainline and there will be a noise impact for approximately two years. This will constitute a high adverse impact and moderate adverse effect. The constructed scheme will affect the setting of the asset to its east where previously the farm looked across open fields. This will constitute a medium adverse impact.	Temporary high adverse Permanent medium adverse	Temporary Moderate adverse Permanent minor adverse	There will be an increase in noise affecting the asset's rural setting. This will result in a low adverse impact. The combined permanent construction and operational impacts will result in a low adverse impact.	Low adverse	Minor adverse	This is a new effect
WHA039	Field Cottage, Streethay Cottage and Elverceter	N/A	Low	Remaining buildings will experience temporary disruption of setting during earth moving for construction of the mainline along the boundary of the asset and demolition of Field	Temporary High adverse Permanent Medium adverse	Temporary Moderate adverse Permanent minor adverse	There will be an increase in noise affecting the asset's rural setting. This will result in a low adverse impact. The combined permanent construction and	Low adverse	Minor adverse	This is a new effect

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
				Cottage. There will be a noise impact for approximately two years. This will constitute a high adverse impact and moderate adverse effect. The presence of the constructed scheme will cause a medium adverse impact on remaining buildings, which will survive on an island surrounded by road and rail infrastructure.			operational impacts will result in a low adverse impact.			
WHA227	Curborough piecemeal enclosure	Historic Landscape	Low	The AP2 revised scheme will bisect the landscape between Orchard Farm and Curborough, but will be in cutting. There will be some loss of fabric and legibility.	Medium adverse	Minor adverse	There will be increases in noise affecting the asset's rural character and setting. The combined permanent construction and operational impacts will adversely alter key characteristics of the setting of this asset, resulting in a medium adverse impact.	Medium adverse	Minor adverse	This is no longer a significant effect

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
WHA321	Ravenshaw Wood relict fields	N/A	Moderate	The AP2 revised scheme embankment and landscaping will require the removal of some of this asset resulting in the loss of some below ground features identified in geophysical survey (CN052) but not, including the 'King's Standing' mound.	Low adverse	Minor adverse	No impact on significance.	No change	Neutral	This is no longer a significant effect
WHA320	Mare Brook Prehistoric Landscape	N/A	Low	The AP2 revised scheme will have no effect on this asset.	No change	Neutral	No impact on significance.	No change	Neutral	This is no longer a significant effect
WHA309	Coventry Canal	Listed building	Moderate	The local landscape setting of the canal will not be disrupted during construction and there will be no residual effects on the asset.	No change	neutral	There will be changes in noise levels affecting the asset's quiet rural setting. This will result in a low adverse impact.	Low adverse	Minor adverse	This is no longer a significant effect
WHA344	Cropmarks at Wood End	N/A	Low	The AP2 revised scheme will not affect this asset.	No change	Neutral	No impact on significance.	No change	Neutral	This is no longer a significant effect

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
WHA345	Cropmarks at Brokendown Wood	N/A	Low	The AP2 revised scheme will not affect this asset.	No change	Neutral	No impact on significance.	No change	Neutral	This is no longer a significant effect
WHA222	Ravenshaw Wood	N/A	High	The asset will experience disruption to its character and setting, and the experience of approaching and entering the woodland. There will be disturbance during removal of part of the woodland itself, and there will also be construction related noise within the woodland. This will constitute a medium adverse impact and major adverse effect. Part of the woodland will be removed for construction of the main alignment. This will constitute a medium adverse impact and major adverse effect.	Temporary medium adverse Permanent medium adverse	Temporary major adverse Permanent major adverse	The asset will be subject to noise, detracting from its quiet character and the setting of the remianing woodland. The combined presence and operation of the AP2 revised scheme will result in a high adverse impact and major adverse effect	High adverse	Major adverse	New temporary effect at construction.
WHA302	Whittington Heath Golf	N/A	Moderate	The asset will be demolished for construction of the AP2	Permanent high adverse	Permanent major adverse	No impact on significance	No change	Neutral	Still a significant effect, at construction but changed from

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
	Course Clubhouse			revised scheme cutting and earthworks. This will constitute a high adverse impact and major adverse effect						moderate adverse to major adverse.
WHA225	Vicar's Coppice	N/A	High	The asset will be affected during construction along its boundary for approximately one year and six months, which will alter the setting and experience of approaching and entering the woodland. There will be disturbance during removal of trees along the boundary of the woodland itself, and there will also be construction related noise within the woodland for approximately two years. This will constitute a low adverse impact and moderate adverse effect Part of the woodland will be removed for construction of the main alignment. This will constitute a low adverse	Temporary low adverse Permanent low adverse	Temporary Moderate adverse Permanent moderate adverse	The asset will have its rural character affected by noise. The combined presence and operation of the AP2 revised scheme will result in a low adverse impact and moderate adverse effect	Low adverse	Moderate adverse	This is a new temporary effect at construction at construction

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different environmental effect from that reported in the main ES or the Additional Provision (AP1) ES
				Nature of impact including mitigation	**Scale of impact**	**Effect**	**Nature of impact including mitigation**	**Scale of impact**	**Effect**	
				impact and moderate adverse effect						
WHA359	Streethay House Farm	Listed Building	Moderate	The asset will experience temporary disruption of its setting and historic access during construction. There will also be a noise impact during construction. This will constitute a medium adverse impact and moderate adverse effect	Temporary medium adverse impact	Temporary moderate adverse effect.	No impact on significance.	No change.	Neutral	New temporary significant adverse effect.

Environmental topic:	Cultural heritage	CH
Appendix name:	Survey reports	004
Community forum area:	Whittington to Handsacre	022

Contents

1 Introduction 1
2 Geophysical surveys 1
CN045 Land off Ash Tree Lane 1
Annex 1: Survey equipment and data processing 11
Annex 2: Geophysical interpretation 11

List of figures

Figure 1 - CN045 Site location 4
Figure 2 - CN045 Greyscale plot (south) 5
Figure 3 - CN045 XY trace (south) 6
Figure 4 - CN045 Interpretation (south) 7
Figure 5 - CN045 Greyscale plot (north) 8
Figure 6 - CN045 XY trace (north) 9
Figure 7 - CN045 Interpretation (north) 10

1 Introduction

1.1.1 This appendix provides an update to Appendix CH-004-022 Cultural heritage survey reports from the main Environmental Statement (ES) as a result of updated baseline information, assessed as part of the Supplementary Environmental Statement (SES) and the Additional Provision 2 Environmental Statement (AP2 ES). This update should be read in conjunction with Appendix CH-004-022 Cultural heritage survey reports from the main ES.

2 Geophysical surveys

CN045 Land off Ash Tree Lane

Introduction

2.1.1 Survey parcel CN045 was not reported in the main ES due to access being unavailable at the time.

Project background

2.1.2 Wessex Archaeology was commissioned by HS2 to carry out a geophysical survey of area CN045 off Ash Tree Lane, near Lichfield, Staffordshire (Figure 1), hereafter "the site" (centred on NGR 414724,309908). The survey forms part of an ongoing programme of archaeological works being undertaken ahead of the proposed development of HS2.

2.1.3 The geophysical survey undertaken here has been preceded by desk-based research[1] and a remote sensing survey comprising LiDAR and hyperspectral survey and analysis[2]. Geophysical survey areas have been identified based on the archaeological potential and conclusions identified in these reports.

2.1.4 This site, CN045, was selected for geophysical survey as it is considered to be a known area of high risk with known archaeology in the area.

Site details

2.1.5 The site is comprised of four arable fields located approximately 3km north-east of Lichfield, Staffordshire. The site is bounded to the north-east by the Coventry Canal, to the north and west by hedgerows and further arable land and to the south by the west coast mainline train route. The gradiometer survey covered 16.3ha.

2.1.6 The site lies on the crest of a hill at 75m aOD (above Ordnance Datum) and falls away from this height to 65m aOD to the east and south.

2.1.7 The solid geology is recorded as primarily Mercia Mudstone Formation (Early Triassic) to the north of the site with Bromsgrove Sandstone Formation (Early Triassic) recorded to the south. No superficial deposits are recorded on the site.

2.1.8 The soils underlying the majority of the site are likely to be stagnogley soils of the 711b (Brockhurst 1) association with deposits of typical cambic gley soils of the 831c (Wigton Moor) association and brown earths of the 541b (Bromsgrove) association[3]. Soils derived from such geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey.

Archaeological background

2.1.9 For a detailed assessment of the known archaeology of the site and surrounding area the relevant baseline should be consulted[4]. A summary of relevant sites within 1km of the survey area is provided below and have been included to provide context and inform the geophysical interpretation. Sites referred to can be found either within the gazetteer for CFA 22 in the Environmental Statement[5] (STN numbers) in the supplementary survey works (WHA numbers) or in the Staffordshire SMR (MST numbers).

2.1.10 Features and sites in the area are predominantly of medieval, post medieval and 20th century date. These relate to agricultural activity and local industrial activity.

2.1.11 An undated rectilinear enclosure is located approximately 1km to the north-east of the site, it layout suggest a prehistoric or Romano-British date. This is evident as soil marks on aerial photography (WHA312).

2.1.12 A ring ditch of probable late Neolithic or Bronze Age origin has been identified as a cropmark 730m north-east of the site and is evident in aerial photography (WHA311).

2.1.13 Within the wider landscape, the site lies near to Lichfield and the medieval hamlet of Streethay. Findspots have been recorded of Neolithic, Bronze Age, Roman, and Anglo-Saxon/early medieval date.

2.1.14 Lichfield is an ancient town with its earliest roots in the medieval period, with some evidence for occupation in the prehistoric period. During the medieval period, Lichfield was established and its first cathedral dates to 700AD. Work started on the current cathedral in 1195. The town continued to grow and was enclosed by a ditch and bank. Many historic building survive and archaeological remains have been discovered throughout the city.

2.1.15 The exact extents of the village of Streethay in the medieval period are unknown, but are thought to have been contained within the estate cantered on the later 13th century manor house (WHA314). Earlier buildings however are present at Streethay House Farm.

2.1.16 Streethay Manor is an early 17th century Grade II listed building, set within a scheduled monument. The scheduled area is a polygonal, flat moated site approximately 80x75m . The manor has had alterations within the 18th and 20th centuries to the gardens however a plunge bath on the site is thought to be dated to the late 17th century (WHA132).

2.1.17 A possible medieval moated site has been identified 350m west of the site through crop marks identified from in aerial photography and Ordnance Survey maps up to the mid-20th century (WHA132). Further features have been identified with relation to this on aerial photographs and other archaeological features have been detected in previous geophysical surveys.

2.1.18 A watermill is evident on historic mapping 800m south of the site. Whilst no upstanding features remain, LiDAR has identified ponds and leats that may be related (WHA306).

[1] CH-001-022, HS2 Environmental Statement, 2013
[2] CH-004-022, HS2 Environmental Statement, 2013
[3] Soil Survey of England and Wales, 1983
[4] CH-001-022, HS2 Environmental Statement, 2013
[5] CH-002-022, HS2 Environmental Statement, 2013

Survey objectives

2.1.19 A Written Scheme of Investigation (WSI) was prepared by Wessex Archaeology which outlined the aims of the survey and the proposed methodology to be followed[6]. The stated aims include the following:

- to conduct a detailed survey which covers as much of the specified area as possible, allowing for artificial obstructions;
- to clarify the presence/absence and extent of any buried archaeological remains within the site;
- to determine the general nature of the remains present.
- to combine the results of the geophysical surveys with data from other archaeological assessments carried out as part of the project in order to analyse the archaeological potential of the survey locations

2.1.20 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

Methods

Survey dates

2.1.21 A detailed gradiometer survey was carried out by Wessex Archaeology's in-house geophysics team between the 17 and 20 February 2015.

Grid location

2.1.22 The individual survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS instrument, which is precise to approximately 0.02m and therefore exceeds Historic England (HE) recommendations[7].

2.1.23 A representative sample of survey grid nodes (around 10%) were re-surveyed in the mornings in the event they were left out in the field overnight. This was undertaken along with a visual inspection of entire lines of grid nodes to ensure the survey grid remained accurate for the entire survey.

Instruments used and survey method

2.1.24 The magnetometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1m between sensors. Data were collected at 0.25m intervals along transects spaced 1m apart with an effective sensitivity of 0.03nT, in accordance with HE guidelines[8].

2.1.25 Data were collected in the zigzag method with grids oriented north to south (Grid North). The first direction walked for each grid was heading towards the north.

[6] Wessex Archaeology, 2014
[7] English Heritage, 2008
[8] ibid

Data processing

2.1.26 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse (ZMT) function (±5nT thresholds) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. These two steps were applied to all survey data, with no interpolation applied.

2.1.27 Further details of the geophysical and survey equipment, methods and processing are described in Annex 1.

Data presentation

2.1.28 The processed gradiometer data were output as .png image files and georeferenced in CAD (AutoCAD Map 3D 2011); these images were exported as georeferenced .png image files (accompanied by .pgw files). The interpretation layers were digitised in CAD and the resulting interpretation layers were exported as ESRI shapefiles, in accordance with the specification. The data images and interpretation shapefiles were then used to produce the final figures in GIS (ESRI ArcMap 10).

2.1.29 The gradiometer data are displayed at -2nT (white) to +3nT (black) for the greyscale image and ±25nT at 25nT per cm for the XY trace plots. The XY trace plot images have been produced at a scale of 1:1500.

Results

2.1.30 The gradiometer survey has been successful in identifying anomalies of likely and possible archaeological interest, along with numerous trends. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:1500 (Figures 2 to 4).

2.1.31 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (Figure 4). Full definitions of the interpretation terms used in this report are provided in Annex 2.

2.1.32 Numerous ferrous anomalies are visible throughout the detailed survey dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.

Interpretation: archaeology

2.1.33 The features of greatest interest are located in the southern half of the survey area as ditch-like anomalies at 4000 to 4002. These three features have magnetic values over +3nT and have been classed as archaeology. 4000 is a pair of curvilinear ditches which are likely to be of the greatest significance whereas 4001 and 4002 look like they are likely to be former field boundaries.

2.1.34 A narrow ditch-like anomaly is visible at 4003 and is classed as possible archaeology. Given its shared alignment with nearby ploughing trends this feature is likely to relate to some form of agricultural boundary.

2.1.35 Field drains have been identified in the data such as around 4004. This is represented by dipolar anomalies consistent with ceramic materials.

2.1.36 A broad diffuse edged bipolar anomaly is visible in the data at 4005; this feature is considered to be natural given its form.

2.1.37 Far fewer features have been identified in the northern half of the dataset. A pair of weak ditches at 4006 and 4007 have been classed as possible archaeology due in part to their weak responses (around +1nT) and because they appear to correspond to the position of former field boundaries.

2.1.38 A number of small positive anomalies can be seen scattered across the dataset. These have been classed as possible archaeology as they could represent cut archaeological features such as postholes

2.1.39 A number of trends are visible within the data. Some are trends of uncertain origin, for example 4008 whereas others such as 4009 correspond to clear ploughing trends. The trends of uncertain origin could represent weak archaeological features but could equally be formed by agricultural or geological processes.

2.1.40 The far north of the survey area has a higher concentration of ferrous responses with a noticeable linear concentration around 4010 that runs along the line of a former field boundary.

2.1.41 Other noticeable ferrous responses are located at 4011 and 4012 and look similar to the responses expected from old quarry pits. The higher concentration of ferrous in the surrounding area could relate to quarry activity and the subsequent backfilling of the pits.

Interpretation: modern services

2.1.42 No clear modern services have been identified within the geophysical data.

2.1.43 Gradiometer data will not be able to locate and identify all services present on site. This report and accompanying illustrations should not be used as the sole source for service locations and appropriate equipment should be used to confirm the location of buried services before any trenches are opened on site.

Conclusions

2.1.44 The detailed gradiometer survey has been successful in detecting anomalies of likely and possible archaeological interest within the site, along with ploughing trends, areas of increased magnetic response and natural features. The anomalies of possible archaeological interest are primarily small pit-like features.

Discussion

2.1.45 The anomalies of likely interest are a number of clear ditches observed in the southern half of the site; two look to relate to former field boundaries but the other two around 4000 may prove to be of greater significance given their curvilinear form.

2.1.46 Two possible quarry pits have been identified to the north at 4011 and 4012 that look to date to the post-medieval based on the large amount of ferrous material associated with them.

2.1.47 The majority of detected features appear to relate to agricultural activity with possible former field boundaries and ploughing trends detected right across the site. It is possible that some of the trends of uncertain origin relate to earlier phases of agricultural activity.

2.1.48 It should be noted that small, weakly magnetised features may produce responses that are below the detection threshold of magnetometers. It may therefore be the case that more archaeological features may be encountered than have been identified through geophysical survey. Given how weak many of the features interpreted in this data are it seems very likely that more features may be present than were detected during the survey.

References

English Heritage, 2008. Geophysical Survey in Archaeological Field Evaluation. Research and Professional Service Guideline No. 1, 2nd Edition

HS2 Environmental Statement, 2013. London-West Midlands Environmental Statement, Volume 5: Technical Appendices: CFA22: Whittington to Handsacre

Ordnance Survey, 1884. OS County Series: Staffordshire 1:2500

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Ordnance Survey, 1977. Quaternary Map of the United Kingdom: South. Ordnance Survey. Southampton.

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Wessex Archaeology, 2014. HS2: Geophysical Survey Written Scheme of Investigation: Staffordshire. Report Reference: 86257.01

HER records consulted

WHA132 - Streethay Manor House, Plunge Bath and moated site
WHA 306 – Bunyan's Mill at Mill Farm
WHA310 – Medieval moat and cropmarks, West of Fulfen Wood, Streethay
WHA311 – Cropmark of Late Neolithic or Bronze Age ring ditch, Whittington
WHA312 – Site of prehistoric or Romano-British enclosure, Thatchmoore, Whittington
WHA314 – Medieval settlement of Streethay
MST 16156 - Buckle find spot, Lichfield

Figures

Figure 1 - CN045 Site location

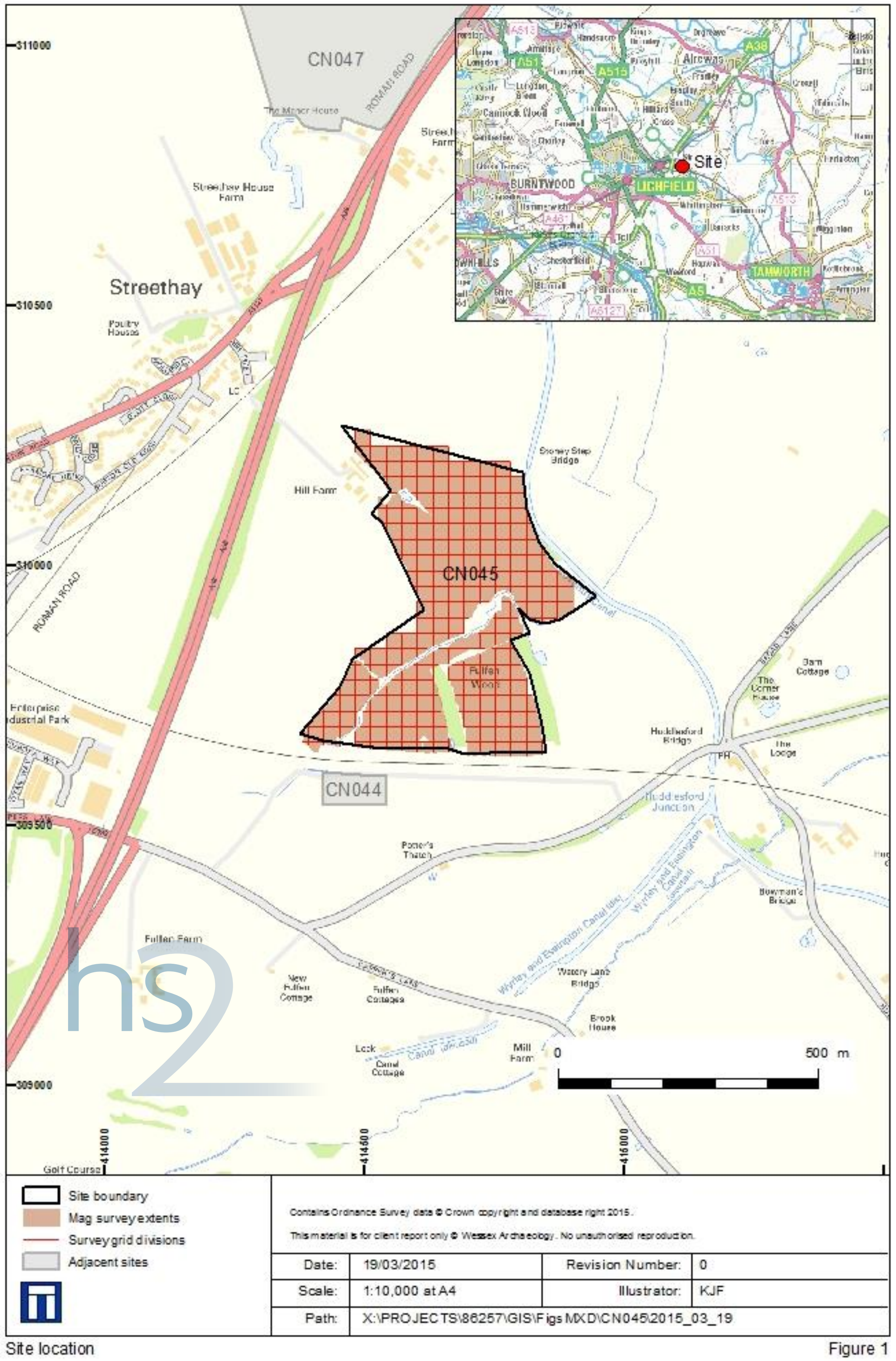
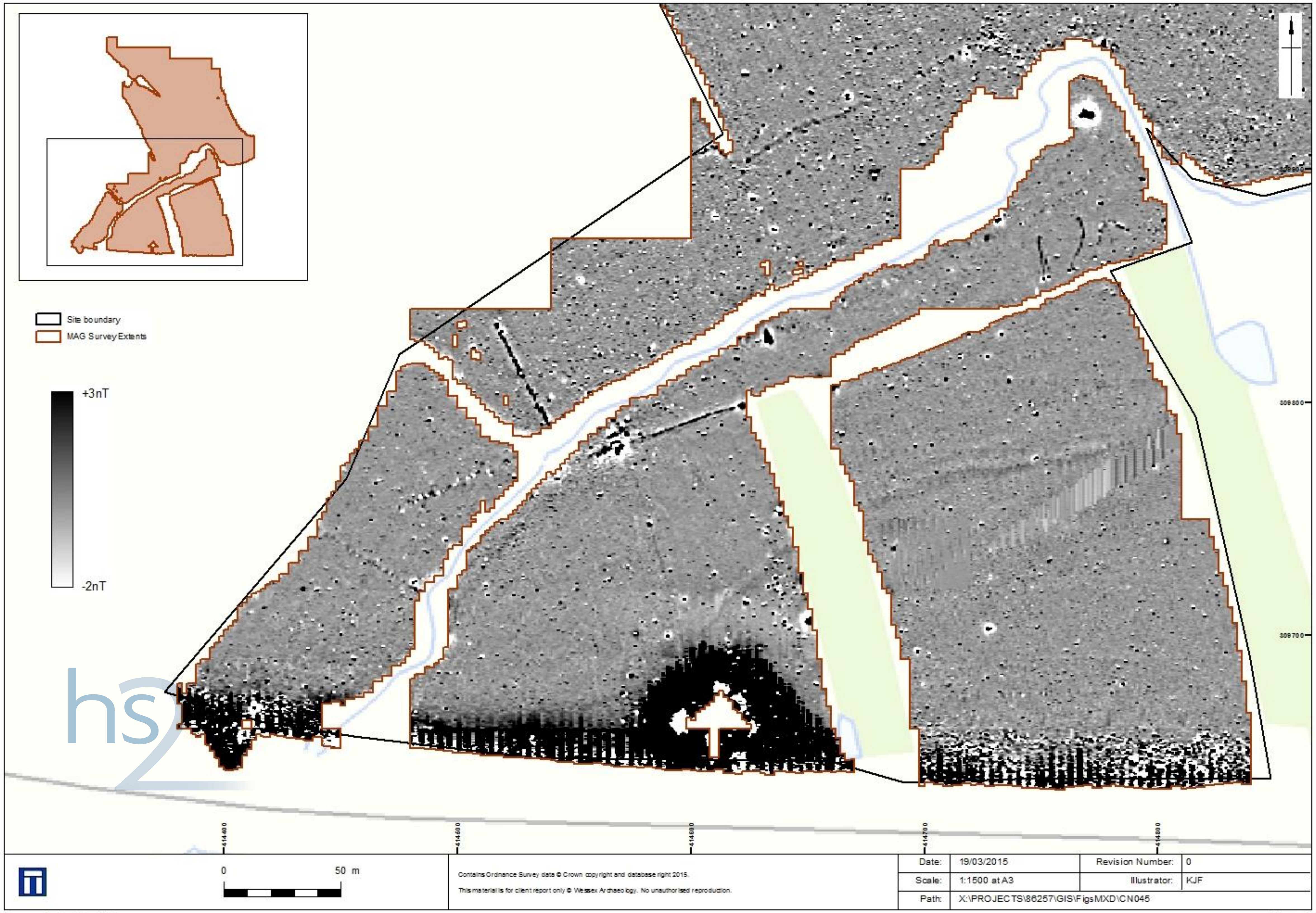


Figure 2 - CN045 Greyscale plot (south)



Greyscale plot (south)

Figure 2

Figure 3 - CN045 XY trace (south)

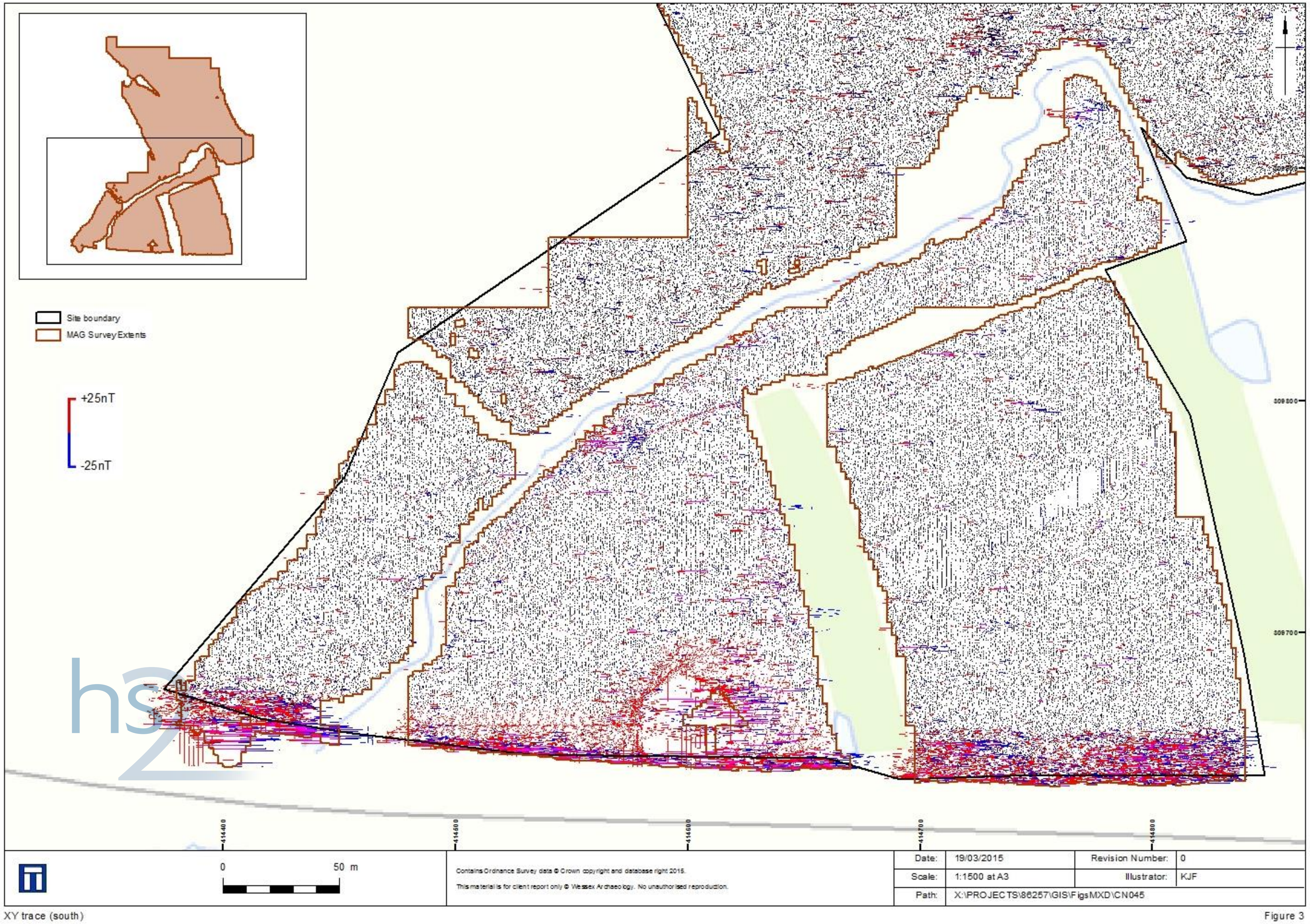


Figure 4 - CN045 Interpretation (south)

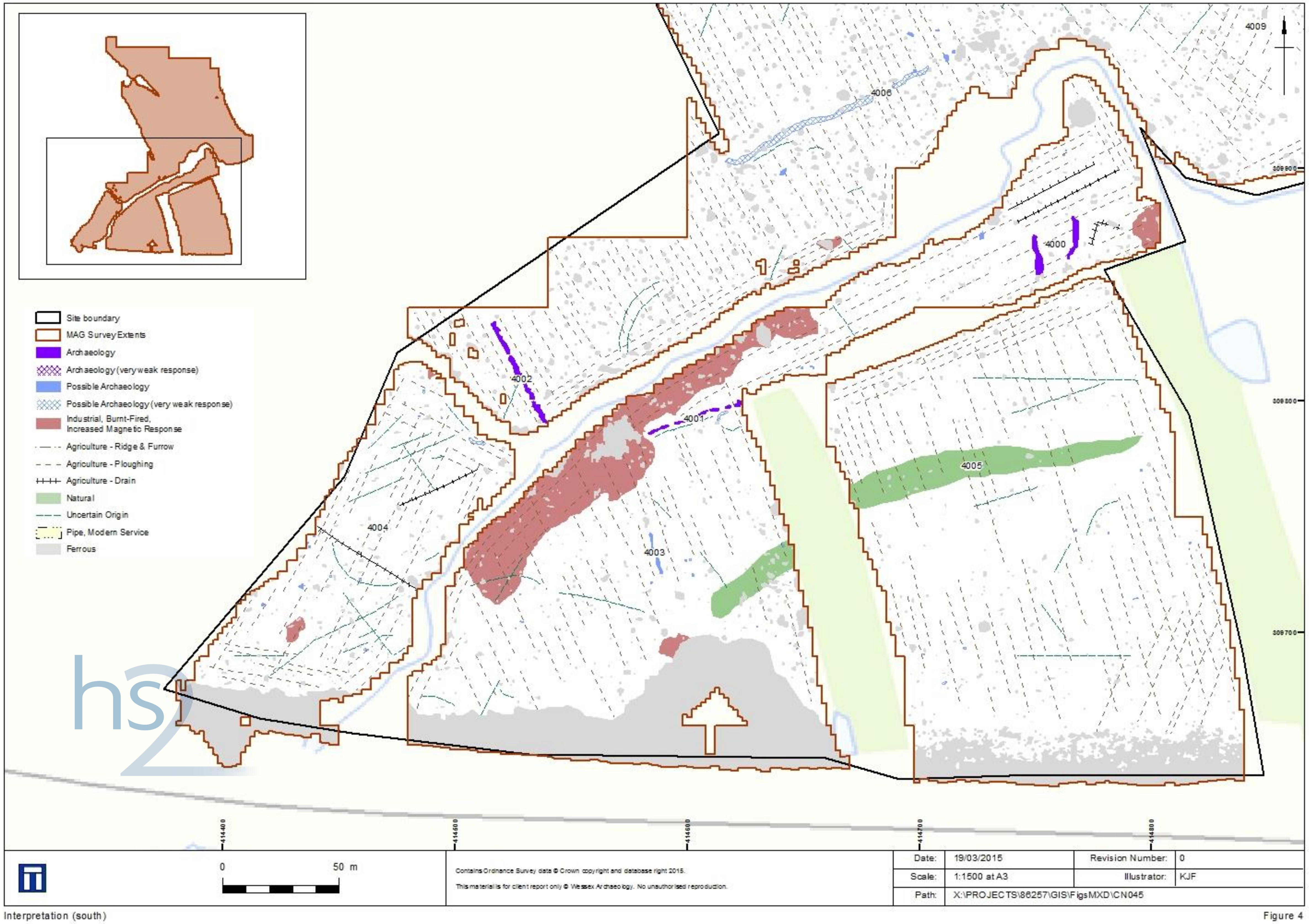
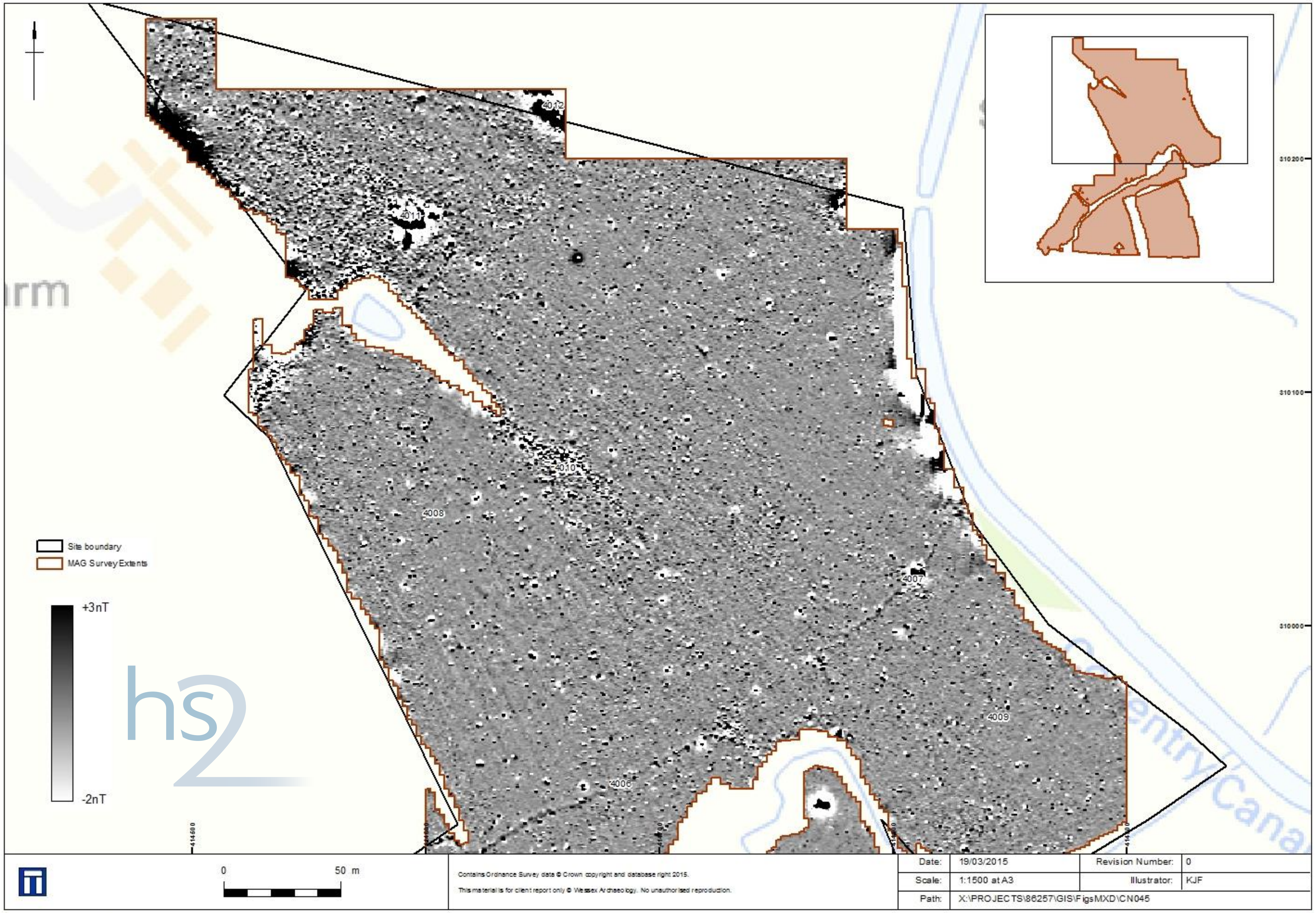


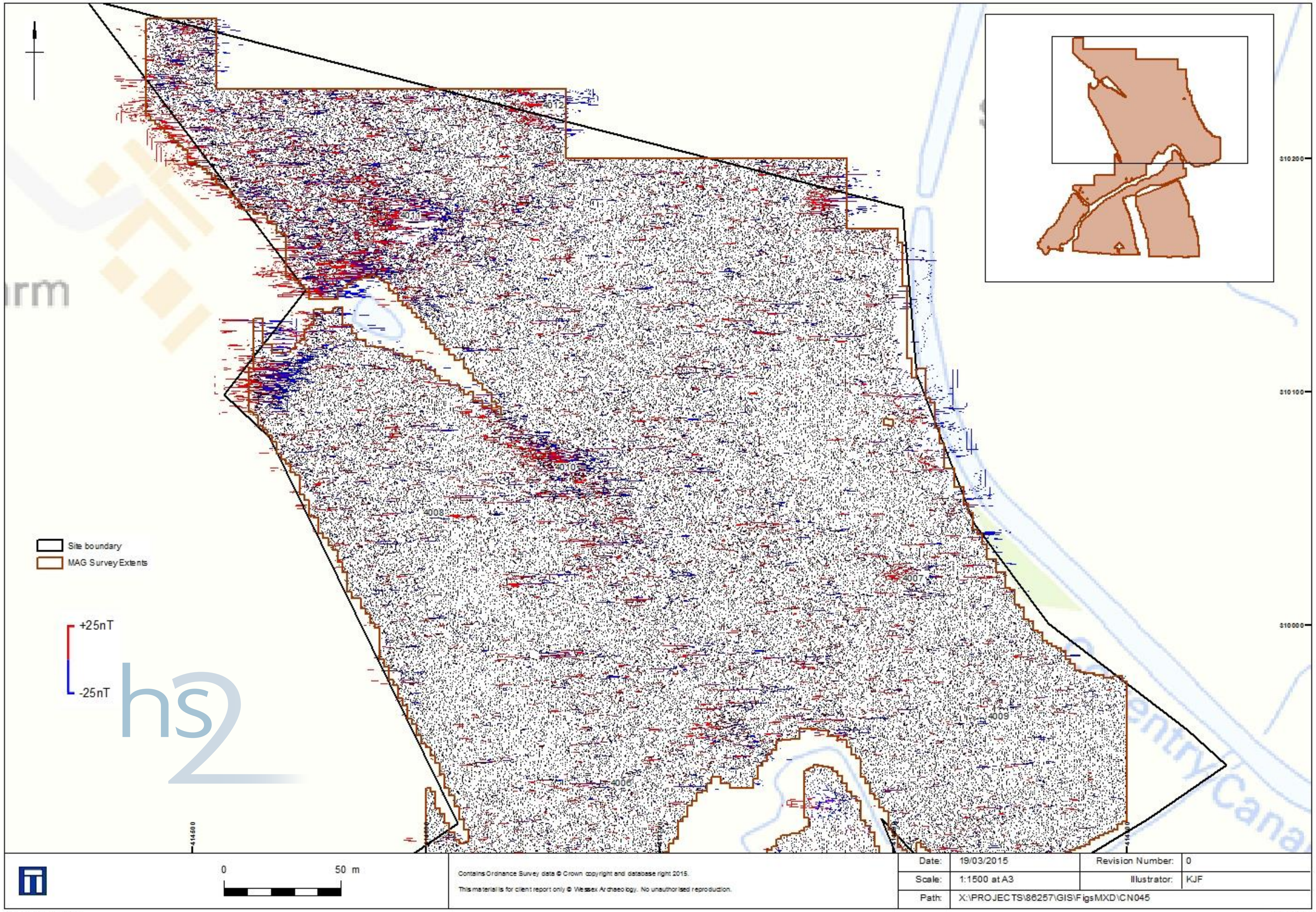
Figure 5 - CN045 Greyscale plot (north)



Greyscale plot (north)

Figure 5

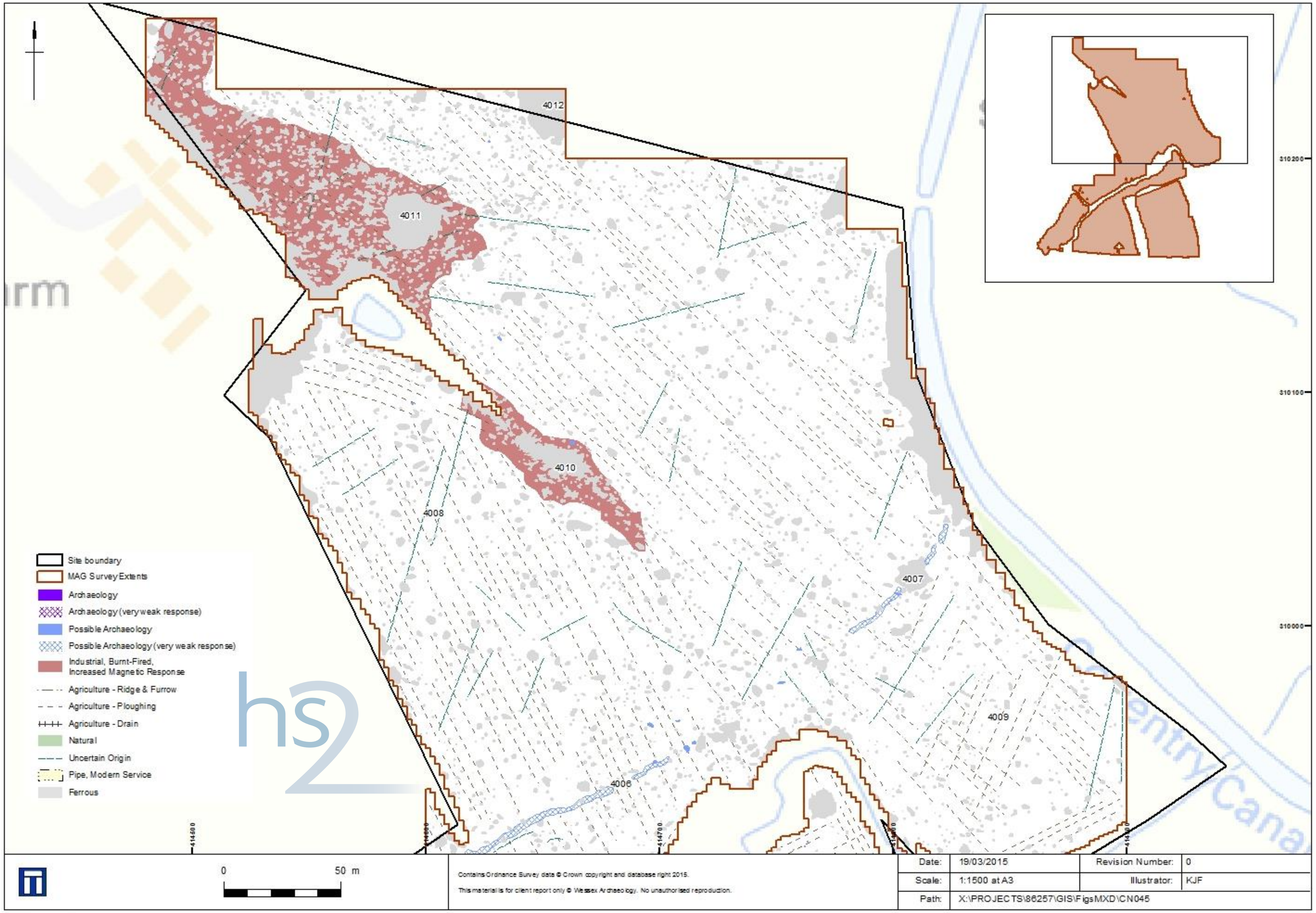
Figure 6 - CN045 XY trace (north)



XY trace (north)

Figure 6

Figure 7 - CN045 Interpretation (north)



Interpretation (north)

Figure 7

Annex 1: Survey equipment and data processing

Survey methods and equipment

2.1.49 The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

2.1.50 The gradiometers have an effective resolution of 0.03nT over a ±100nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

2.1.51 Wessex Archaeology conducts detailed gradiometer surveys using an accurate 20m or 30m site grid, which is achieved using a Leica Viva RTK GNSS instrument and then extended using tapes. The Leica Viva system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by HE[9] for geophysical surveys.

2.1.52 The detailed surveys consist of 20m x 20m or 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20m or 30m grid respectively, and are the recommended methodologies for archaeological surveys of this type[10].

2.1.53 Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.125m intervals along traverses spaced up to 0.25m apart, resulting in a maximum of 28800 readings per 30m grid, exceeding that recommended by HE[11] for characterisation surveys.

Post-processing

2.1.54 The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

2.1.55 As the scanning data are not as closely distributed as with detailed survey, they are georeferenced using the GPS information and interpolated to highlight similar anomalies in adjacent transects. Directional trends may be removed before interpolation to produce more easily understood images.

2.1.56 Typical data and image processing steps may include:

- destripe – applying a zero mean traverse in order to remove differences caused by directional effects inherent in the magnetometer;
- destagger – shifting each traverse longitudinally by a number of readings. This corrects for operator errors and is used to enhance linear features;
- despike – filtering isolated data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings (generally only used for earth resistance data);
- deslope - this function is used to remove a linear trend within a data set. It is most commonly used to remove grid edge discontinuities that can result from applying zero mean traverse to a data set.
- multiply - the multiply function multiplies the data by a negative or positive constant value. It has a variety of functions but its typical use is to normalise data that has been collected with sensors at different heights from the ground.

2.1.57 Typical displays of the data used during processing and analysis:

- XY Plot – presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies.
- Greyscale – presents the data in plain view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.

Annex 2: Geophysical interpretation

Interpretation categories

2.1.58 The interpretation methodology used by Wessex Archaeology separates the anomalies into two main categories: archaeological and unidentified responses.

2.1.59 The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

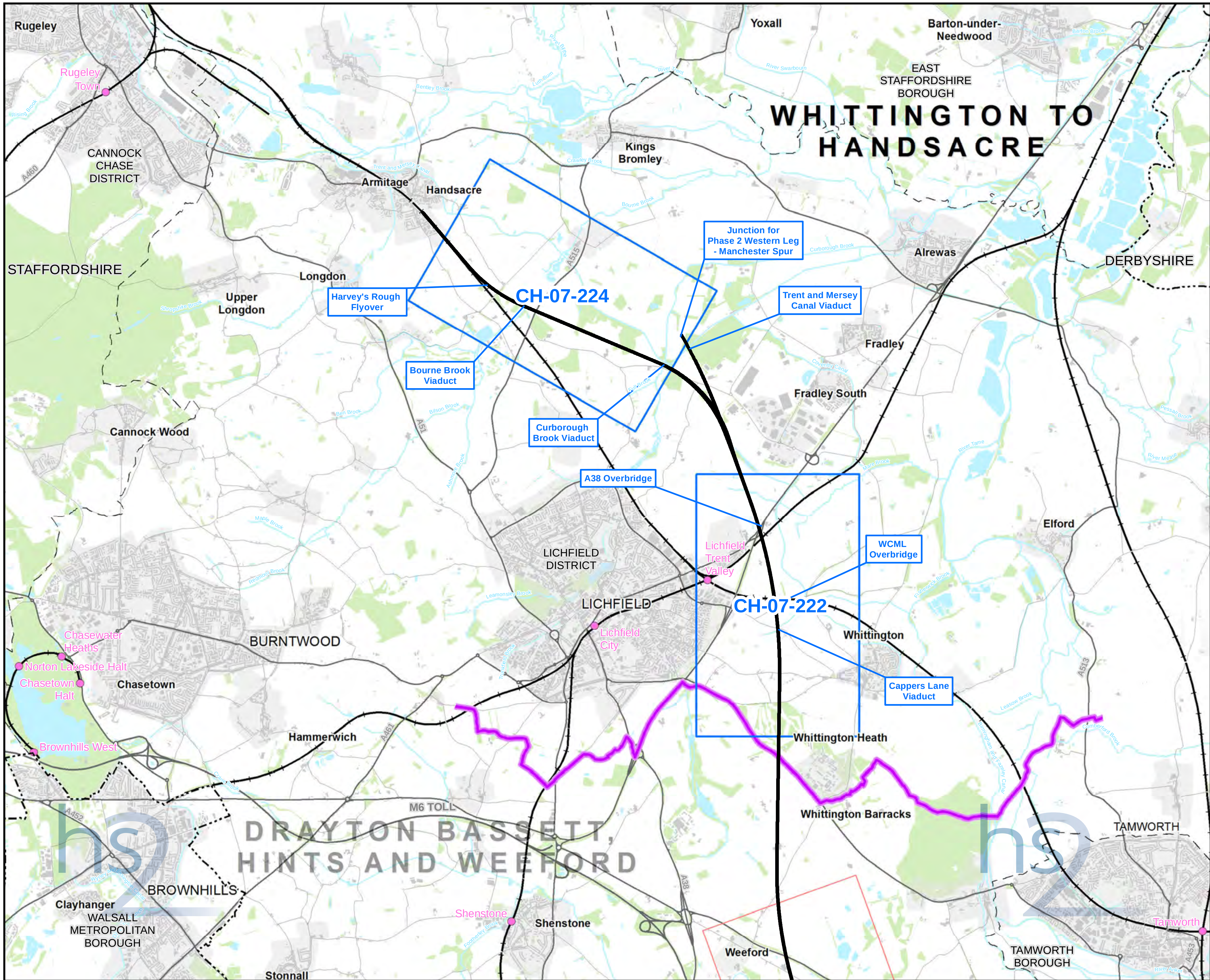
- archaeology - used when there is a clear geophysical response and anthropogenic pattern.
- possible archaeology - used for features which give a response but which form no discernible pattern or trend.

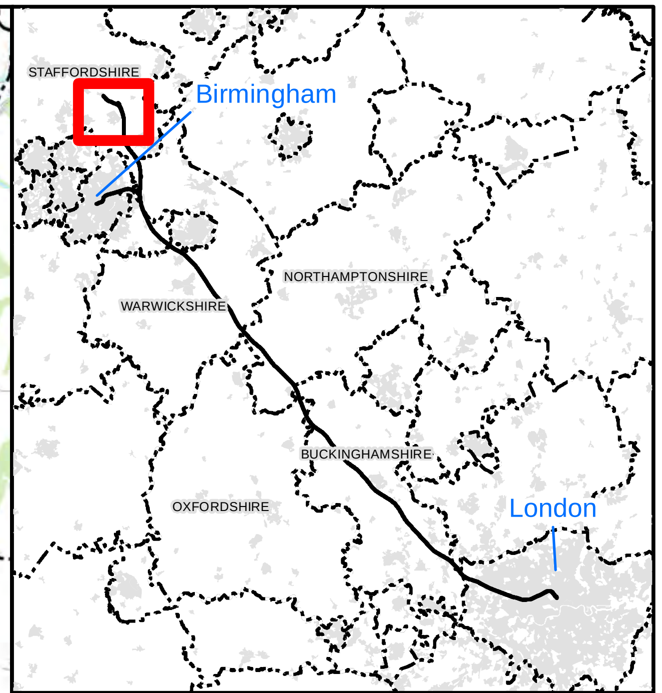
[9] English Heritage, 2008
[10] ibid
[11] ibid

2.1.60 The unidentified category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- industrial, burnt-fired, increased magnetic response - used for areas dominated by bipolar and dipolar anomalies which may have some archaeological potential.
- uncertain origin - used for low amplitude or indistinct linear anomalies.
- ferrous - used for responses caused by ferrous material. These anomalies are likely to be of modern origin.
- agricultural - used for linear trends that can be shown to relate to agricultural activity including ridge and furrow, drainage and ploughing scars.
- natural - used for spreads of anomalies that are considered to be geological or more discrete anomalies considered to be natural.

2.1.61 Finally, services such as water pipes are marked where they have been identified along with ceramic field drains.





Map Series Information:

This map series shows archaeological geophysical survey locations within the land required for the construction of the Proposed Scheme

Note: Not all data layers in the legend are represented on every map.

Main Map Legend

- Route in tunnel
- Route on surface
- Depot, station, headhouse or portal building
- Community forum boundary
- Existing railway station
- County boundary
- District/Borough boundary
- Map sheets included in this community forum with amendment
- Map sheets not included in this community forum

Map Number: CH-07-INDEX-CFA22

Map Name: Index Map of: Archaeological Geophysical Survey - Location
SES and AP2 ES

Community Forum Area CFA22: Whittington to Handsacre

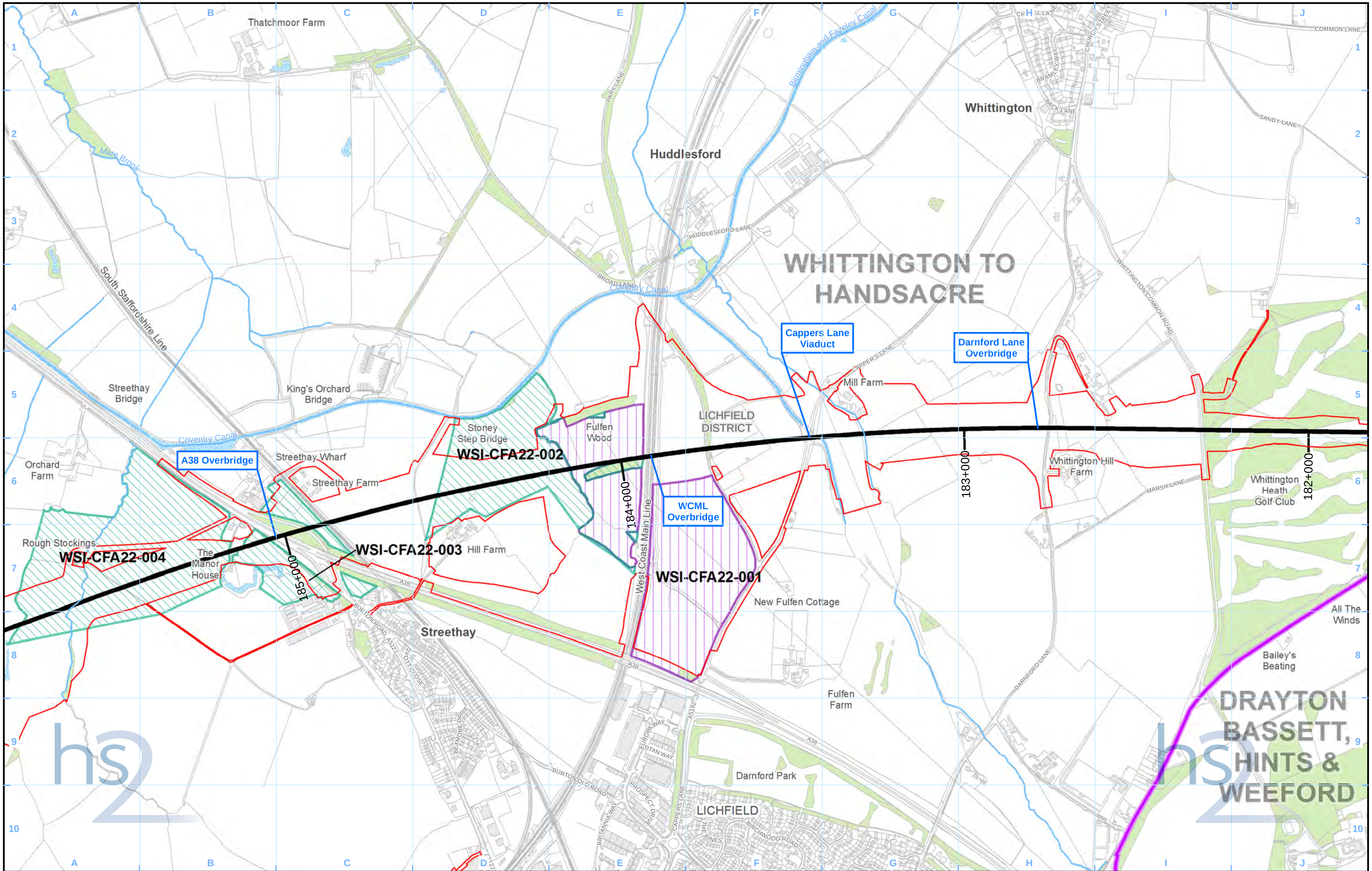
Registered in England. Registration number 06791686. Registered office: One Canada Square, London, E14 5AB.

Scale at A3: 1:60,000

0 600 1,200 1,800 2,400 Metres

Doc Number: C253-ATK-EV-MAP-030-001856-AP02-P01

Date: 10/06/15



Legend

- Route in tunnel
- Route on surface
- Depot, station, headhouse or portal building
- Land potentially required during construction
- Community forum boundary
- County boundary
- District/Borough boundary
- Watercourse
- Water body
- Woodland

Area identified for survey 2014

- Geophysical and Fieldwalking surveys
- Geophysical surveys

Areas surveyed in 2013

- Fieldwalking surveys completed
- Geophysical surveys completed

Map Number: CH-07-222

Map Name: Archaeological Geophysical Survey - Location SES and AP2 ES

Community Forum Area CFA22: Whittington to Handsacre

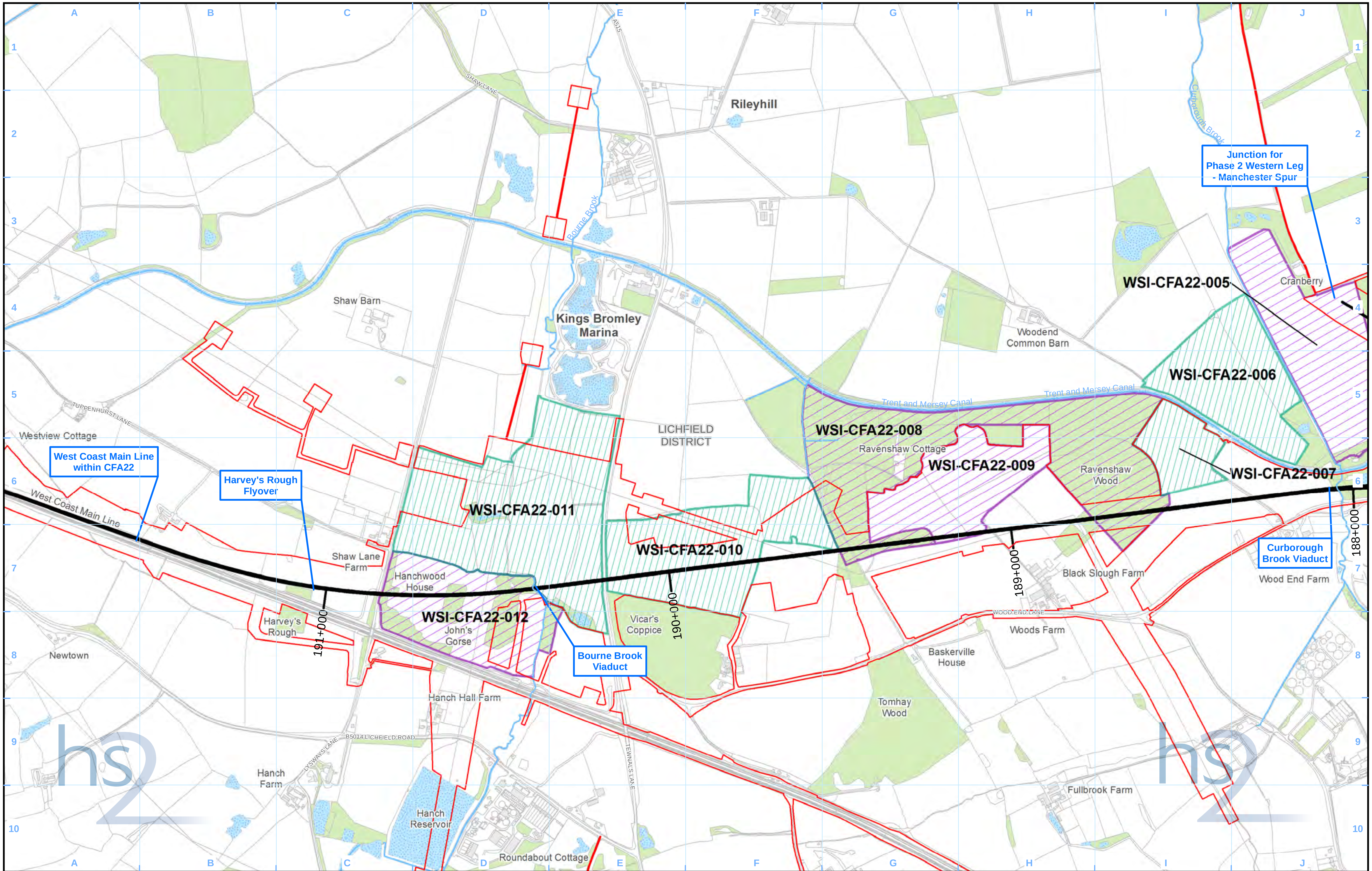
Registered in England. Registration number 06791686. Registered office: One Canada Square, London, E14 5AB.

Scale at A3: 1:10,000

0 100 200 300 400 Metres

Doc Number: C253-ATK-EV-MAP-030-001803-AP02-P01

Date: 08/06/15



Legend

- Route in tunnel
- Route on surface
- Depot, station, headhouse or portal building
- Land potentially required during construction
- Community forum boundary
- County boundary
- District/Borough boundary
- Watercourse
- Water body
- Woodland

Area identified for survey 2014

- Geophysical and Fieldwalking surveys
- Geophysical surveys

Areas surveyed in 2013

- Fieldwalking surveys completed
- Geophysical surveys completed

Map Number: CH-07-224

Map Name: Archaeological Geophysical Survey - Location SES and AP2 ES

Community Forum Area CFA22: Whittington to Handsacre

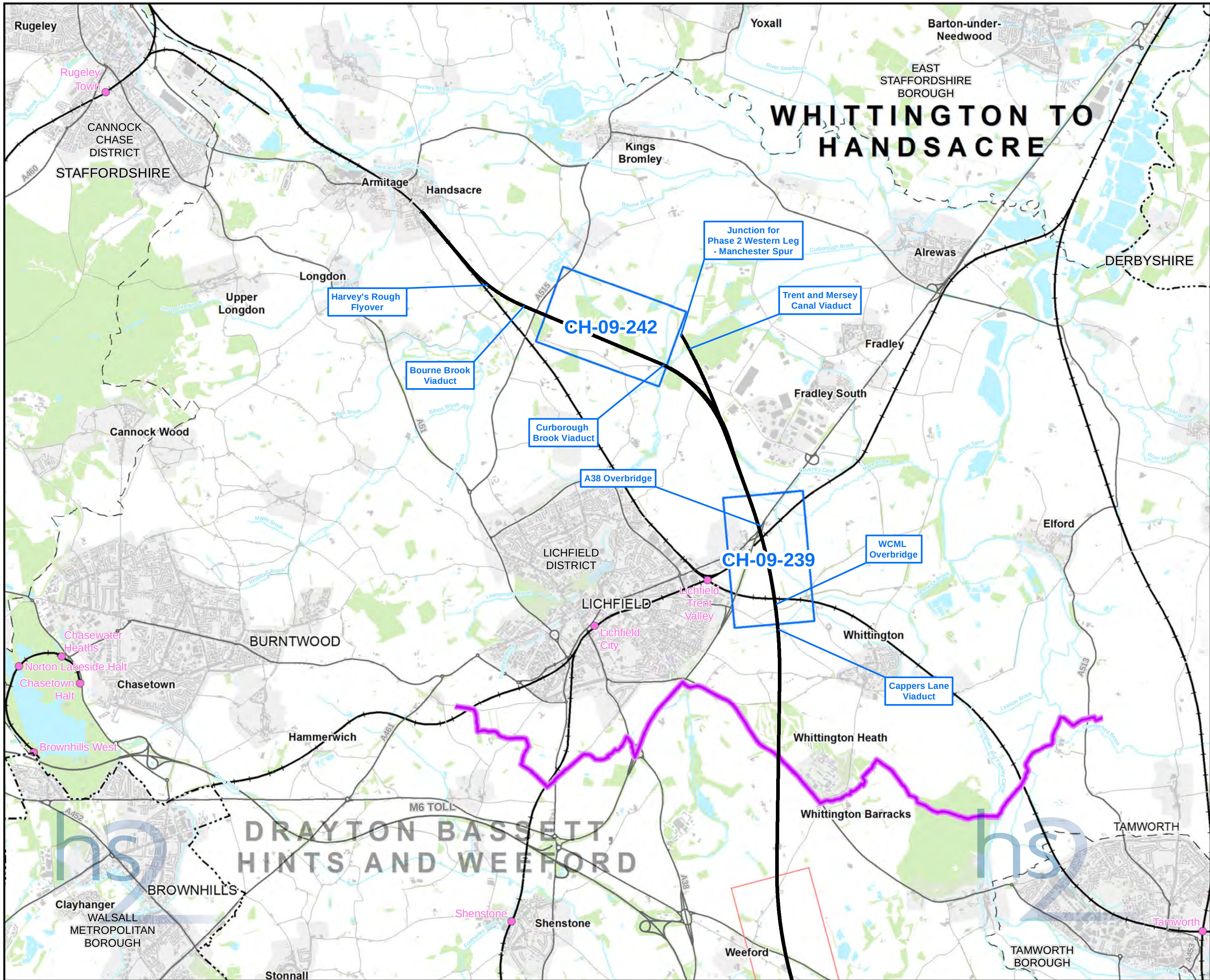
Scale at A3: 1:10,000

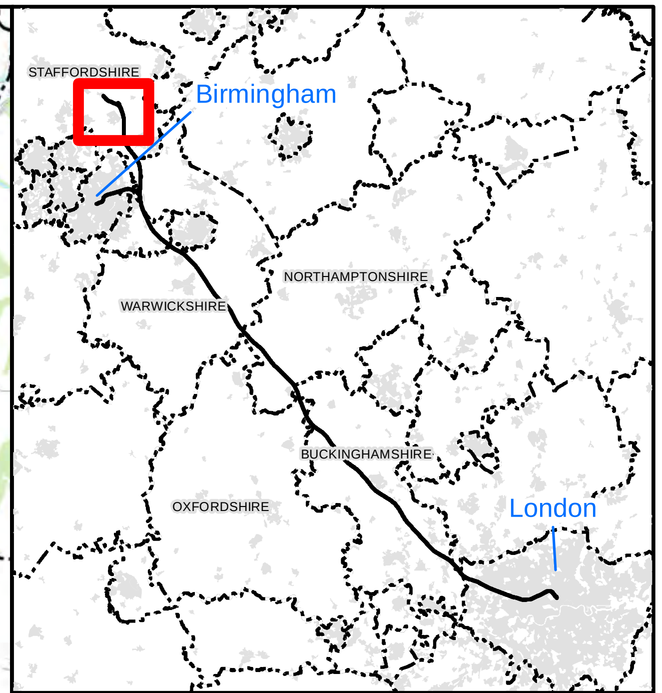
0 100 200 300 400 Metres

Registered in England. Registration number 06791686.
Registered office: One Canada Square, London, E14 5AB.

Doc Number: C253-ATK-EV-MAP-030-001805-AP02-P01

Date: 08/06/15





Map Series Information:

This map series shows magnetometer survey results within the land required for the construction of the Proposed Scheme

Note: Not all data layers in the legend are represented on every map.

Main Map Legend

- Route in tunnel
- Route on surface
- Depot, station, headhouse or portal building
- Community forum boundary
- Existing railway station
- County boundary
- District/Borough boundary
- Map sheets included in this community forum with amendment
- Map sheets not included in this community forum

Map Number: CH-09-INDEX-CFA22

Map Name: Index Map of: Archaeological Geophysical Survey - Magnetometer Data Plot SES and AP2 ES

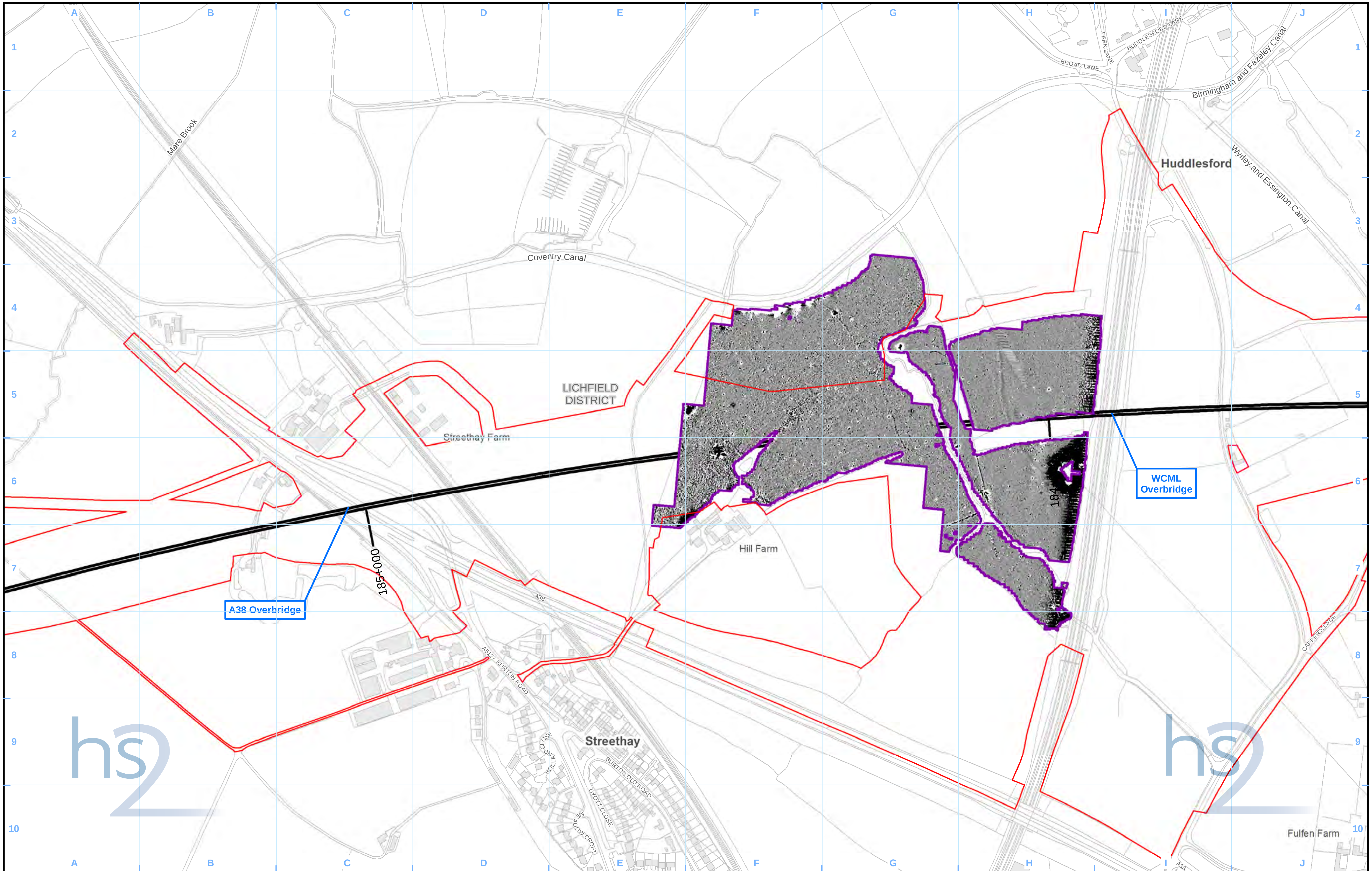
Community Forum Area CFA22: Whittington to Handsacre

Scale at A3: 1:60,000

0 600 1,200 1,800 2,400 Metres

Doc Number: C253-ATK-EV-MAP-030-001863-AP02-P01

Date: 10/06/15



Legend

- Route in tunnel
- Route on surface
- Depot, station, headhouse or portal building
- Land potentially required during construction
- Community forum boundary
- District/Borough boundary
- Edge of geophysical survey

Map Number CH-09-239

Map Name
Archaeological Geophysical Survey - Magnetometer Data Plot SES and AP2 ES

Community Forum Area CFA22: Whittington to Handsacre

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Scale at A3: 1:5,000

0 50 100 150 200
Metres

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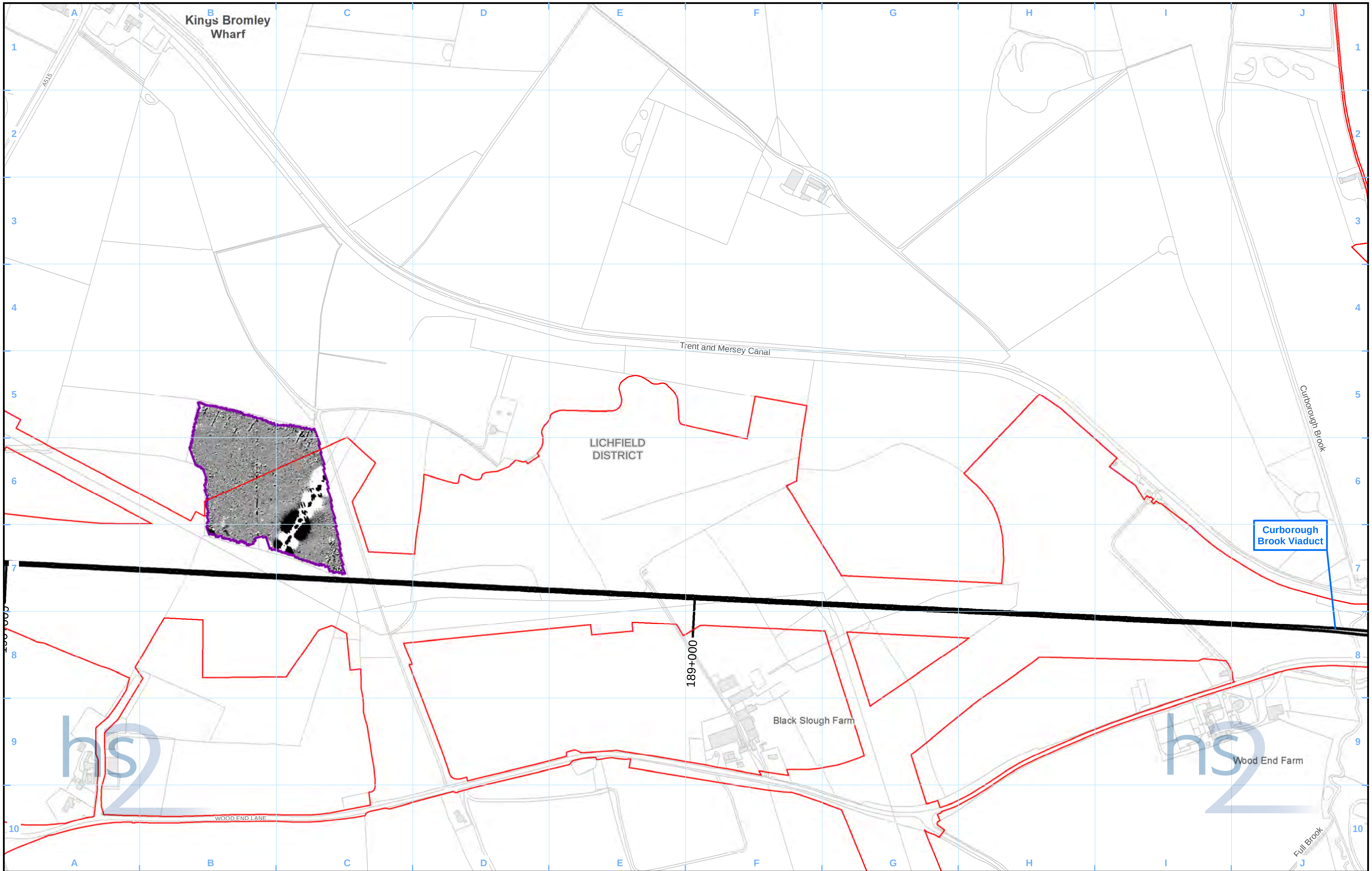
Registered office: One Canada Square, London, E14 5AB.

Doc Number: C253-ATK-EV-MAP-030-001825-AP02-P01

Date: 08/06/15



Legend

- Route in tunnel
- Route on surface
- Depot, station, headhouse or portal building
- Land potentially required during construction
- Community forum boundary
- District/Borough boundary
- Edge of geophysical survey

Map Number: CH-09-242

Map Name: Archaeological Geophysical Survey - Magnetometer Data Plot SES and AP2 ES

Community Forum Area CFA22: Whittington to Handsacre

Scale at A3: 1:5,000

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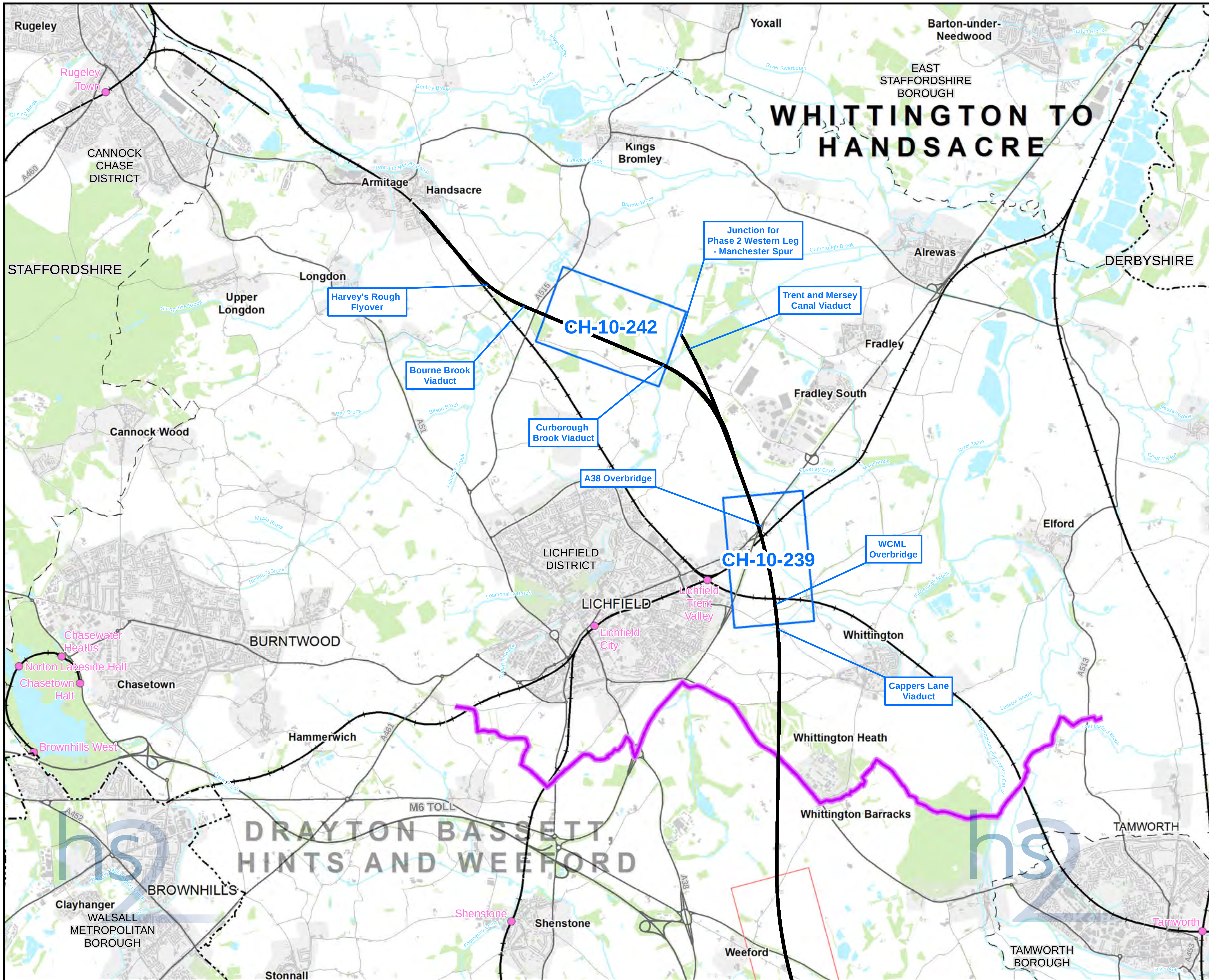
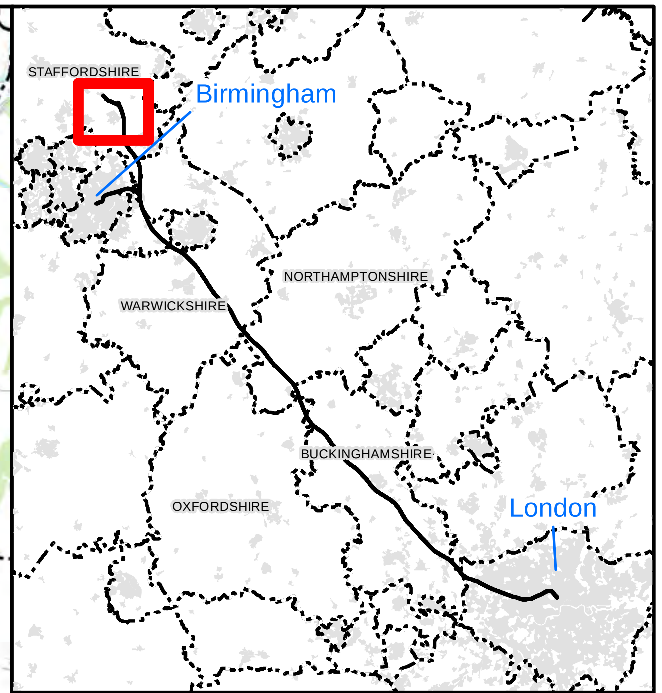
Metres

Registered in England. Registration number 06791686.
Registered office: One Canada Square, London, E14 5AB.

Doc Number: C253-ATK-EV-MAP-030-001826-AP02-P01

Date: 08/06/15





Map Series Information:

This map series shows interpretation of magnetometer survey results within the land required for the construction of the Proposed Scheme

Note: Not all data layers in the legend are represented on every map.

Main Map Legend

- Route in tunnel
- Route on surface
- Depot, station, headhouse or portal building
- Community forum boundary
- Existing railway station
- County boundary
- District/Borough boundary
- Map sheets included in this community forum with amendment
- Map sheets not included in this community forum

Map Number: CH-10-INDEX-CFA22

Map Name: Index Map of: Archaeological Geophysical Survey - Interpretation Plot SES and AP2 ES

Community Forum Area CFA22: Whittington to Handsacre

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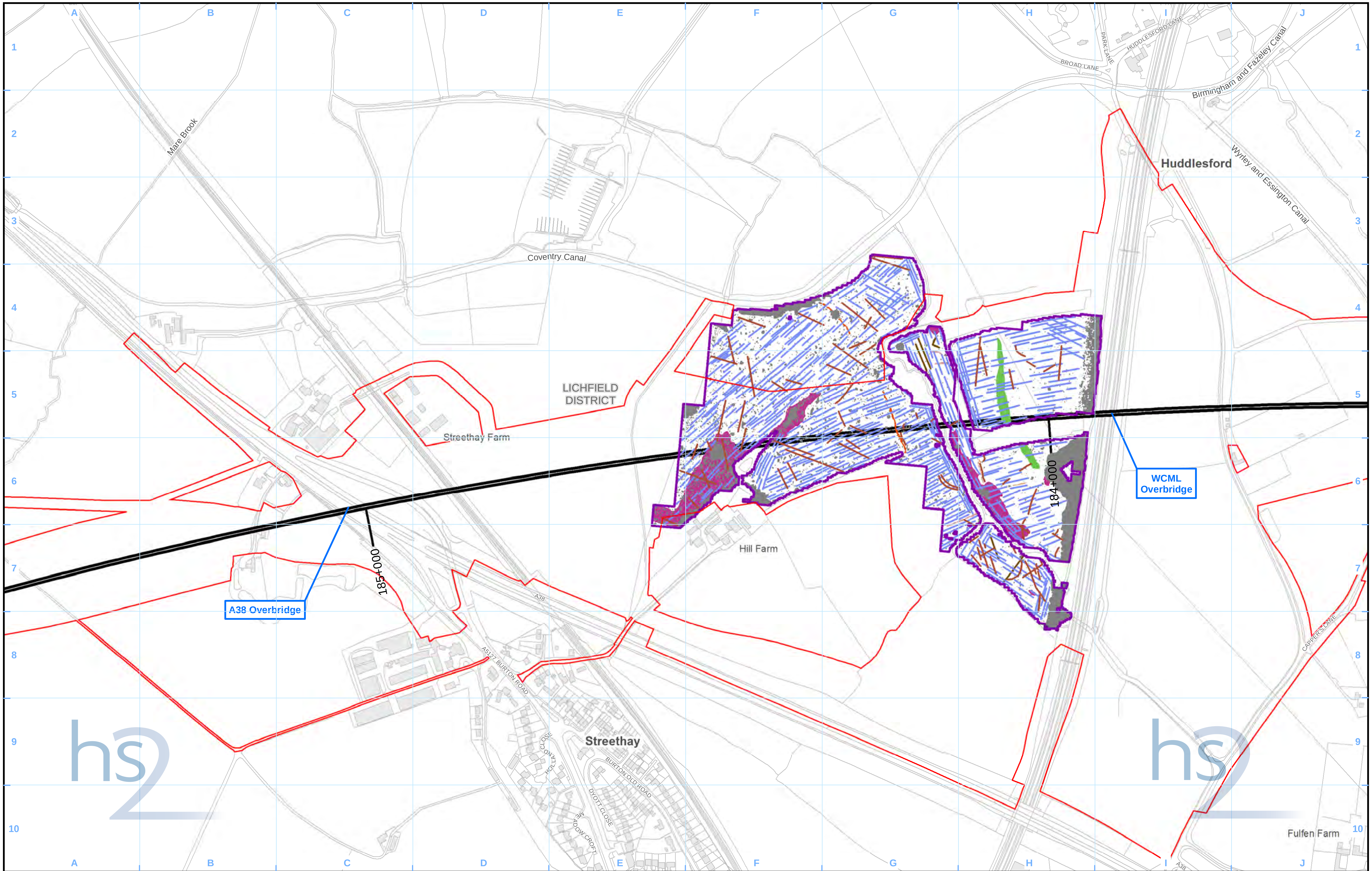
Scale at A3: 1:60,000

0 600 1,200 1,800 2,400 Metres

Registered in England. Registration number 06791686.
Registered office: One Canada Square, London, E14 5AB.

Doc Number: C253-ATK-EV-MAP-030-001870-AP02-P01

Date: 10/06/15



Legend

Route in tunnel
Route on surface
Depot, station, headhouse or portal building
Land potentially required during construction
Community forum boundary
District/Borough boundary
Edge of geophysical survey

Geophysical survey results
Possible archaeology (VWR)
Drain
Pipe
Plough
Ridge and furrow
Trend

Uncertain origin
Archaeology (discrete)
Archaeology (zone)
Archaeology (VWR)
Possible archaeology (VWR)
Possible archaeology
Ferrous

Old field boundary
Increased magnetic response
Industrial burnt fired
Modern service
Natural
Pipe, modern service
Plough

Ridge and furrow
Uncertain

Map Number CH-10-239

Map Name
Archaeological Geophysical Survey - Interpretation Plot SES and AP2 ES

Community Forum Area CFA22: Whittington to Handsacre

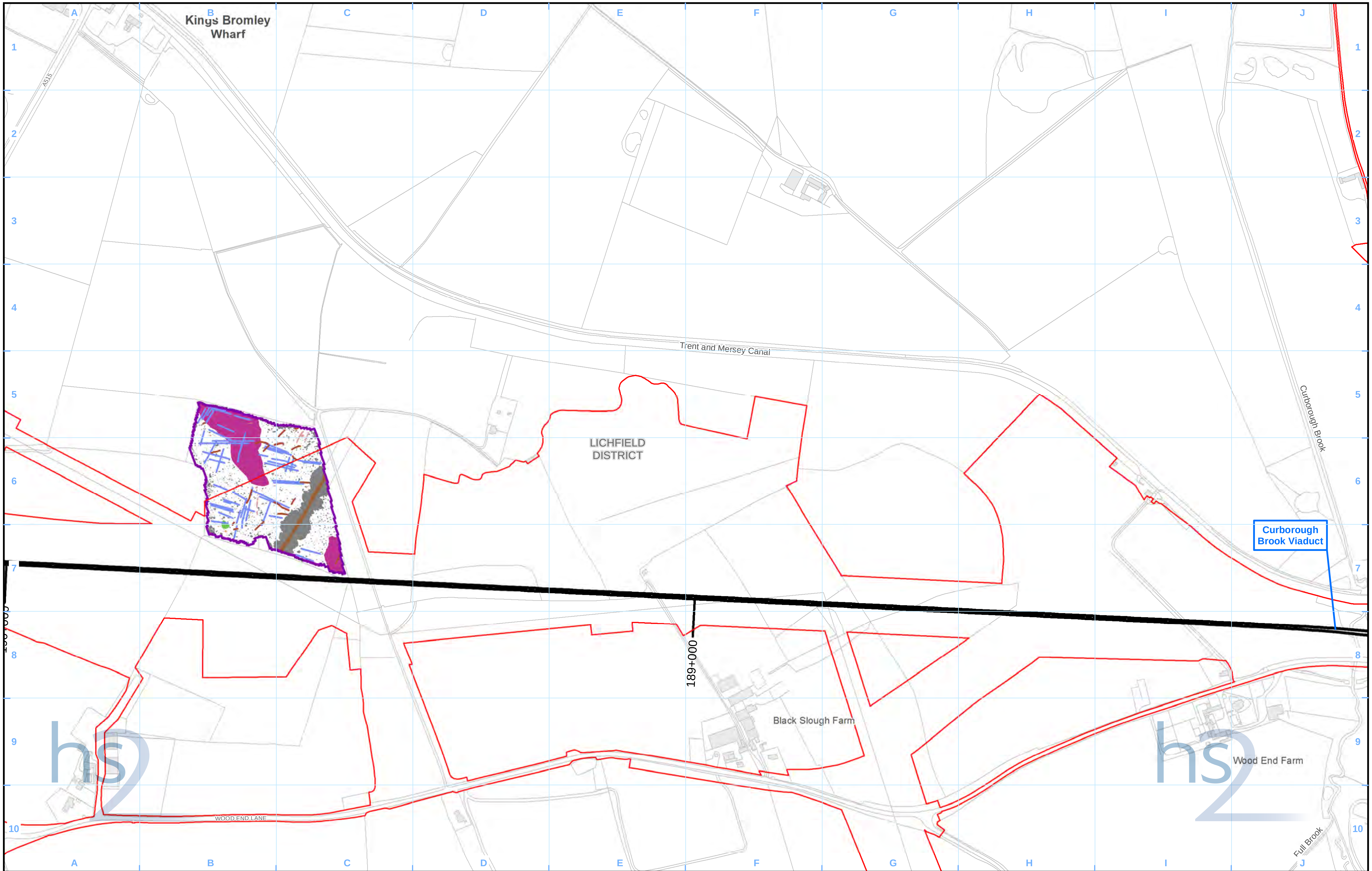
Registered in England. Registration number 06791686.
Registered office: One Canada Square, London, E14 5AB.

Scale at A3: 1:5,000

0 50 100 150 200
Metres

Doc Number: C253-ATK-EV-MAP-030-001846-AP02-P01

Date: 08/06/15



Legend

Route in tunnel
Route on surface
Depot, station, headhouse or portal building
Land potentially required during construction
Community forum boundary
District/Borough boundary
Edge of geophysical survey

Geophysical survey results
Possible archaeology (VWR)
Drain
Pipe
Plough
Ridge and furrow
Trend
Uncertain origin
Archaeology (discrete)
Archaeology (zone)
Archaeology (VWR)
Possible archaeology (VWR)
Possible archaeology
Ferrous
Old field boundary
Increased magnetic response
Industrial burnt fired
Modern service
Natural
Pipe, modern service
Plough
Ridge and furrow
Uncertain

Map Number
CH-10-242

Map Name
Archaeological Geophysical Survey - Interpretation Plot SES and AP2 ES

Community Forum Area CFA22: Whittington to Handsacre

Registered in England. Registration number 06791686.
Registered office: One Canada Square, London, E14 5AB.

Scale at A3: 1:5,000

0 50 100 150 200
Metres

Doc Number: C253-ATK-EV-MAP-030-001847-AP02-P01

Date: 08/06/15

Environmental topic:	Landscape and visual assessment	LV
Appendix name:	Landscape report	001
Community forum area:	Whittington to Handsacre	022

Contents

Contents ii
1 Introduction 1
Environmental baseline report 2
2 Introduction 2
3 Landscape character assessment 2
4 Visual baseline 2

List of figures

Figure 1: Viewpoint 353.3.007: Winter view. Date taken: 24 February 2015. Sony A7R, focal length 57mm (stitched panorama). 4

1 Introduction

1.1.1 This appendix provides an update to Appendix LV-001-022 landscape report from the main Environmental Statement (ES) (Volume 5, 3.5.2.22.9) as a result of design changes as part of the Additional Provision 2 Environmental Statement (AP2 ES). This appendix details the baseline for a representative viewpoint that is additional to those reported in the main ES. It should be read in conjunction with Appendix LV-001-022 Landscape report from the main ES, which provides baseline descriptions for all landscape character areas (LCA) and representative viewpoints.

1.1.2 AP2 ES Map series LV-03, and LV-04, as referred to within this landscape and visual assessment appendix, should be read in conjunction with the original Volume 5 Landscape and visual assessment map book.

Environmental baseline report

2 Introduction

2.1.1 This section describes the baseline for new landscape character areas (LCAs) and new visual assessment viewpoints located within the study area for this CFA, which have been identified to inform the SES and AP2 ES. A summary of the landscape and visual baseline is provided in CFAXX of this SES and AP2 ES. The LCA Maps LV-02-0xx to LV-02-0xx (Volume 5 of this SES and AP2 ES, Landscape and Visual Assessment Map Book), which are based on an aerial photograph, also help to provide an overview of the character of the area, illustrating the pattern of development, distribution of open spaces and spread of vegetation.

2.1.2 This section is organised as follows:

- information on each new LCA identified within the study area, including a description of the area and an analysis of the condition, tranquillity, value and sensitivity of each LCA. These are ordered from south to north along the route of the Proposed Scheme; and
- information on the nature of the existing views towards the Proposed Scheme from representative visual assessment viewpoints identified to inform the SES AP2 ES, during both winter and summer, and daytime and night-time where relevant. These are ordered from south to north along the route of the Proposed Scheme.

3 Landscape character assessment

3.1.1 No new landscape character areas in addition to those identified in the main ES are affected by the AP2 revised scheme.

4 Visual baseline

4.1.1 Descriptions of the new representative viewpoint identified to inform the SES and AP2 ES are provided below. The viewpoints are shown on maps LV-03-093 and LV-04-093 (Volume 5 of this SES and AP2 ES). For each viewpoint, the first part of the baseline description relates to the view during winter, the second part relates to the summer view for viewpoints considered in the operational assessment and, for residential areas, the third part relates to the view at night-time.

4.1.2 Photographs have been included to represent the view from visual receptors during winter and, where relevant, summer. For some visual receptors, no appropriate location from which to capture a representative photograph of the view was available, therefore no photograph has been included and the assessment has been undertaken based on professional judgement.

4.1.3 The viewpoint number identifies the viewpoint locations which are shown on m aps LV-03-093 and LV-04-093 to LV-04-095 (Volume 5 of this SES and AP2 ES). In each case, the middle number (xxx.x.xxx) identifies the type of receptor as follows:

1. protected views - these relate to those viewpoints, panoramas and viewing corridors that have been designated by local planning authorities, county councils or other relevant stakeholders. Protected views have a high sensitivity to change. None of these receptor types have been identified within the study area;
2. residential views – these have a high sensitivity to change, as attention is often focused on the landscape surrounding the property, rather than on another focused activity (as will be the case in predominantly employment or industrial areas);
3. recreational views – these receptors (apart from those engaged in active sports) generally have a high sensitivity to change, as attention is focused on enjoyment of the landscape. Tourists engaged in activities whereby attention is focused on the surrounding landscape or townscape also have a high sensitivity to change;
4. transport views - travel through an area is often the means by which the greatest numbers of people view the landscape. Because of the glimpsed nature of the view from trains or road vehicles, people travelling through an area on main roads have a low sensitivity to change. People travelling through urban areas (including pedestrians where the focus is not in recreation) also generally have a low sensitivity to change;
5. hotels and healthcare institutions - people staying in hotels and healthcare institutions have periods of time when their attention may be focused on the landscape, whilst at other times attention is more likely to be focused on other activities. Based on the level of interaction with the surrounding landscape, these receptors have a medium sensitivity to change. None of these receptor types have been identified within the study area;

6. employment - people at work and within educational institutions are the least sensitive receptors, as their attention is likely to be focused on their work activity. These receptors have a low sensitivity to change; and

7. active sports - people engaged in active sports have a low sensitivity to change as their attention is likely to be focused on their activity.

Viewpoint 353.3.007: View east from PRoW Streethay Footpath 6 near Hill Farm

This view is eastwards from the public right of way (PRoW) Streethay Footpath 6 crossing agricultural land towards Stoney Step Bridge over the Coventry Canal.

Winter

A field boundary hedgerow runs eastward from the foreground towards a line of trees along the western side of the Coventry Canal in the middle ground. Hill Farm is on the right side of the view in the middle ground, seen against the skyline. Agricultural and light aircraft storage buildings to both sides of the South Staffordshire Railway are in the middle ground on the left side of the view. The background is formed by fields and narrow belts of mature trees on rising land east of the Coventry Canal, towards Whittington Hurst. An overhead electricity transmission line crosses the right side of the view from middle ground to background.

Summer

In summer the trees in the hedgerow running from the foreground towards the middle ground would partially screen further views to the east. Due to seasonal constraints it has not been possible to capture an equivalent summer photographic view.

Figure 1: Viewpoint 353.3.007: Winter view. Date taken: 24 February 2015. Sony A7R, focal length 57mm (stitched panorama).

Environmental topic:	Sound, noise and vibration	SV
Appendix name:	Construction assessment report	003
Community forum area:	Whittington to Handsacre	022

Contents

1 Introduction 3
2 Scope, assumptions and limitations 3
2.1 Changes of relevance to this assessment 3
3 Effects arising during construction 3
3.1 Avoidance and mitigation measures 3
3.2 Quantitative identification of impacts and effects 4
3.3 Assessment of significance of effects 28

List of tables

Table 1 - Assessment of construction induced ground-borne vibration at residential receptors 5
Table 2 - Assessment of construction induced ground-borne vibration at non-residential receptors 7
Table 3 - Assessment of construction noise at residential receptors 9
Table 4 - Assessment of construction noise at non-residential receptors 21
Table 5 - Assessment of construction traffic noise levels 27

1 Introduction

1.1.1 This appendix provides an update to Appendix SV-003-022 construction assessment report for the Whittington to Handsacre community forum area (CFA22) from the main Environmental Statement (ES) as a result of a revised scheme as part of the Additional Provision 2 Environmental Statement (AP2 ES). This update should be read in conjunction with Appendix SV-003-022 Construction assessment report from the main ES.

2 Scope, assumptions and limitations

2.1.1 The assessment scope, key assumptions and limitations for sound, noise and vibration are as set out in Volume 1, the Scope and Methodology Report (SMR) (Volume 5: Appendix CT-001-000/1) and the SMR Addendum (Volume 5: Appendix CT-001-000/2) of the main ES.

2.1.2 Local assumptions and limitations for sound, noise and vibration are set out in Volume 2, CFA22.

2.1 Changes of relevance to this assessment

Amendment of Provisions 2

2.1.1 Construction noise and vibration assessments have been undertaken for the following amendments:

- a lowering of the HS2 route north of the A51 Tamworth Road so that the route can run in cutting to the north of Lichfield and pass beneath the West Coast Main Line (WCML), the South Staffordshire Railway Line (SSL) and the A38; and
- realignment of the HS2 route to allow the link to Handsacre to pass to the south of the Trent and Mersey Canal.

3 Effects arising during construction

3.1 Avoidance and mitigation measures

3.1.1 Avoidance and mitigation measures are set out in main ES, Volume 2, CFA22, section 11 and the SES and AP2 ES Volume 2, CFA22.

3.2 Quantitative identification of impacts and effects

Ground-borne vibration

3.2.1 The assessment results for construction induced ground-borne vibration at residential and non residential receptors are presented in Tables 1 and 2 respectively for assessment locations in CFA22 which are within the scoping distance of the AP2 amendments being considered. Assessment locations defined for the quantitative assessment of impacts are shown on map series SV-03 in the CFA22 AP ES Volume 5 sound, noise and vibration map book.

3.2.2 An explanation of the information within Table 1 and Table 2 is provided in main ES, Volume 5: Appendix SV001-000 and Appendix SV-003-022.

Table 1 - Assessment of construction induced ground-borne vibration at residential receptors

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Peak particle velocity (PPV) [mm/s] on foundation	Typical/highest monthly indoor vibration dose value (VDV) [m/s^1.75] Day 07:00-23:00	Typical/highest monthly indoor vibration dose value (VDV) [m/s^1.75] Night 23:00-07:00	Construction activity resulting in highest forecast vibration levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
623	Tuppenhurst Lane, Rugeley	0.39	0.19/0.19	-	Earthworks	NA	3	R	T	-	-	-	-	-	
17473	Lichfield Road, Whittington, Lichfield	0.19	0.1/0.1	-	Earthworks	NA	2	R	T	-	-	-	-	-	
17519	Darnford Lane, Lichfield	0.17	0.04/0.04	-	Earthworks	NA	2	R	T	-	-	-	-	-	
17748	Park Lane, Huddlesford, Lichfield	1.21	0.22/0.22	-	Earthworks	A	1	R	T	-	-	Y	9	-	~
17774	Capper's Lane, Lichfield	0.64	0.14/0.14	-	Earthworks	NA	1	R	T	-	-	-	-	-	
17785	Capper's Lane, Lichfield	0.27	0.07/0.07	-	Earthworks	NA	1	R	T	-	-	-	-	-	
20090	Shaw Lane, Hanch, Lichfield	0.11	0.03/0.03	-	Earthworks	NA	2	R	T	-	-	-	-	-	
20138	Shaw Lane, Hanch, Lichfield	0.16	0.04/0.04	-	Earthworks	NA	1	R	T	-	-	-	-	-	
21095	Wood End Lane, Curborough, Lichfield	0.2	0.05/0.05	-	Earthworks	NA	1	R	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Peak particle velocity (PPV) [mm/s] on foundation	Typical/highest monthly indoor vibration dose value (VDV) [m/s$^{1.75}$]		Construction activity resulting in highest forecast vibration levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
			Day 07:00-23:00	Night 23:00-07:00											
22478	Wood End Lane, Fradley, Lichfield	0.18	0.05/0.05	-	Earthworks	NA	4	R	T	-	-	-	-	-	
22669	Burton Road, Streethay, Lichfield	0.21	0.05/0.05	-	Earthworks	NA	1	R	T	-	-	-	-	-	
23304	Ash Tree Lane, Streethay, Lichfield	0.16	0.04/0.04	-	Earthworks	NA	1	R	T	-	-	-	-	-	
700649	Capper's Lane, LIchfield	0.85	0.16/0.16	-	Earthworks	NA	1	R	T	-	-	-	-	-	

Table 2 - Assessment of construction induced ground-borne vibration at non-residential receptors

Assessment location		**Impact criteria**				**Significance criteria**									**Significant effect**
ID	**Area represented**	**PPV [mm/s] on foundation**	**Typical/highest monthly indoor VDV [m/s$^{1.75}$]**		**Construction activity resulting in highest forecast vibration levels**	**Type of effect**	**Number of impacts**	**Type of receptor**	**Receptor design**	**Existing environment**	**Unique feature**	**Combined impact**	**Impact duration [months]**	**Mitigation effect**	
			Day 07:00-23:00	**Night 23:00-07:00**											
18213	General Commercial, Nanscawen Road, Fradley, Lichfield	0.27	0.06/0.06	-	Earthworks	B	1	V3	T	-	-	-	-	-	
22478	Wood End Lane, Fradley, Lichfield	0.18	0.05/0.05	-	Earthworks	B	2	V3	T	-	-	-	-	-	

Airborne sound: direct impacts and effects

3.2.3 Activities associated with the construction phases of the AP2 revised scheme will generate airborne noise. The assessment of the likely impacts and significant effects as a result of the construction noise has considered the effects on:

- residential receptors, both as individual dwellings and communities; and
- non-residential receptors, including quiet areas.

3.2.4 For each type of receptor, subject to the scoping distance of the AP2 amendments being considered, and based upon supplied plant information, the typical and highest monthly LAeq,T noise levels from construction activities have been calculated at the façade of assessment locations, which are representative of a number of receptors in the study area.

3.2.5 The assessment results, impact criteria and significance criteria for the assessment of the AP2 revised scheme at residential and non-residential receptors are presented in Table 3 and Table 4 respectively.

3.2.6 An explanation of the information within Table 3 and Table 4 is provided in main ES, Volume 5: Appendix SV001-000 and Appendix SV-003-022.

Table 3 - Assessment of construction noise at residential receptors

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
623	Tuppenhurst Lane, Rugeley	67/70 [A]	-	-	Site clearance	A	3	R	T	-	-	-	2	-	~
746	Tuppenhurst Lane, Rugeley	55/61 [A]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
5666	Tuppenhurst Lane, Rugeley	34/39 [A]	-	-	Retaining wall construction	NA	51	R	T	-	-	-	-	-	
5738	Alandale Avenue, Rugeley	46/53 [A]	-	-	Retaining wall construction	NA	24	R	T	-	-	-	-	-	
5818	Harvey Road, Rugeley	39/47 [A]	-	-	Retaining wall construction	NA	61	R	T	-	-	-	-	-	
6042	Bridge Road, Rugeley	41/48 [A]	-	-	Retaining wall construction	NA	45	R	T	-	-	-	-	-	
6336	Proctor Road, Rugeley	49/55 [A]	-	-	Retaining wall construction	NA	37	R	T	-	-	-	-	-	
6354	Johns Avenue, Rugeley	50/55 [A]	-	-	Retaining wall construction	NA	11	R	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
6455	Millcroft Way, Handsacre, Rugeley	33/39 [A]	-	-	Retaining wall construction	NA	18	R	T	-	-	-	-	-	
6492	Lichfield Road, Handsacre, Rugeley	43/53 [A]	-	-	Retaining wall construction	NA	10	R	T	-	-	-	-	-	
6607	Barn Road, Handsacre, Rugeley	45/65 [A]	-	-	Retaining wall construction	NA	15	R	T	-	-	-	-	-	
6934	Lichfield Road, Armitage, Rugeley	39/43 [A]	-	-	Retaining wall construction	NA	24	R	T	-	-	-	-	-	
7044	Handsacre Crescent, Rugeley	36/39 [A]	-	-	Retaining wall construction	NA	46	R	T	-	-	-	-	-	
7181	Lichfield Road, Armitage, Rugeley	46/62 [A]	-	-	Earthworks	NA	6	R	T	-	-	-	-	-	
7293	Millcroft Way, Handsacre, Rugeley	37/43 [B]	-	-	Retaining wall construction	NA	14	R	T	-	-	-	-	-	
7426	Rowan Drive, Handsacre, Rugeley	42/48 [A]	-	-	Retaining wall construction	NA	32	R	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
7467	Rowan Drive, Handsacre, Rugeley	43/60 [A]	-	-	Retaining wall construction	SA	23	R	T	-	-	-	-	-	
7597	Chestnut Close, Handsacre, Rugeley	51/58 [A]	-	-	Retaining wall construction	SA	11	R	T	-	-	-	-	-	
7621	Chestnut Close, Handsacre, Rugeley	47/53 [A]	-	-	Earthworks	SA	20	R	T	-	-	-	-	-	
7798	Lichfield Road, Armitage, Rugeley	38/42 [A]	-	-	Retaining wall construction	NA	21	R	T	-	-	-	-	-	
10729	Capper's Lane, Lichfield	63/62 [A]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	
10745	Europa Way, Britannia Enterprise Park, Lichfield	61/51 [B]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	
17473	Whittington Common Road, Whittington, Lichfield	59/66 [A]	-	-	Topsoil strip	A	2	R	T	-	-	-	11	-	~
17519	Darnford Lane, Lichfield	53/70 [A]	-	-	Site clearance	A	3	R	T	-	-	-	12	-	~

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
17578	Marsh Lane, Whittington, Lichfield	44/64 [A]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	
17597	Darnford Lane, Lichfield	50/66 [A]	-	-	Site clearance	A	1	R	T	-	-	-	2	-	~
17721	Capper's Lane, Lichfield	51/57 [A]	-	-	Site clearance	NA	8	R	T	-	-	-	-	-	
17748	Broad Lane, Huddlesford, Lichfield	51/80 [A]	52/55 [C]	54/56 [C]	Site clearance	S	1	R	T	-	-	Y	13	NI	CSV22-D01
17758	Capper's Lane, Lichfield	51/62 [C]	-	-	Site clearance	NA	2	R	T	-	-	-	-	-	
17767	Capper's Lane, Lichfield	48/59 [A]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	
17774	Capper's Lane, Lichfield	55/72 [C]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	
17785	Capper's Lane, Lichfield	51/70 [A]	-	-	Site clearance	A	1	R	T	-	-	-	5	-	~

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
17800	Capper's Lane, Lichfield	48/66 [A]	-	-	Site clearance	A	0	R	T	-	-	-	1	-	~
18106	Wood End Lane, Elmhurst, Lichfield	52/59 [A]	-	-	Site clearance	NA	4	R	T	-	-	-	-	-	
18521	Lime Way, Streethay, Lichfield	48/52 [A]	-	-	Retained Cut	NA	8	R	T	-	-	-	-	-	
18547	Rayson Close, Streethay, Lichfield	53/57 [A]	-	-	Retained Cut	NA	9	R	T	-	-	-	-	-	
18550	Rayson Close, Streethay, Lichfield	45/53 [B]	-	-	Retained Cut	NA	2	R	T	-	-	-	-	-	
18558	Rayson Close, Streethay, Lichfield	49/52 [A]	-	-	Retained Cut	NA	13	R	T	-	-	-	-	-	
18665	Wood End Lane, Fradley, Lichfield	46/60 [A]	-	-	Topsoil strip	NA	1	R	T	-	-	-	-	-	
18978	Wood End Lane, Fradley, Lichfield	44/55 [A]	-	-	Topsoil strip	NA	3	R	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
19720	Lichfield Road, Hanch, Lichfield	64/55 [B]	-	-	Topsoil strip	NA	10	R	T	-	-	-	-	-	
19867	Lichfield Road, Hanch, Lichfield	53/59 [A]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
20009	Lichfield Road, Hanch, Lichfield	46/55 [A]	-	-	Topsoil strip	NA	1	R	T	-	-	-	-	-	
20044	Shaw Lane, Hanch, Lichfield	46/55 [A]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
20090	Shaw Lane, Hanch, Lichfield	45/67 [A]	-	-	Topsoil strip	A	2	R	T	-	-	-	4	-	~
20138	Shaw Lane, Hanch, Lichfield	45/62 [A]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
20395	Wood End Lane, Curborough, Lichfield	46/56 [C]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	
20441	Wood End Lane, Curborough, Lichfield	47/57 [A]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
20527	Bromley Hayes, Lichfield	50/50 [A]	-	-	Site clearance	NA	2	R	T	-	-	-	-	-	
21095	Wood End Lane, Curborough, Lichfield	54/67 [C]	-	-	Earthworks	NA	5	R	T	-	-	-	-	-	
21213	Bromley Hayes, Lichfield	55/50 [A]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	
22478	Wood End Lane, Fradley, Lichfield	48/65 [A]	-	-	Earthworks	NA	4	R	T	-	-	-	-	-	
22642	Burton Road, Streethay, Lichfield	49/56 [C]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
22669	Burton Road, Streethay, Lichfield	49/73 [C]	-	-	Topsoil strip	NA	1	R	T	-	-	-	-	-	
22736	Burton Road, Streethay, Lichfield	55/57 [B]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
22797	Burton Road, Streethay, Lichfield	58/64 [C]	-	-	Topsoil strip	NA	2	R	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
22853	Burton Road, Streethay, Lichfield	63/56 [C]	-	-	Retained Cut	NA	3	R	T	-	-	-	-	-	
22879	Burton Road, Streethay, Lichfield	52/58 [C]	-	-	Retained Cut	NA	3	R	T	-	-	-	-	-	
22924	Holland Close, Streethay, Lichfield	64/53 [C]	-	-	Retained Cut	NA	7	R	T	-	-	-	-	-	
22961	Holland Close, Streethay, Lichfield	52/51 [A]	-	-	Demolition works	NA	5	R	T	-	-	-	-	-	
23242	Ash Tree Lane, Streethay, Lichfield	57/58 [B]	-	-	Demolition works	NA	7	R	T	-	-	-	-	-	
23264	Burton Road, Streethay, Lichfield	46/60 [C]	-	-	Earthworks	NA	2	R	T	-	-	-	-	-	
23304	Ash Tree Lane, Streethay, Lichfield	44/65 [A]	-	-	Road construction	NA	1	R	T	-	-	-	-	-	
23337	Ash Tree Lane, Streethay, Lichfield	42/54 [A]	-	-	Topsoil strip	NA	11	R	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
23427	Burton Road, Streethay, Lichfield	39/66 [B]	-	-	Retained Cut	NA	1	R	T	-	-	-	-	-	
24762	Dyott Close, Streethay, Lichfield	43/51 [C]	-	-	Demolition works	NA	4	R	T	-	-	-	-	-	
28123	Lichfield Road, Whittington, Lichfield	48/61 [A]	-	-	Site clearance	NA	2	R	T	-	-	-	-	-	
28337	Chester Road, Defence Medical Services (DMS) Whittington, Lichfield	43/49 [A]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
29081	Common Lane, DMS Whittington, Lichfield	39/46 [B]	-	-	Earthworks	NA	5	R	T	-	-	-	-	-	
29134	Common Lane, DMS Whittington, Lichfield	44/41 [B]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
29256	Tamworth Road, Lichfield	40/43 [B]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
29428	Common Lane, DMS Whittington, Lichfield	39/39 [A]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
29572	Chester Road, DMS Whittington, Lichfield	49/43 [A]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
29888	Sandy Lane, Lichfield	50/57 [A]	-	-	Site clearance	NA	3	R	T	-	-	-	-	-	
30592	Lichfield Road, Whittington, Lichfield	46/57 [A]	-	-	Site clearance	NA	2	R	T	-	-	-	-	-	
30770	Darnford Lane, Lichfield	49/59 [A]	-	-	Site clearance	NA	8	R	T	-	-	-	-	-	
30808	Darnford Lane, Lichfield	44/65 [A]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	
31347	Broad Lane, Huddlesford, Lichfield	48/53 [A]	-	-	Topsoil strip	NA	1	R	T	-	-	-	-	-	
31367	Huddlesford Lane, Huddlesford, Lichfield	44/55 [A]	-	-	Site clearance	NA	3	R	T	-	-	-	-	-	
31472	Huddlesford Lane, Huddlesford, Lichfield	50/52 [A]	-	-	Site clearance	NA	4	R	T	-	-	-	-	-	
33376	Darnford Lane, Lichfield	38/72 [A]	-	-	Site clearance	A	1	R	T	-	-	-	2	-	~

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
700650	Fradley Junction, Fradley, Lichfield	58/55 [A]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	
700651	Fradley Junction, Fradley, Lichfield	49/60 [A]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	
700652	Lichfield Road, Lichfield	39/44 [A]	-	-	Retaining wall construction	NA	4	R	T	-	-	-	-	-	
701099	Millcroft Way, Handsacre, Rugeley	39/44 [A]	-	-	Retaining wall construction	NA	101	R	T	-	-	-	-	-	
701100	The Croft Leys, Handsacre, Rugeley	35/37 [A]	-	-	Retaining wall construction	NA	139	R	T	-	-	-	-	-	
701101	Tuppenhurst Lane, Handsacre, Rugeley	33/47 [A]	-	-	Retaining wall construction	NA	52	R	T	-	-	-	-	-	
721012	Shaw Lane, Hanch, Lichfield	45/69 [B]	-	-	Topsoil strip	NA	1	R	T	-	-	-	-	-	
721014	Wood End Lane, Curborough, Lichfield	61/63 [A]	-	-	Earthworks	NA	1	R	T	-	-	-	-	-	
721015	Gorse Lane, Fradley	53/58 [A]	-	-	Site clearance	NA	1	R	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade [Assessment category A/B/C]			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00											
721035	Burton Road, Streethay, Lichfield	46/71 [C]	-	-	Retained Cut	NA	1	R	T	-	-	-	-	-	
903015	Burton Road, Streethay, Lichfield	48/71 [C]	-	-	Demolition works	NA	1	R	T	-	-	-	-	-	
903016	Streethay Village, eastern perimeter	43/50 [A]			Earthworks	NA	1	R	T	-	-	-	-	-	
903017	Streethay Village, north eastern perimeter	45/52 [A]			Earthworks	NA	1	R	T	-	-	-	-	-	

Table 4 - Assessment of construction noise at non-residential receptors

Assessment location		**Impact criteria**				**Significance criteria**									**Significant effect**
ID	**Area represented**	**Typical/highest monthly outdoor L_{pAeq} [dB] at the facade**			**Construction activity resulting in highest forecast noise levels**	**Type of effect**	**Number of impacts represented**	**Type of receptor**	**Receptor design**	**Existing environment**	**Unique feature**	**Combined impact**	**Impact duration [months]**	**Mitigation effect**	
		Day 07:00-19:00	**Evening 19:00-23:00/Weekend**	**Night 23:00-07:00**											
746	Cattery, Tuppenhurst Lane, Rugeley	55/61	-	-	Earthworks	B	1	G5	T	-	-	-	-	-	
10433	Club House, Darnford Lane, Lichfield	51/55	-	-	Site clearance	B	1	G4	T	-	-	-	-	-	
10745	General Commercial, Europa Way, Lichfield	51/61	-	-	Site clearance	B	10	G5	T	-	-	-	-	-	
13325	Factory, Titan Way, Lichfield	55/47	-	-	Site clearance	B	26	G5	T	-	-	-	-	-	
18213	General Commercial, Nanscawen Road, Fradley, Lichfield	51/57	-	-	Topsoil strip	B	1	G5	T	-	-	-	-	-	
18281	General Commercial, Lancaster Road, Hilliard's Cross	59/48	-	-	Site clearance	B	3	G5	T	-	-	-	-	-	
18665	General Commercial, Wood End Lane, Hilliard's Cross	46/60	-	-	Topsoil strip	B	11	G5	T	L	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00/Weekend	Night 23:00-07:00											
19720	General Commercial, Lichfield Road, Hanch, Lichfield	64/55	-	-	Topsoil strip	B	1	G5	T	-	-	-	-	-	
20178	General Commercial, Watery Lane, Curborough	47/51	-	-	Site clearance	B	1	G5	T	L	-	-	-	-	
20527	General Commercial, Bromley Hayes, Lichfield	50/50	-	-	Site clearance	B	5	G5	T	-	-	-	-	-	
21095	General Commercial, Wood End Lane, Curborough, Lichfield	54/67	-	-	Earthworks	B	1	G5	T	-	-	-	-	-	
21136	General Commercial, Wood End Lane, Curborough	67/62	-	-	Earthworks	B	1	G5	T	-	-	-	-	-	
21312	General Commercial, Burton Old Road, Streethay	60/49	-	-	Site clearance	B	1	G5	T	-	-	-	-	-	
21694	General Commercial, Burton Road, Streethay, Lichfield	49/49	-	-	Demolition works	B	1	G5	T	-	-	-	-	-	
22232	General Commercial, Netherstowe Lane, Curborough	48/52	-	-	Site clearance	B	1	G5	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00/Weekend	Night 23:00-07:00											
22478	Office, Wood End Lane, Fradley, Lichfield	48/65	-	-	Earthworks	B	2	G5	T	-	-	-	-	-	
22736	Office, Burton Road, Streethay, Lichfield	55/57	-	-	Earthworks	B	1	G5	T	-	-	-	-	-	
23518	Office, Wellington Crescent, Hilliard's Cross	41/55	-	-	Demolition works	B	15	G5	T	-	-	-	-	-	
23625	General Commercial, Rykneld Street	43/56	-	-	Topsoil strip	B	1	G5	T	-	-	-	-	-	
24230	General Commercial, Wood End Lane	39/60	-	-	Site clearance	B	2	G5	T	-	-	-	-	-	
24857	General Commercial, Wood End Lane, Hilliard's Cross	48/57	-	-	Site clearance	B	1	G5	T	-	-	-	-	-	
29490	Museum, Chester Road, Whittington	54/46	-	-	Earthworks	B	1	G3	T	-	-	-	-	-	
29975	Community Centre, Whittington Barracks, Lichfield	42/48	-	-	Earthworks	B	3	G5	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00/Weekend	Night 23:00-07:00											
31367	The Plough Inn, Huddlesford Lane, Huddlesford	44/55	-	-	Site clearance	B	2	G5	T	-	-	-	-	-	
31466	General Commercial, Huddlesford Lane, Huddlesford	52/52	-	-	Site clearance	B	1	G5	T	-	-	-	-	-	
31505	Club, Huddlesford Lane, Huddlesford	46/57	-	-	Topsoil strip	B	1	G5	T	-	-	-	-	-	
34767	General Commercial, Brookhay Lane, Hilliard's Cross	48/53	-	-	Retained Cut	B	1	G5	T	-	-	-	-	-	
700631	Tamworth Road, DMS Whittington, Lichfield	49/59	-	-	Earthworks	B	1	G5	T	-	-	-	-	-	
700632	Tamworth Road, DMS Whittington, Lichfield	47/54	-	-	Earthworks	B	1	G5	T	-	-	-	-	-	
700647	School, Heath Avenue, DMS Whittington, Lichfield	44/48	-	-	Earthworks	B	1	G4	T	-	-	-	-	-	
700648	The Thomas Spencer Hall, Church Street, Whittington, Lichfield	44/48	-	-	Site clearance	B	1	G3	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00/Weekend	Night 23:00-07:00											
700649	Capper's Lane, Lichfield	35/77	-	-	Site clearance	B	1	G4	S	-	-	-	-	-	~
700651	General Commercial, Fradley Junction, Fradley, Lichfield	49/60	-	-	Site clearance	B	1	G5	T	L	-	-	-	-	
701066	Tamworth Road, DMS Whittington, Lichfield	52/54	-	-	Earthworks	B	1	G5	T	-	-	-	-	-	
701067	Heath Avenue, Tamworth Road, DMS Whittington, Lichfield	51/65	-	-	Earthworks	B	1	G5	T	-	-	-	-	-	
701090	Streethay Wharf, Lichfield	55/56	-	-	Earthworks	B	1	G4	S	-	-	-	-	-	
701091	Kings Bromley Wharf, Tewnals Lane, Lichfield	61/56	-	-	Site clearance	B	1	G4	S	-	-	-	-	-	
701101	The Old Peculiar, Tuppenhurst Lane, Handsacre, Rugeley	49/51	-	-	Retaining wall construction	B	1	G5	T	-	-	-	-	-	
721011	Hayes Meadow Primary School, Handsacre	42/47	-	-	Retaining wall construction	B	1	G4	T	-	-	-	-	-	

Assessment location		Impact criteria				Significance criteria									Significant effect
ID	Area represented	Typical/highest monthly outdoor L_{pAeq} [dB] at the facade			Construction activity resulting in highest forecast noise levels	Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Impact duration [months]	Mitigation effect	
		Day 07:00-19:00	Evening 19:00-23:00/Weekend	Night 23:00-07:00											
721019	General Commercial, Wood End Lane, Hilliard's Cross	45/65	-	-	Site clearance	B	1	G5	T	-	-	-	-	-	
721029	Kings Orchard Marina, Streethay, Lichfield	55/56	-	-	Earthworks	B	1	G4	S	-	-	-	-	-	~

Airbourne sound: indirect effects

3.2.7 The indirect effects from construction road traffic associated with the construction phases of the AP2 revised scheme are presented in Table 5 for potentially significant road links in the vicinity of the amendments.

3.2.8 An explanation of the information within Table 5 is provided in the main ES, Volume 5: Appendix SV 001-000 and Appendix Sv-003-022.

Table 5 - Assessment of construction traffic noise levels

Road name	**Link**	**Future baseline sound level (dB)**	**Future baseline sound level + construction traffic (dB)**	**Change (dB)**	**Significant effect**
		Daytime $L_{pAeq,16hr}$ 07:00-23:00	**Daytime $L_{pAeq,16hr}$ 07:00-23:00**		
A51	Tamworth Road overbridge construction compound to Whittington Common Road junction	68.8	68.9	+0.1	
Whittington Common Road	Lichfield Road underbridge construction compound to the A51 Tamworth Road	61.1	61.7	+0.6	
Capper's Lane	Park Lane to Capper's Lane Viaduct construction Compound	62.7	62.8	+0.1	
Capper's Lane	A38 to A5127 Burton Road	69.9	69.9	0	
Park Lane	Capper's Lane to the A38 Southbound Roadhead	55.7	63.0	+7.3	
A38	A38 London Road to Capper's Lane	79.9	80.4	+0.5	
A38	Capper's Lane to Wood End Lane	79.8	80.3	+0.5	
A5127 Burton Road	A38 to Capper's Lane	68.8	68.8	0	
A5	A38 London Road roundabout to the A5148 roundabout	73.8	74.2	+0.4	
A5127 Birmingham Road	A5 to A461	70.4	71.1	+0.7	
Wood End Lane	A515 Tewnals Lane to Curborough flyover construction compound	66.4	67.0	+0.6	
A515 Tewnals Lane	Common Lane to Wood End Lane	67.6	68.0	+0.4	

3.3 Assessment of significance of effects

Residential receptors: direct effects- individual dwellings

3.3.1 The main ES did not identify any dwellings in the area which are forecast to experience noise levels higher than the noise insulation trigger levels as defined in the draft Code of Construction Practice (CoCP).

3.3.2 Taking account of the avoidance and mitigation measures as set out in the AP2 ES Volume 2: CFA22, one residential building represented by assessment location receptor 17748 (marked as CSV22-D01 in Table 3) is forecast to experience noise levels higher than the noise insulation trigger levels as defined in the draft CoCP for both day time and night time periods. For day and night time construction the trigger level is an equivalent continuous noise level of 75dB[1] and 55dB[2] measured outdoors respectively.

3.3.3 The mitigation measures, including noise insulation, will reduce noise inside all dwellings, such that it does not reach a level where it would significantly affect residents.

Residential receptors: direct effects- communities

3.3.4 The main ES did not identify any receptor or community in which the adverse effects identified were considered to be significant.

3.3.5 The avoidance and mitigation measures in this area will avoid airborne construction noise adverse effects[3] on the majority of receptors and communities.

3.3.6 With regard to noise outside dwellings, the assessment of temporary effects takes account of construction noise relative to existing sound levels. Users who occasionally sleep overnight at locations such as moorings, camp sites or caravan parks that do not permit long term residential use are not considered to be significantly affected by noise due to construction of the AP2 revised scheme, due to the short and irregular exposure to noise from the AP2 revised scheme.

3.3.7 In locations with lower existing sound levels[4], construction noise effects are likely to be caused by changes to noise levels outside dwellings. These may be considered by the local community as an effect on the acoustic character of the area and hence be perceived as a change in the quality of life. These effects are considered to be significant when assessed on a community basis taking account of the local context.

3.3.8 In this area, the mitigation measures reduce the effects of outdoor construction noise on the acoustic character around the local residential communities such that the adverse effects identified are considered to be not significant.

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[1] LpAeq,0800-1800 measured at the façade
[2] LpAeq,2200-0700 measured at the facade
[3] Information is provided in the emerging National Planning Practice Guidance – Noise http://planningguidance.planningportal.gov.uk, refer to the noise exposure hierarchy.
[4] Further information is provided in Main ES, Volume 5: Appendix SV-001-000.

Residential receptors: indirect effects

3.3.9 The main ES did not identify any receptor in which the adverse effects identified were considered to be significant however, based upon traffic information for the AP2 revised scheme, the amendments reduce the identified minor impact along Capper's Lane and the A38 to no impact. A moderate impact is, however, predicted along Park Lane. Taking account of incorporated mitigation, the limited number of properties adjacent to these roads and the predicted change in traffic noise levels, no indirect construction noise significant effects have been identified.

3.3.10 In certain instances a qualitative assessment has been undertaken. This was the case for assessment of noise due to construction traffic along the A5206 London Road, Cricket Lane, the A51 Western Bypass and the A515 Tewnals Lane.

3.3.11 Construction traffic accesses the A51 Tamworth Road from the A38 via Cricket Lane and the A5206 London Road. It is anticipated that vehicle numbers along these roads are similar to those on the A51 Tamworth Road. The qualitative assessment has therefore concluded that the impact would be <1dB, hence no significant temporary noise effect is considered likely.

3.3.12 Construction traffic accesses A51 Western By-Pass road, via the A5127 Birmingham Road. It is anticipated that vehicle numbers along these roads are similar to those on A5127 Birmingham Road. The qualitative assessment has therefore concluded that the impact would be <1dB, hence no significant temporary noise effect is considered likely.

3.3.13 Construction traffic accesses the A515 Tewnals Lane from the A51 Stafford Road. It is anticipated that vehicle numbers along these roads are similar to those on the A515 between Common Lane and Wood End Lane. The qualitative assessment has therefore concluded that the impact would be <1dB, hence no significant temporary noise effect is considered likely.

Non-residential receptors- direct effects

3.3.14 Significant construction noise or vibration effects on non-residential receptors are unlikely to occur in this area.

Non-residential receptors- indirect effects

3.3.15 Significant noise effects on non-residential receptors arising from construction traffic are unlikely to occur in this area.

Cumulative effects from the AP2 revised scheme and other committed development

3.3.16 This assessment has considered the potential cumulative construction noise effects of the AP2 revised scheme and other committed developments. Within this area, the construction noise or vibration associated with these developments in conjunction with the construction of the AP2 revised scheme do not result in any significant cumulative effects.

Environmental topic:	Sound, noise and vibration	SV
Appendix name:	Operation assessment	004
Community forum area:	Whittington to Handsacre	022

Contents

1 Introduction 1
1.1 Structure of the sound, noise and vibration appendices 1
1.2 Evaluation of impacts and effects 2
2 Scope, assumptions and limitations 3
2.1 Regional and local policy guidance 3
2.2 Engagement 3
2.3 Methodology 3
2.4 Assumptions 3
2.5 Local limitations 3
3 Environmental baseline 4
3.1 Existing baseline 4
3.2 Future baseline 4
4 Effects arising during operation 5
4.1 Introduction 5
4.2 Avoidance and mitigation measures 5
4.3 Quantitative identification of impacts and effects 5
4.4 Assessment of impacts and effects 33
4.5 Summary of Changes from main ES/AP1 ES 37

List of tables

Table 1 - Ground-borne sound and vibration impacts and effects at residential and non-residential receptors 7
Table 2 - Summary of operational ground-borne noise and vibration impacts 9
Table 3 - Operational airborne sound level, noise impacts and effects 11
Table 4 - Summary of operational airborne sound impacts 33
Table 5 - Direct adverse effects on residential communities and shared open areas that are considered significant on a community basis 34

1 Introduction

1.1 Structure of the sound, noise and vibration appendices

1.1.1 The sound, noise and vibration appendices comprise four sections. The first of these details the methodology used (SES and AP2 ES Appendix SV-001-000) and relates to the sound, noise and vibration assessment for all community forum areas (CFA).

1.1.2 For the Whittington to Handsacre community forum area (CFA22), the other three sections are as follows:

- baseline sound, noise and vibration (main ES Appendix SV-002-022);
- construction sound, noise and vibration (SES and AP2 ES Appendix SV-003-022); and
- operational sound, noise and vibration (SES and AP2 ES Appendix SV-004-022) (this appendix).

1.1.3 The outcomes of this assessment are summarised in SES and AP2 ES, Volume 2: CFA22 Report, Chapter 14 Sound, Noise and Vibration.

1.1.4 Maps referred to throughout the sound, noise and vibration appendices are contained in the SES and AP2 ES Volume 5 sound, noise and vibration map book.

1.1.5 This appendix presents the likely noise and vibration impacts, effects and significant effects arising from the operation of the AP2 revised scheme for the Whittington to Handsacre area on:

- people, primarily where they live ('residential receptors') in terms a) individual dwellings and b) on a wider community basis, including any shared community spaces; and
- community facilities such as schools, hospitals, places of worship, and also commercial properties such as offices and hotels, collectively described as 'non-residential receptors' and 'quiet areas'.

1.1.6 The assessment of likely impacts, effects and significant effects from operational noise and vibration on agricultural, community, ecological or heritage receptors and the assessment of tranquillity are presented in the following documents within Volume 5:

- Agriculture, forestry and soils — SES and AP2 ES Appendix AG-001-022
- Community — SES and AP2 ES Appendix CM-001-022
- Ecology — SES and AP2 ES Appendix EC-005-003
- Heritage — SES and AP2 ES Appendix CH-003-022
- Landscape and Visual — SES and AP2 ES Appendix LV-001-022

1.2 Evaluation of impacts and effects

1.2.1 This appendix provides a quantitative assessment of operational noise and vibration impacts and effects and a qualitative assessment of likely significant effects, based on the impacts and effects identified and other local context information consistent with the scope and methodology defined for the AP2 revised scheme.

1.2.2 Indirect effects arising from permanent changes in traffic patterns on the existing road and rail networks as a consequence of the AP2 revised scheme are also reported in this appendix, where they would occur within the study area as defined in main ES Volume 5 Appendix SV-001-000.

1.2.3 Route-wide impacts, effects and significant effects associated with noise or vibration from the operation of the AP2 revised scheme are reported in SES and AP2 ES Volume 3.

1.2.4 Off-route effects of noise or vibration arising from the operation of the AP2 revised scheme, including those likely to arise from permanent changes in traffic patterns on roads or railways outside of the study area for direct effects are reported in SES and AP2 ES Volume 4.

1.2.5 In undertaking the assessment of sound, noise and vibration, consistent with EIA Regulations and National Planning Practice Guidance1 a differentiation between impacts, effects, adverse effects and significant effects is made. Further information is provided in main ES Volume 5: Appendix SV-001-000.

1.2.6 The assessment of impacts has been undertaken at assessment locations that are representative of a number of dwellings or other sensitive receptors. The Assessment Locations employed in this assessment are presented on SES and AP2 ES map series Sv-02 in the SES AND AP2 ES CFA22 Volume 5 sound, noise and vibration map book.

[1] National Planning Practice Guidance – Noise http://planningguidance.planningportal.gov.uk ; refer to the table summarising noise exposure hierarchy

2 Scope, assumptions and limitations

2.1 Regional and local policy guidance

2.1.1 The policy framework for sound, noise and vibration is set out in main ES Volume 1 and in main ES Appendix SV-001-000. As part of the engagement with local authorities through the Planning Forum Sub Group - Acoustics, information regarding any specific local planning guidance in respect of noise and vibration has been requested. Whilst no information has been received for this study area via the Planning Forum Sub Group - Acoustics, the following local policy guidance on noise and vibration has been identified:

- Lichfield District Council – Local Plan – Our Strategy (July 2012).

2.1.2 This guidance has been considered as part of formulating the detailed application of the impact and significance criteria set out in main ES Volume 5, Appendix SV-001-000.

2.2 Engagement

2.2.1 Details of engagement on a route-wide basis with the local and county authorities' Environmental Health Practitioners via the Planning Forum Sub Group - Acoustics, is set out in main ES Volume 1, Section 8.

2.2.2 Engagement with communities has been via the Community Forums, as set out in main ES Volume 1.

2.3 Methodology

2.3.1 The methodology used for the assessment of airborne sound, ground-borne sound and vibration impacts and the determination of significant effects is defined in the Scope and Methodology Report (SMR) (main ES, Volume 5: Appendix CT-001-000/1), is clarified in a number of areas by the SMR addendum (main ES, Volume 5: Appendix CT-001-000/2). Further information is contained in main ES, Volume 5: Appendix SV-001-000.

2.4 Assumptions

2.4.1 Route-wide assumptions are outlined in the main ES Volume 1, Section 8, and are further detailed in the main ES Volume 5: Appendix SV-001-000. Local assumptions that apply to the assessment of operational sound noise and vibration within this CFA are set out in SES and AP2 ES Volume 2: Report 22.

2.5 Local limitations

2.5.1 In this area, there are a number of locations where the land or property owners did not permit baseline sound level monitoring to be undertaken at their premises. However, sufficient information has been obtained to undertake the assessment. Further information is provided in main ES Volume 5: Appendix SV-002-022.

3 Environmental baseline

3.1 Existing baseline

3.1.1 Baseline sound level data has been collected at locations representative of the airborne sound-sensitive receptors. The existing and future baseline airborne sound levels derived from these measurements are included within Table 3. Details of the baseline data collection and the methodology are given in main ES Volume 5: Appendix SV-001-000 and specifically for this study area in main ES Volume 5: Appendix SV-002-022.

3.1.2 The majority of receptors adjacent to the line of the route are not currently subject to appreciable vibration and therefore vibration at all receptors has been assessed using the absolute vibration criteria as described in main ES Volume 5: Appendix SV-001-000.

3.1.3 The amendments in this CFA area do not necessitate a requirement to obtain additional baseline sound or vibration levels.

3.2 Future baseline

3.2.1 The assessment is based upon the predicted change in sound levels that result from the AP2 revised scheme. The assessment initially considered a reasonable worst case (that would overestimate the change in levels) by assuming that sound levels would not change from the existing baseline year of 2012/2013. Where significant effects were identified on this basis, the effects have been assessed using the baseline year of 2026 to coincide with the proposed start of passenger services. The future baseline is for the sound environment that would exist in 2026 without the AP2 revised scheme.

4 Effects arising during operation

4.1 Introduction

4.1.1 The assessment is reported first for ground-borne sound and vibration and then for airborne sound. Under each of these headings, the results of the quantitative identification of impacts and effects are presented. This is followed by the identification of significant effects and the evidence used to support these conclusions.

4.1.2 The structure of this assessment report is:

- avoidance and mitigation measures;
- quantitative identification of impact and effects:
  - ground-borne sound and vibration;
  - residential;
  - non-residential;
  - airborne sound;
  - residential; and
  - non-residential.
- assessment of impacts and effects:
  - residential receptors: direct effects – dwellings;
  - residential receptors: direct effects – communities;
  - residential receptors: indirect effects;
  - non-residential receptors: direct effects;
  - non-residential receptors: indirect effects; and
  - cumulative effects from the AP2 revised scheme and other committed development.

4.2 Avoidance and mitigation measures

4.2.1 Avoidance and mitigation measures are set out in SES and AP2 ES Volume 2: Report 22.

4.3 Quantitative identification of impacts and effects

Ground-borne sound and vibration

4.3.1 Assessment locations defined for the quantitative assessment of impacts are shown on map series SV-02 in the SES and AP2 ES CFA22 Volume 5 sound, noise and vibration map book.

4.3.2 For each Assessment Location, the assessment results for residential and non-residential receptors are presented in Table 1. Explanation of the information in Table 1 is provided in main ES Appendix SV-004-022, with the following additional notes.

B	For non-residential receptors further detail about the type of effect is set out in the text of Volume 5: Appendix SV-001-000.
NA	Type of effect - Generally no adverse effect
A	Type of effect - Adverse effect
S	Type of effect - Significant adverse effect
VDV	Vibration Dose Value
~	The forecast adverse effects are not considered to be significant on a community basis (further information on methodology is provided in main ES Volume 5: Appendix SV-001-000).
^	The impact methodology has identified a potential significant effect at this receptor which based upon further qualitative information is not considered to be a likely significant effect. Please refer the end of this Appendix for further information.
	Where the significant effect column is highlighted in pink, then a significant effect is identified at the referenced residential community area, or individual receptor.
	Yellow denotes a low ground-borne noise impact or a minor ground-borne vibration impact
	Orange denotes a medium ground-borne noise impact or a moderate ground-borne vibration impact
	Red denotes a high ground-borne noise impact or a major ground-borne vibration impact
	Dark red denotes a very high ground-borne noise impact

Table 1 - Ground-borne sound and vibration impacts and effects at residential and non-residential receptors

Assessment location		Impact criteria				Significance criteria								
ID	Area represented	Ground-borne sound level dB LpASmax	VDV m/s1.75 Daytime (07:00 – 23:00)	VDV m/s1.75 Night time (23:00 – 07:00)	% increase or decrease in VDV	Number of impacts represented	Type of effect	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation effect	Significant effect
623	Tuppenhurst Lane, Rugeley	-	0.15	0.07	-	3	NA	R	T	-	-	-	-	
5738	Alandale Avenue, Rugeley	-	0.00	0.00	-	24	NA	R	T	-	-	-	-	
6336	Proctor Road, Rugeley	-	0.00	0.00	-	37	NA	R	T	-	-	-	-	
6354	Johns Avenue, Rugeley	-	0.00	0.00	-	11	NA	R	T	-	-	-	-	
6455	Millcroft Way, Handsacre	-	0.00	0.00	-	18	NA	R	T	-	-	-	-	
6492	Beech Close, Handsacre	-	0.00	0.00	-	11	NA	R	T	-	-	-	-	
6607	Barn Road, Handsacre	-	0.00	0.00	-	17	NA	R	T	-	-	-	-	
7293	Millcroft Way, Handsacre	-	0.00	0.00	-	14	NA	R	T	-	-	-	-	
7467	Rowan Drive, Handsacre	-	0.27	0.14	-	23	A	R	T	-	-	-	-	^
7597	Chestnut Close, Handsacre	-	0.00	0.00	-	11	NA	R	T	-	-	-	-	
7621	Chestnut Close, Handsacre	-	0.10	0.05	-	20	NA	R	T	-	-	-	-	
17748	Broad Lane, Huddlesford	-	0.09	0.04	-	1	NA	R	T	-	-	-	-	

Assessment location		Impact criteria				Significance criteria								
ID	Area represented	Ground-borne sound level dB LpASmax	VDV m/s1.75 Daytime (07:00 – 23:00)	VDV m/s1.75 Night time (23:00 – 07:00)	% increase or decrease in VDV	Number of impacts represented	Type of effect	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation effect	Significant effect
17785	Capper's Lane, Lichfield	-	0.00	0.00	-	1	NA	R	T	-	-	-	-	
22669	Burton Road, Streethay	-	0.17	0.09	-	1	NA	R	T	-	-	-	-	

Impact summary

4.3.3 The operational ground-borne noise and vibration impacts identified in Table 1 are summarised in Table 2.

Table 2 - Summary of operational ground-borne noise and vibration impacts

	Number of ground-borne sound impacts			
	Low	**Medium**	**High**	**Very High**
Residential properties	0	0	0	0
Non-residential properties	0			0
	Number of ground-borne vibration impacts			
	Minor	Moderate	Major	Risk of building damage
Residential properties	23	0	0	0
Non-residential properties	0			0

Airborne sound: direct impacts and effects

4.3.4 The direct effects from the operation of the AP2 revised scheme as well as any new, amended or altered roads or railway lines, which are identified as part of the scheme, are presented in Table 3.

4.3.5 The assessment information, impact criteria and significance criteria for the assessment of the incorporated mitigation case at residential and non-residential receptors are presented in Table 3. The results should be considered in conjunction with the information contained in map series Sv-02 in the SES and AP2 ES CFA22 Volume 5 sound, noise and vibration map book.

4.3.6 Explanation of the Table 3 information is provided in main ES, Volume 5: Appendix SV001-000, with the following additional notes:

	Where the significant effect column is marked, then a significant effect is identified at the referenced group of dwellings, or individual residential or non-residential receptor.
	Yellow denotes a minor impact at a residential building – a change is of 3-5 dB
	Orange denotes a moderate impact at a residential building – a change is of 5-10 dB
	Red denotes a major impact at a residential building – a change is of >10 dB
*	Day - $L_{pAeq,07:00-23:00}$
**	Night - $L_{pAeq,23:00-07:00}$
***	Max - L_{pAFMax} In the AP2 revised scheme only column, two values are presented. The first is the value for the HS2 mitigated train and the second is the value for the TSI compliant train. For further information refer to main ES Volume 5: Appendix SV-001-000.
****	Where the AP2 revised scheme modifies an existing source, i.e. road or railway realignments, the *AP2 revised scheme only* level in the table includes the sound from the modified source. In this situation the *Do something (Opening year baseline + Year 15 traffic)* level has been corrected so as to not double count the sound associated with the road or railway on its new and existing alignment.
A	Adverse effect
B	For non-residential receptors further detail about the type of effect is set out in the text of main ES Appendix SV-001-000.
CD	Committed Development. The value in brackets in the number of impacts represented column is the value with the committed development.
G	(G1)Theatres, large auditoria and concert halls, (G2) Sound recording and broadcast studios, (G3) Places of meeting for religious worship, courts, cinemas, lecture theatres, museums and small auditoria or halls, (G4) Schools, colleges, hospitals, hotels and libraries, and (G5) Offices and general commercial premises

H	High existing ambient sound level. Defined as >65dB$L_{Aeq, day}$ and/or >55dB$L_{Aeq, night}$
L	Low existing ambient sound level. Defined as <42dB$L_{Aeq, day}$ and/or <32dB$L_{Aeq, night}$
LD	Landscape receptor
NA	Generally no adverse effect
NI	The receptor is predicted to qualify for mitigation, which shall be provided to the specification defined in the Noise Insulation (Railways and other Guided Rail Systems) Regulations 1996
R	Residential
RM	Residential mooring
S	Significant adverse effect
U	Unacceptable adverse effect
#	A change of 3dB or greater has been identified however, the assessment methodology only defines an impact where the absolute sound level from the AP2 revised scheme is greater or equal to 50 dB $L_{pAeq, 23:00-07:00}$ during the daytime or 40 dB $L_{pAeq, 07:00-23:00}$ at night. At the receptor denoted the absolute level condition is not met and therefore no impact is identified.
~	The forecast adverse effects are not considered to be significant on a community basis (further information on methodology is provided in main ES Volume 5: Appendix SV-001-000).
$	A change of 3dB or greater has been identified however, the impact methodology for non-residential receptors includes a screening criteria for G3 building use of 50 dB $L_{pAeq,07:00-23:00}$, for G4 building use 55 dB $L_{pAeq,07:00-23:00}$ and 45 dB $L_{pAeq,23:00-07:00}$, for G5 building use 55 dB $L_{pAeq,07:00-23:00}$. At the receptor denoted the screening criteria is not met and therefore no impact is identified. Further information is provided in main ES Volume 5: Appendix SV-001-000.
^	The impact methodology has either identified an impact at a receptor which based upon further qualitative information does not gives rise to a significant effect. Further information is provided at the end of this Appendix.

Table 3 - Operational airborne sound level, noise impacts and effects

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
277	Lysways Lane, Hanch	44	33	58/-	45	34	53	44	33	-2	0	NA	2	R	T	-	-	-	-	
572	Lichfield Road, Armitage	41	30	54/-	42	33	52	41	30	-1	-2	NA	2	R	T	L	-	-	-	
623	Tuppenhurst Lane, Rugeley	59	49	75/-	54	48	54	59	49	5	1	A	3	R	T	-	-	-	-	~
642	Lichfield Road, King's Bromley	51	39	63/-	57	38	60	57	39	0	1	A	2	R	T	-	-	-	-	
746	Tuppenhurst Lane, Rugeley	52	41	64/-	50	34	51	52	41	2	7	A	1	R	T	-	-	-	-	~
3228	Foxleigh Meadows, Handsacre	44	38	54/-	53	42	53	54	43	0	1	NA	104	R	T	-	-	-	-	
5666	Tuppenhurst Lane, Rugeley	46	40	58/-	57	44	60	57	45	0	1	A	51	R	T	-	-	-	-	
5738	Alandale Avenue, Rugeley	54	48	67/-	58	51	56	59	52	1	1	A	24	R	T	-	-	-	-	

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
5818	Tuppenhurst Lane, Rugeley	43	36	55/-	57	44	60	57	44	0	0	NA	61	R	T	-	-	-	-	
6025	Tuppenhurst Lane, Rugeley	43	34	59/-	45	39	46	47	41	2	1	NA	2	R	T	-	-	-	-	
6042	Bridge Road, Rugeley	45	38	56/-	46	41	50	46	41	0	0	NA	45	R	T	-	-	-	-	
6336	Proctor Road, Rugeley	55	48	70/-	54	49	59	55	48	1	-1	A	37	R	T	-	-	-	-	
6354	Johns Avenue, Rugeley	60	51	75/-	58	51	56	60	52	2	1	A	11	R	T	-	-	-	-	
6455	Millcroft Way, Handsacre	40	31	61/-	55	40	64	55	41	0	1	NA	18	R	T	-	-	-	-	
6492	Beech Close, Handsacre	59	50	77/-	51	48	54	59	50	8	2	A	10	R	T	-	-	-	-	OSV22-C02
6574	Spode Avenue, Rugeley	50	42	66/-	51	46	53	53	48	2	1	A	23	R	T	-	-	-	-	
6607	Barn Road, Handsacre	64	54	69/-	51	45	54	64	55	12	10	A	15	R	T	-	-	Y	-	OSV22-C02
6861	Fair View, Rugeley	46	38	61/-	57	42	64	57	43	0	1	NA	41	R	T	-	-	-	-	

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
6934	Lichfield Road, Armitage	45	37	60/-	57	42	58	57	42	0	0	NA	24	R	T	-	-	-	-	
7044	Handsacre Crescent, Rugeley	42	35	55/-	43	33	43	45	35	2	2	NA	46	R	T	-	-	-	-	
7136	Hill Top View, Rugeley	42	34	55/-	43	33	49	44	34	1	1	NA	47	R	T	-	-	-	-	
7181	Lichfield Road, Armitage	52	39	67/-	57	33	47	57	39	0	7	NA	6	R	T	L	-	-	-	#
7293	Millcroft Way, Handsacre	56	46	70/-	60	45	64	60	46	1	1	A	14	R	T	-	-	-	-	
7426	Rowan Drive, Handsacre	48	38	62/-	53	31	48	54	38	0	7	NA	32	R	T	L	-	-	-	#
7467	Rowan Drive, Handsacre	58	49	77/-	51	42	48	58	49	7	7	A	23	R	T	-	-	Y	-	OSV22-C02
7597	Chestnut Close, Handsacre	64	54	69/-	54	45	54	64	54	9	9	A	11	R	T	-	-	-	-	OSV22-C02
7621	Chestnut Close, Handsacre	53	44	72/-	51	45	54	53	44	2	-1	A	20	R	T	-	-	-	-	
7798	Lichfield Road, Armitage	47	39	65/-	57	42	64	57	44	0	1	NA	21	R	T	-	-	-	-	

Assessment Location		Impact criteria										Significance criteria								
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		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
7844	Tuppenhurst Lane, Rugeley	42	33	55/-	45	39	46	47	40	2	1	NA	1	R	T	-	-	-	-	
7852	Tuppenhurst Lane, Rugeley	40	31	53/-	45	39	46	46	40	1	1	NA	2	R	T	-	-	-	-	
7913	Highfields Avenue, Rugeley	46	39	62/-	57	44	60	57	45	0	1	NA	23	R	T	-	-	-	-	
10433	Darnford Lane, Whittington	42	33	62/64	51	47	55	51	47	0	0	NA	1	R	T	-	-	-	-	
10729	Capper's Lane, Lichfield	52	43	72/74	55	51	59	56	51	1	0	A	1	R	T	-	-	-	-	
10745	Europa Way, Lichfield	40	31	55/58	58	49	52	58	49	0	0	NA	1	R	T	-	-	-	-	
11741	Darnford Lane, Lichfield	40	31	56/59	49	46	53	49	46	1	0	NA	1	R	T	-	-	-	-	
12749	Tamworth Road, Lichfield	41	32	60/63	68	54	76	68	54	0	0	NA	5	R	T	H	-	-	-	
13325	Titan Way, Britannia Enterprise Park	37	28	54/57	55	46	46	55	46	0	0	NA	4	R	T	-	-	-	-	

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		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
17473	Lichfield Road, Whittington	56	47	74/77	40	37	45	56	47	16	10	A	2	R	T	L	-	-	-	OSV22-C01
17519	Darnford Lane, Lichfield	55	45	72/74	44	41	45	55	46	11	6	A	2	R	T	-	-	-	-	OSV22-C01
17578	Marsh Lane, Whittington	49	40	67/70	43	40	49	50	43	7	3	A	1	R	T	-	-	-	-	OSV22-C01
17597	Darnford Lane, Lichfield	48	39	68/71	48	45	53	51	46	3	1	NA	1	R	T	-	-	-	-	#
17721	Capper's Lane, Lichfield	47	38	67/70	56	51	59	57	51	0	0	NA	8	R	T	-	-	-	-	
17748	Broad Lane, Huddlesford	60	51	75/78	69	64	82	70	64	0	0	A	1	R	T	H	-	-	-	
17758	Capper's Lane, Lichfield	52	42	68/72	69	64	82	69	64	0	0	A	2	R	T	H	-	-	-	
17767	Capper's Lane, Lichfield	51	42	75/78	67	62	78	67	62	0	0	A	1	R	T	H	-	-	-	
17774	Capper's Lane, Lichfield	56	46	76/79	62	57	73	63	57	1	0	A	1	R	T	H	-	-	-	
17785	Capper's Lane, Lichfield	58	49	79/82	65	60	74	66	60	1	0	S	1	R	T	H	-	-	NI	OSV22-D01

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		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
17800	Capper's Lane, Whittington	54	45	77/80	62	57	78	63	57	1	0	A	1	R	T	H	-	-	-	
18106	Wood End Lane, Elmhurst	52	43	69/71	54	41	53	56	44	2	3	A	4	R	T	-	-	-	-	~
18521	Lime Way, Streethay	41	32	54/56	59	54	60	59	54	0	0	NA	8	R	T	-	-	-	-	
18547	Rayson Close, Streethay	46	38	59/62	56	51	60	56	51	0	0	NA	9	R	T	-	-	-	-	
18550	Rayson Close, Streethay	42	33	55/58	60	55	62	60	55	0	0	NA	2	R	T	H	-	-	-	
18558	Rayson Close, Streethay	41	32	57/60	55	49	64	55	49	0	0	NA	13	R	T	-	-	-	-	
18600	Elmhurst, Lichfield	44	35	60/62	62	39	52	62	40	0	1	NA	1	R	T	-	-	-	-	
18978	Wood End Lane, Alrewas and Fradley	56	47	70/72	52	51	55	56	51	4	1	A	6	R	T	-	-	-	-	~
19720	Lichfield Road, Hanch	43	34	58/61	59	42	61	59	42	0	1	NA	10	R	T	-	-	-	-	
19867	Lichfield Road, Hanch	49	39	62/65	51	40	62	49	39	-2	-1	NA	1	R	T	-	-	-	-	
20009	Lichfield Road, Hanch	53	38	60/63	57	40	61	55	38	-3	-1	NA	1	R	T	-	-	-	-	

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		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
20044	Shaw Lane, Hanch	50	40	62/-	56	45	67	55	40	-1	-5	NA	1	R	T	-	-	-	-	
20090	Shaw Lane, Hanch	47	38	67/-	53	37	51	47	38	-6	1	NA	2	R	T	-	-	-	-	
20124	Lysways Lane, Hanch	47	35	60/-	49	38	57	47	35	-3	-2	NA	1	R	T	-	-	-	-	
20395	Wood End Lane, Curborough	50	42	66/68	68	60	81	68	60	0	0	A	1	R	T	H	-	-	-	
20441	Wood End Lane, Curborough	54	44	71/72	46	42	51	54	46	8	4	A	1	R	T	-	-	-	-	~
20508	Elmhurst, Lichfield	43	35	57/58	62	39	52	62	40	0	1	NA	1	R	T	-	-	-	-	
20527	Bromley Hayes, Lichfield	49	39	63/65	54	48	70	55	48	1	1	NA	2	R	T	-	-	-	-	
20579	Riley Hill, Lichfield	47	37	61/63	45	33	57	49	38	4	6	NA	2	R	T	L	-	-	-	#
21095	Riley Hill, Lichfield	55	46	70/72	63	56	78	60	53	-3	-3	NA	5	R	T	H	-	-	-	~
21136	Wood End Lane, King's Bromley	57	48	74/76	47	43	59	57	48	10	6	A	1	R	T	-	-	-	-	~

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		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
21213	Woodend Common Barn, King's Bromley	54	45	67/70	40	36	45	54	45	14	9	A	1	R	T	L	-	-	-	~
21441	Burton Road, Streethay	37	29	49/52	65	59	74	65	59	0	0	NA	16	R	T	H	-	-	-	
21549	Bailye Close, Streethay	39	32	53/56	57	50	60	57	50	0	0	NA	14	R	T	-	-	-	-	
21649	Bexmore Drive, Streethay	38	30	53/56	62	56	74	62	56	0	0	NA	25	R	T	H	-	-	-	
21694	Bailye Close, Streethay	39	31	54/57	51	46	61	52	46	0	0	NA	15	R	T	-	-	-	-	
21739	Bexmore Drive, Streethay	38	30	52/55	52	45	56	52	45	0	0	NA	12	R	T	-	-	-	-	
22232	Netherstowe, Lichfield	48	38	63/66	44	40	47	49	42	4	2	NA	5	R	T	-	-	-	-	#
22329	Netherstowe, Lichfield	46	36	63/66	43	39	46	47	41	4	2	NA	5	R	T	L	-	-	-	#
22341	Netherstowe, Lichfield	54	45	69/72	47	43	54	54	47	8	3	A	1	R	T	-	-	-	-	~
22642	Burton Road, Streethay	68	63	65/68	69	64	75	68	63	0	0	S	1	R	T	H	-	-	NI	OSV22-D05

Assessment Location		Impact criteria										Significance criteria								
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		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
22669	Burton Road, Streethay	63	54	77/80	65	60	67	65	60	0	0	A	2	R	T	H	-	-	-	
22736	Burton Road, Streethay	58	51	67/70	62	54	67	61	53	0	-1	A	1	R	T	-	-	-	-	
22797	Burton Road, Streethay	60	52	66/69	65	60	67	64	59	0	0	A	2	R	T	H	-	-	-	
22853	Burton Road, Streethay	51	43	62/65	70	57	75	70	57	0	0	A	3	R	T	H	-	-	-	
22879	Burton Road, Streethay	54	46	59/62	70	57	75	70	57	0	0	A	3	R	T	H	-	-	-	
22924	Holland Close, Lichfield	42	33	55/58	70	57	75	70	57	0	0	NA	7	R	T	H	-	-	-	
22961	Holland Close, Lichfield	42	34	57/60	55	49	64	55	49	0	0	NA	5	R	T	-	-	-	-	
22989	Holland Close, Lichfield	42	34	57/60	55	49	64	55	49	0	0	NA	3	R	T	-	-	-	-	
22993	Meadow Croft, Lichfield	41	33	57/60	55	49	64	55	49	0	0	NA	5	R	T	-	-	-	-	
23033	Meadow Croft, Lichfield	41	33	54/57	54	49	67	54	49	0	0	NA	6	R	T	-	-	-	-	
23072	Dyott Close, Lichfield	39	31	52/55	54	49	67	55	49	0	0	NA	8	R	T	-	-	-	-	
23097	Burton Old Road, Streethay	43	36	52/55	55	49	64	54	49	0	0	NA	13	R	T	-	-	-	-	

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		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
23147	Burton Old Road, Streethay	38	30	53/55	54	48	54	54	48	0	0	NA	6	R	T	-	-	-	-	
23175	Burton Old Road, Streethay	39	30	53/55	56	50	58	56	50	0	0	NA	7	R	T	-	-	-	-	
23242	Ash Tree Lane, Lichfield	48	40	61/64	63	58	68	63	58	0	0	A	7	R	T	H	-	-	-	
23264	Burton Road, Streethay	54	47	63/65	66	53	74	66	53	0	0	A	2	R	T	H	-	-	-	
23337	Ash Tree Lane, Lichfield	48	40	60/63	55	49	64	54	49	0	0	NA	11	R	T	-	-	-	-	
23625	Rykneld Street, Streethay	57	49	68/71	57	53	61	57	53	0	0	A	1	R	T	-	-	-	-	
24762	Dyott Close, Lichfield	49	41	57/60	67	54	75	67	54	0	0	A	4	R	T	H	-	-	-	
24839	Burton Old Road, Streethay	38	29	52/55	54	48	54	54	48	0	0	NA	10	R	T	-	-	-	-	
24857	Wood End Lane, Fradley	49	40	63/66	76	70	84	76	70	0	0	A	1	R	T	H	-	-	-	
25097	Shaw Lane, Bromley Hayes	41	32	54/-	47	34	44	47	32	0	-2	NA	1	R	T	-	-	-	-	

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		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
28123	Lichfield Road, Whittington	55	46	76/79	56	52	70	58	53	3	1	A	2	R	T	-	-	-	-	OSV22-C01
28146	Lichfield Road, Whittington	46	36	65/68	48	45	53	50	45	2	1	NA	5	R	T	-	-	-	-	
29081	Common Lane, DMS Whittington	38	28	57/60	59	54	68	59	54	0	0	NA	5	R	T	-	-	-	-	
29572	DMS Whittington, Whittington	44	34	63/66	49	38	62	50	40	1	1	NA	1	R	T	-	-	-	-	
29888	Sandy Lane, Lichfield	52	43	71/74	44	39	45	53	44	9	5	A	3	R	T	-	-	-	-	~
29922	Sandy Lane, Lichfield	42	33	58/61	44	39	45	46	40	2	1	NA	1	R	T	-	-	-	-	#
29989	Heath Avenue, DMS Whittington	47	38	63/66	44	39	45	48	41	4	2	NA	4	R	T	-	-	-	-	#
30010	Heath Avenue, DMS Whittington	48	39	64/67	44	39	45	48	41	5	2	NA	8	R	T	-	-	-	-	#
30052	Heath Avenue, DMS Whittington	45	35	63/66	44	39	45	47	40	4	2	NA	10	R	T	-	-	-	-	#

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		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
30168	Worcester Road, DMS Whittington	41	32	57/60	63	58	78	63	58	0	0	NA	18	R	T	H	-	-	-	
30246	Chester Road, DMS Whittington	39	30	55/58	51	40	56	51	41	0	0	NA	51	R	T	-	-	-	-	
30522	Nottingham Road, DMS Whittington	39	29	54/57	51	40	56	51	41	0	0	NA	70	R	T	-	-	-	-	
30592	Lichfield Road, Whittington	47	38	63/67	53	49	67	54	49	1	0	NA	2	R	T	-	-	-	-	
30600	Lichfield Road, Whittington	44	35	60/63	53	49	67	53	49	1	0	NA	1	R	T	-	-	-	-	
30770	Darnford Lane, Lichfield	44	34	60/62	48	45	53	49	45	1	0	NA	8	R	T	-	-	-	-	
30808	Darnford Lane, Lichfield	49	39	65/67	45	42	53	50	44	5	2	NA	1	R	T	-	-	-	-	#
31091	Back Lane, Whittington	38	29	53/56	57	52	69	57	52	0	0	NA	12	R	T	-	-	-	-	
31340	Back Lane, Whittington	38	29	54/57	54	49	69	54	49	0	0	NA	7	R	T	-	-	-	-	
31347	Broad Lane, Whittington	43	35	58/61	48	44	46	48	44	0	0	NA	1	R	T	-	-	-	-	

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		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
31367	Huddlesford, Lichfield	47	39	63/66	53	47	52	54	47	1	0	NA	3	R	T	-	-	-	-	
31466	Huddlesford, Lichfield	46	38	66/69	49	47	54	51	48	2	0	NA	2	R	T	-	-	-	-	
31472	Huddlesford, Lichfield	45	37	62/65	53	48	51	54	48	0	0	NA	4	R	T	-	-	-	-	
33376	Darnford Lane, Lichfield	50	41	68/70	45	42	53	51	44	6	3	A	1	R	T	-	-	-	-	OSV22-C01
34767	Brookhay Lane, Lichfield	44	36	58/61	54	50	61	54	50	0	0	NA	3	R	T	-	-	-	-	
700649	Mill Farm Moorings	59	50	73/75	57	52	68	61	54	4	2	A	-	R M	T	-	-	-	-	~
700650	Fradley Junction, Alrewas	56	46	72/75	40	36	45	56	46	16	10	A	1	R	T	L	-	-	-	~
700651	Fradley Junction, Alrewas	48	38	62/65	40	36	45	48	40	8	4	NA	10	R	T	L	-	-	-	#
700652	Lichfield Road, Armitage	52	43	69/-	58	51	56	59	52	1	1	A	4	R	T	-	-	-	-	
701090	Streethay Moorings	59	51	77/80	62	54	67	63	54	1	1	A	-	R M	T	-	-	-	-	

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ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
701091	King's Bromley Wharf Marina	45	35	59/-	57	45	64	57	45	0	0	NA	-	R M	T	-	-	-	-	
701099	Millcroft Way, Handsacre	36	27	58/-	55	40	64	55	40	0	0	NA	101	R	T	-	-	-	-	
701100	Linford Close, Rugeley	36	27	54/-	56	45	59	56	45	0	0	NA	139	R	T	-	-	-	-	
701101	Lichfield Road, Armitage	38	29	62/65	51	48	54	51	48	0	0	NA	52	R	T	-	-	-	-	
701102	Station Drive, Rugeley	26	17	55/58	60	45	64	60	45	0	0	NA	31	R	T	-	-	-	-	
903015	Elverceter, Streethay	56	46	75/77	65	60	67	65	60	0	0	A	1	R	T	-	-	-	-	
903016	Streethay Village, Eastern Perimieter	46	37	65/68	65	60	67	65	60	0	0	NA	-	C D	T	-	-	-	-	
903017	Streethay Village, North-Eastern Perimieter	44	35	64/67	65	60	67	65	60	0	0	NA	-	C D	T	-	-	-	-	
746	Tuppenhurst Lane, Rugeley (Cattery)	52	41	64/-	50	34	51	52	41	2	7	B	1	G5	T	-	-	-	-	$
6574	Hayes Meadow Primary School, Spode Avenue, Handsacre, (School)	50	42	66/-	51	46	53	54	48	2	1	B	1	G5	T	-	-	-	-	

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
7913	Tuppenhurst Lane, Rugeley, (Shopping)	46	39	62/-	57	44	60	57	45	0	1	B	1	G5	T	-	-	-	-	
10433	Club House,, Millfield (club)	42	33	62/64	51	47	55	51	47	0	0	B	1	G 4	T	-	-	-	-	$
10745	Titan Way, Britannia Enterprise Park, (General Commercial)	40	31	55/58	58	49	52	58	49	0	0	B	5	G5	T	-	-	-	-	
10745	Europa Way, Britannia Enterprise Park, (General Commercial)	40	31	55/58	58	49	52	58	49	0	0	B	3	G5	T	-	-	-	-	
10745	Europa House, Europa Way, Britannia Enterprise Park, (General Commercial)	40	31	55/58	58	49	52	58	49	0	0	B	2	G5	T	-	-	-	-	
13325	Britannia House, Britannia Way, Britannia Enterprise Park, (Office)	37	28	54/57	55	46	46	55	46	0	0	B	2	G5	T	-	-	-	-	
13325	Europa Way, Britannia Enterprise Park, (General Commercial)	37	28	54/57	55	46	46	55	46	0	0	B	13	G5	T	-	-	-	-	

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
13325	Prospect Drive, Britannia Enterprise Park, (General Commercial)	37	28	54/57	55	46	46	55	46	0	0	B	6	G5	T	-	-	-	-	
13325	Titan Way, Britannia Enterprise Park, (General Commercial)	37	28	54/57	55	46	46	55	46	0	0	B	5	G5	T	-	-	-	-	
18213	Nanscawen Road, Fradley, (General Commercial)	59	50	74/77	45	41	49	59	50	14	8	B	1	G5	T	-	-	-	-	^
18281	Common Lane, Fradley, (Office)	43	33	57/60	58	52	69	58	52	0	0	B	1	G5	T	-	-	-	-	
18281	Blenheim Way, Fradley Park, (General Commercial)	43	33	57/60	58	52	69	58	52	0	0	B	1	G5	T	-	-	-	-	
18281	Lancaster Road, Fradley Park, (General Commercial)	43	33	57/60	58	52	69	58	52	0	0	B	1	G5	T	-	-	-	-	
18665	Fradley Business Centre, Wood End Lane, Fradley, (Office)	62	52	80/82	42	41	53	62	53	20	12	B	11	G5	T	L	-	-	-	^

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
19720	Elmhurst Spring, Lichfield Road, Hanch, (General Commercial)	43	34	58/61	59	42	61	59	42	0	1	B	1	G5	T	-	-	-	-	
20527	Kings Bromley Wharf, , Bromley Hayes, (General Commercial)	49	39	63/65	54	48	70	55	48	1	1	B	2	G5	T	-	-	-	-	
20527	Bromley Wharf, , Bromley Hayes, (Shopping)	49	39	63/65	54	48	70	55	48	1	1	B	3	G5	T	-	-	-	-	
21095	Wood End Farm, Wood End Lane, Curborough, (General Commercial)	55	46	70/72	63	56	78	60	53	-3	-3	B	1	G5	T	-	-	-	-	
21136	Woods Farm, Wood End Lane, Curborough, (General Commercial)	57	48	74/76	47	43	59	57	48	10	6	B	1	G5	T	-	-	-	-	^
21312	Burton Road, Streethay, (General Commercial)	37	29	53/56	51	45	54	51	45	0	0	B	1	G5	T	-	-	-	-	
21694	Streethay Service Station, Burton Road,	39	31	54/57	51	46	61	52	46	0	0	B	1	G5	T	-	-	-	-	

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
	Streethay, (General Commercial)																			
22232	Curborough House Farm, Netherstowe, (General Commercial)	48	38	63/66	44	40	47	49	42	4	2	B	1	G5	T		-	-	-	$
22478	Wood End Lane, Fradley, (Office)	66	56	83/86	49	33	54	66	56	17	23	B	2	G5	T	-	-	-	-	^
22736	Burton Road, Streethay, (Office)	58	51	67/70	62	54	67	61	53	0	-1	B	1	G5	T	-	-	-	-	
23518	Lancaster House, Wellington Crescent, Fradley Park, (General Commercial)	52	43	67/70	51	47	55	54	48	3	1	B	2	G5	T	-	-	-	-	$
23518	Wellington Crescent, Fradley Park, (Office)	52	43	67/70	51	47	55	54	48	3	1	B	3	G5	T	-	-	-	-	$
23518	Trent House, Wellington Crescent, Fradley Park, (General Commercial)	52	43	67/70	51	47	55	54	48	3	1	B	1	G5	T	-	-	-	-	$

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
23518	Brickyard Farm, Rykneld Street, Streethay, (Office)	52	43	67/70	51	47	55	54	48	3	1	B	1	G5	T	-	-	-	-	$
23518	Lincoln House, Wellington Crescent, Fradley Park, (General Commercial)	52	43	67/70	51	47	55	54	48	3	1	B	1	G5	T	-	-	-	-	$
23518	Wood End Lane, Fradley, (General Commercial)	52	43	67/70	51	47	55	54	48	3	1	B	1	G5	T	-	-	-	-	$
23518	Tame House, Wellington Crescent, Fradley Park, (General Commercial)	52	43	67/70	51	47	55	54	48	3	1	B	5	G5	T	-	-	-	-	$
23518	Bridgford Building, Wellington Crescent, Fradley Park, (General Commercial)	52	43	67/70	51	47	55	54	48	3	1	B	1	G5	T	-	-	-	-	$
23625	Orchard Farm, Rykneld Street, Streethay, (General Commercial)	57	49	68/71	57	53	61	57	53	0	0	B	1	G5	T	-	-	-	-	

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
24230	Fradley Distribution Park, Wood End Lane, Fradley, (General Commercial)	52	42	68/71	45	44	51	52	46	8	2	B	1	G5	T	-	-	-	-	$
24230	Halifax Avenue, Fradley Park, (General Commercial)	52	42	68/71	45	44	51	52	46	8	2	B	1	G5	T	-	-	-	-	$
24857	Fradley Distribution Park, Wood End Lane, Fradley, (General Commercial)	49	40	63/66	76	70	84	76	70	0	0	B	1	G5	T	H	-	-	-	
29490	Staffordshire Regiment Museum, DMS Whittington, Lichfield, (Museum)	45	36	60/62	69	64	78	69	64	0	0	B	1	G3	T	H	-	-	-	
29975	DMS Whittington, , Lichfield, (General Commercial)	45	36	60/63	48	37	56	49	39	2	2	B	1	G5	T	-	-	-	-	
29975	The Mercian Regiment, DMS Whittington, Lichfield, (Office)	45	36	60/63	48	37	56	49	39	2	2	B	1	G5	T	-	-	-	-	

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
29975	DMS Whittington (Central Government Office)	45	36	60/63	48	37	56	49	39	2	2	B	1	G5	T	-	-	-	-	
31367	Plough Cottages, , Huddlesford, (General Commercial)	47	39	63/66	53	47	52	54	47	1	0	B	1	G5	T	-	-	-	-	
31367	Plough Inn, Huddlesford Lane, Huddlesford, (Inn)	47	39	63/66	53	47	52	54	47	1	0	B	1	G5	T	-	-	-	-	
31466	Huddlesford House Farm, Huddlesford (General Commercial)	46	38	66/69	49	47	54	51	48	2	0	B	1	G5	T	-	-	-	-	
31505	Canal Side Cottages, Huddlesford Lane, Huddlesford, (Club)	48	40	65/68	51	48	61	52	48	2	0	B	1	G5	T	-	-	-	-	
34767	Bearshay Farm, Brookhay Lane, Lichfield, (General Commercial)	44	36	58/61	54	50	61	54	50	0	0	B	1	G5	T	-	-	-	-	

Assessment Location		Impact criteria										Significance criteria								
ID	Area represented	AP2 revised scheme only (Year 15 traffic)			Do nothing (Opening year baseline)			Do something (Opening year baseline + Year 15 traffic) ****		Change		Type of effect	Number of impacts represented	Type of receptor	Receptor design	Existing environment	Unique feature	Combined impact	Mitigation of effect	Significant effect
		Day *	Night **	Max ***	Day *	Night **	Max ***	Day *	Night **	Day *	Night **									
700647	Whittington Pre School, Heath Avenue, DMS Whittington, (School)	45	36	60/63	51	40	56	52	41	1	1	B	1	G 4	T	-	-	-	-	
700648	Church Street, Whittington, (Parish Hall)	38	29	53/57	57	52	69	57	52	0	0	B	1	G3	T	-	-	-	-	
700651	Fradley Junction, Alrewas, (General Commercial)	48	38	62/65	40	36	45	48	40	8	4	B	1	G5	T	L	-	-	-	$
701101	The Green, Handsacre, (General Commercial)	38	29	62/65	51	48	54	51	48	0	0	B	1	G5	T	-	-	-	-	

Direct impact - Summary

4.3.7 The operational airborne noise impacts identified in Table 3 are summarised in Table 4.

Table 4 - Summary of operational airborne sound impacts

Receptor	Number of impacts		
	Minor	**Moderate**	**Major**
Residential properties	13	31	2
Non-residential properties	0	0	15
Quiet areas	None	None	None

4.4 Assessment of impacts and effects

Residential receptors: direct effects - individual buildings

4.4.1 Taking account of the avoidance and mitigation measures, as presented in SES and AP2 ES Volume 22: Report 23, incorporated into the AP2 revised scheme, the assessment has identified a number of residential buildings close to the AP2 revised scheme where the daytime forecast noise level does not exceed the threshold level set in the Noise Insulation (Railways and other guided systems) Regulations[2] but the forecast night-time noise level would exceed the World Health Organisation's Interim Target of 55dB, or the maximum noise level (dependent on the number of train passes) as a train passes exceeds the criterion. It is estimated that these buildings will be offered noise insulation as described previously in SES and AP2 ES, CFA22, Volume2, Section 14, Avoidance and mitigation measures. These buildings are indicated on Volume 5: Map Book - Sound, noise and vibration, Map series SV-02:

- Mill Farm, Lichfield, receptor reference 17785 (marked as OSV22-D01 in Table 3); and
- Streethay Wharf, Streethay , receptor reference 22642 (marked as OSV22-D05 in Table 3).

Residential receptors: direct effects –communities

4.4.2 The avoidance and mitigation measures in this area will avoid significant airborne noise effects on the majority of receptors, and at the following communities:

- Whittington (except as noted in Table 5);
- Streethay;
- Lichfield; and
- Handsacre (except as noted in Table 5).

[2] Statutory Instrument 1996 No. 428. The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996. HMSO.

4.4.3 Taking account of the envisaged mitigation, Map Series SV-02 (SES and AP2 ES Volume 5 Map book) shows the long term 40dB[3] night-time sound level contour from the operation of trains on the AP2 revised scheme. The extent of the 40dB night-time sound level contour is equivalent to, or slightly larger than, the 50dB daytime contour[4]. In general, below these levels adverse effects are not expected.

4.4.4 Above 40dB during the night and 50dB during the day the effect of noise is dependent on the baseline sound levels in that area and the change in sound level (magnitude of effect) brought about by the AP2 revised scheme. The airborne noise impacts and effects forecast for the operation of the scheme are presented on Map Series SV-02 (SES and AP2 ES Volume 5 Map Book).

4.4.5 The changes in noise levels are likely to affect the acoustic character of the area such that there is a perceived change in the quality of life and are considered to be significant when assessed on a community basis taking account of the local context.

4.4.6 Minor ground-borne vibration impacts are also identified at approximately 25 residential properties on Rowan Drive, Handsacre. The residential properties are located within close proximity to an existing railway, which includes the operation of freight services that are a source of appreciable vibration. Considering the number and magnitude of the impacts and the existing appreciable ambient vibration these ground-borne vibration impacts are not considered a significant effect.

4.4.7 Approximately 30 isolated properties within the area have been identified as being subject to an observed adverse noise effect; these effects are likely to be considered as an effect on the acoustic character of the area such that there is a perceived change in the quality of life. However, as the affected properties are spatially remote from larger defined residential areas, are subject to smaller magnitudes of noise effect, or are small in number, the effects are not considered to be significant.

4.4.8 The direct adverse effects[5] on the areas of the residential communities identified in Table 5 are considered to be significant.

Table 5 - Direct adverse effects on residential communities and shared open areas that are considered significant on a community basis

Significant effect number (see Map series SV-02, Table 1 and 3)	Source of significant effect	Time of day	Location and details
OSV22-C01	Airborne noise increase from new train services	Daytime and night-time	Around 10 dwellings in the north of Wittington in the vicinity of Darnford Lane, Marsh Lane and Lichfield Road. Forecast increases in sound from the railway are likely to cause a major adverse effect on the acoustic character of the area around the closest properties. The effect on the acoustic character of residential areas reduces on those that are located further from the railway would be a minor effect. There is shared

[3] Defined as the equivalent continuous sound level from 23:00 to 07:00 or $L_{pAeq,night}$)
[4] With the train flows described in the assumptions section of this CFA Report, the daytime sound level (defined as the equivalent continuous sound level from 07:00 to 23:00 or $L_{pAeq,day}$) from the AP2 revised scheme would be approximately 10dB higher than the night-time sound level. The 40dB contour therefore indicates the distance from the AP2 revised scheme at which the daytime sound level would be 50dB.
[5] Information is provided in the National Planning Practice Guidance – Noise http://planningguidance.planningportal.gov.uk, e.g. the table summarising the noise exposure hierarchy

Significant effect number (see Map series SV-02, Table 1 and 3)	Source of significant effect	Time of day	Location and details
			open space adjacent to these dwellings that would also be adversely affected in this community area.
OSV22-C02	Airborne noise increase from new train services (Phase One operation only)	Daytime and night-time	Approaching 60 dwellings on the south of Handacre, closest to the WCML and the tie in to AP2 revised scheme in the vicinity of Chestnut Close, Rowan Drive, Warren Croft, Barn Road and Lichfield Road. Forecast increases in sound from the railway are likely to cause a major adverse effect on the acoustic character of the area around the closest properties. The effect on the acoustic character of residential areas that are located further from the railway would be a moderate effect. There is shared open space located just off Chestnut Close that would also be adversely affected in this community area.

Residential receptors: indirect effects

4.4.9 The transport assessment presented in SES and AP2 ES Volume 5: Appendix TR-001-000, has been used to identify those roads or railways within this study area where the alignment remains as at present, but a change in flow or composition is identified which is greater than the screening criteria defined in main ES Volume 5: Appendix SV-001-000. No roads or railways which exceed the criteria defined in main ES Volume 5: Appendix SV-001-000 have been identified in this study area.

4.4.10 The assessment of operational noise and vibration indicates that significant indirect effects on residential receptors are unlikely to occur in this area.

Non-residential receptors: direct effects

4.4.11 The assessment has identified airborne noise impacts at commercial premises on Nanscawen Road, Fradley Business Centre, Wood Farm and premises on Wood End Lane, represented by receptor references 18213, 18665, 21136 and 22478.

Nanscawen Road

4.4.12 A major operational noise impact has been identified based upon the change in the airborne noise level outside this receptor, reference 18213. An assessment has been undertaken to determine if this impact would result in a likely significant effect at this non-residential receptor, using the significance criteria detailed in main ES Volume 5: Appendix 001-000.

4.4.13 The receptor is currently occupied by Kyocera Unimerco Tooling Limited and consists of a two/three storey purpose built office building constructed from brick walls and double glazed windows. Ventilation is believed to be provided by air conditioning.

4.4.14 The sound insulation that would be provided by this building shell and ventilation arrangement is likely to be substantially greater than the assumption of open windows that forms the basis of the relevant screening criterion defined for this category of building in main ES Volume 5: Appendix SV-001-000. The incident sound levels forecast in Table 3 outside this receptor are therefore unlikely to give rise to a significant observed adverse effect inside this receptor.

Fradley Business Centre

4.4.15 A major operational noise impact has been identified based upon the change in the airborne noise level outside this receptor, reference 18665. An assessment has been undertaken to determine if this impact would result in a likely significant effect at this non-residential receptor, using the significance criteria detailed in main ES Volume 5: Appendix 001-000.

4.4.16 The receptor is currently occupied by Morganrose Electrifire Ltd and is believed to consist of a warehouse/distribution building which is closest to the AP2 revised scheme and a two storey purpose built office building constructed from brick walls and double glazed windows. Ventilation is believed to be provided by opening the windows. The office building is screened from the AP2 revised scheme by the warehouse building.

4.4.17 Considering the orientation of the sensitive areas of the building, the incident sound levels within the office are not likely to result in activity disturbance and therefore, the forecast impact outside this non-residential receptor is unlikely to result in a significant noise effect inside this receptor.

Woods Farm

4.4.18 A major impact has been identified based upon the change in the airborne noise level outside this receptor, reference 21136. An assessment has been undertaken to determine if this impact would result in a likely significant adverse noise effect at this non-residential receptor, using the significance criteria detailed in main ES Volume 5: Appendix 001-000.

4.4.19 The residential area of the farm has been considered within the residential assessment. The commercial area of this receptor is made up of farm/industrial buildings whose operation is not considered to be noise sensitive, and therefore the non-residential part of Woods Farm is not identified as being subject to a significant adverse noise effect.

Wood End Lane

4.4.20 A major operational noise impact has been identified based upon the change in the airborne noise level outside this receptor, reference 22478. An assessment has been undertaken to determine if this impact would result in a likely significant effect at this non-residential receptor, using the significance criteria detailed in Volume 5: Appendix 001-000.

4.4.21 The receptor is currently occupied by Beacon Metals Limited and consists of warehouse/distribution buildings previously part of Fradley Aerodrome. No glazing has been identified in the facades facing the AP2 revised scheme. It is assumed that ventilation is provided by opening the doors. The type of activities undertaken within these premises are not noise sensitive and therefore the incident sound levels from the AP2 revised scheme within the building are not likely to result in activity disturbance and therefore, the impact at this non-residential receptor will not result in a significant adverse noise effect inside this receptor.

Summary

4.4.22 The assessment of operational noise and vibration indicates that no significant effects are likely on non-residential receptors. The assessment of effects on non-residential receptors has been undertaken on a worst case basis.

Non-residential receptors: indirect effects

4.4.23 The transport assessment presented in SES and AP2 ES Volume 5: Appendix TR-001-000, has been used to identify those roads or railways within this study area where the alignment remains as at present, but a change in flow or composition is identified which is greater than the screening criteria defined in main ES Volume 5: Appendix SV-001-000. No roads or railways which exceed the criteria defined in main ES Volume 5: Appendix SV-001-000 have been identified in this study area.

4.4.24 The assessment of operational noise and vibration indicates that significant indirect effects are unlikely to occur on non-residential receptors in this area.

Cumulative effects

4.4.25 Details of properties being currently developed which were afforded planning approval before the safeguarding date are presented in main ES and/or AP2 ES Volume 5: Appendix CT004-000. Within this area, the operational sound, noise or vibration associated with these developments in conjunction with the operation of the AP2 revised scheme do not result in any significant cumulative effects.

4.5 Summary of Changes from main ES/AP1 ES

Groundborne noise and vibration

4.5.1 There is no change in the residual significant effects identified in the main ES and/or AP1 ES.

Airborne sound

4.5.2 There is no change in the residual significant effects identified in the main ES and/or AP1 ES.

Environmental topic:	Water resources and flood risk assessment	WR
Appendix name:	Water resources assessment	002
Community forum area:	Whittington to Handsacre	022

Contents

1 Introduction 1
1.1 Structure of the water resources and flood risk assessment appendices 1
1.2 Study area 1
2 Stakeholder engagement 2
3 Baseline data 3
3.1 General 3
3.2 Surface water features 3
3.3 Groundwater 21
3.4 Groundwater/surface water interaction 25
3.5 Water dependent habitats 30
4 Site specific assessments 34
4.1 Surface water 34
4.2 Groundwater 58
5 References 83

List of tables

Table 1 - Surface water features within 1km of the route the Whittington to Handsacre study area 4
Table 2 - Licensed surface water abstractions 18
Table 3 - Permitted discharges to surface water 19
Table 4 - Licensed groundwater abstractions 22
Table 5 - Groundwater discharge environmental permits 23
Table 6 - Groundwater/surface water interaction 25
Table 7 - Description of water dependent habitats 30
Table 8 - Summary of potential impacts to surface water 35
Table 9 - Aquifer properties 58
Table 10 - Maximum extent of zone of influence in the Whittington to Handsacre study area 59
Table 11 - Summary of potential impacts to groundwater, abstractions, water dependent habitats and groundwater/ surface water interactions 60

1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

1.1.1 The water resources and flood risk assessment appendices comprise four parts. The first of these is a route-wide appendix (Appendix WR-001-000).

1.1.2 Three specific appendices for each community forum area (CFA) are also provided. For the Whittington to Handsacre area these are:

- a Water Resources Assessment (i.e. this appendix);
- a Flood Risk Assessment (Appendix WR-003-022); and
- a River Modelling Report (Appendix WR-004-015).

1.1.3 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the SES and AP2 ES Volume 5: Map Book - Water resources, Maps WR-01 to WR-06 and the SES and AP2 ES Volume 5: Map Book - Ecology, Maps EC-01 to EC-04.

1.2 Study area

1.2.1 The study area is located between Whittington Heath and Armitage within the county of Staffordshire. It is predominantly rural and overlies both superficial and bedrock aquifers. Topography ranges from approximately 65 to 100m above Ordnance Datum (AOD)

1.2.2 The spatial scope of the assessment was based upon the identification of surface water and groundwater features within 1km of the centre line of the route, except where there is clearly no hydraulic connectivity, as outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the AP2 revised scheme. Where works extend more than 200m from the centre line, for example at stations and depots, a professional judgement was made in selecting the appropriate limit to the extension in spatial scope required.

1.2.3 Due to the number of ponds and other water features present within the study area, only those either within the land required for the construction or operation of the AP2 revised scheme, or within the calculated zone of influence, and therefore potentially affected by the AP2 revised scheme have been listed in the baseline.

2 Stakeholder engagement

2.1.1 Discussion with the following stakeholders has been undertaken to inform the water resources assessment.

- the Environment Agency on 31 September 2012 to discuss multiple aspects of the AP2 revised scheme;
- the Environment Agency and Staffordshire Lead Local Flood Authority (LLFA) on 21 December 2012; and
- the Environment Agency on 4 June 2013.

3 Baseline data

3.1 General

3.1.1 The following section provides a current description of water resources including surface water and groundwater.

3.2 Surface water features

3.2.1 All surface water features within 1 km of the AP2 revised scheme are presented in Table 1.

3.2.2 The current surface water baseline is shown in SES and AP2 ES Volume 5: Map Book - Water resources, Maps WR-01-037 and WR-01-038. Where a water feature in Table 1 has been given a map reference it appears on one of these maps.

Table 1 - Surface water features within 1km of the route the Whittington to Handsacre study area

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Tributary to Brook Leasow	At Packington Hall Farm, 690m east of the route. Map WR-01-037 (H5)	Ordinary watercourse	River Tame from River Anker to River Trent (GB104028047050) Poor Status	Good Status	Moderate	-	River Tame		Will not be crossed by the route.
Drain feeder to Fisherwick Brook	At Mill Farm, will be crossed by the route. (SWC-CFA22-001) Map WR-01-037 (E5)	Ordinary watercourse	East Litchfield catchment - tributary of Tame (GB104028047020) Moderate Status	Good Status	Moderate	0.862m³/s	River Tame	14.78 km²	
Tributary to Fisherwick Brook	At Mill Farm, 65m west of the route. Map WR-01-037 (F6)	Ordinary watercourse	East Litchfield catchment - tributary of Tame (GB104028047020) Moderate Status	Good Status	Moderate	-	River Tame		Will not be crossed by the route.
Wyrley and Essington	At Canal Cottage Capper's Lane, will be crossed by the route.	Ordinary watercourse	East Litchfield catchment - tributary of Tame (GB104028047020)	Good Status	Moderate	0.862m³/s	River Tame	14.78km²	

[1] Only ponds within the land required for the permanent AP2 revised scheme are listed in this table.
[2] Map references taken from Volume 5: Map Book - Water resources, Maps WR-01-037 and WR-01-038.
[3] Environment Agency water-feature classification: The Land Drainage Act 1991 defines an Ordinary watercourse as 'A watercourse that is not part of a main river, all rivers and streams, ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers) and passages through which water flows'. 'Main Rivers' are larger rivers and streams designated by DEFRA, main rivers are regulated by the Environment Agency.
[4] Year may vary in different RBMPs.
[5] Environment Agency (2009), *River Basin Management Plan: Humber River Basin District,*
[6] For examples of receptor value see Table 43 in the SMR addendum Volume 5 Appendix CT-001-000/2.
[7] Q95 flow values only provided for water features that will be crossed by the route.

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Canal (under restoration)	(SWC-CFA22-002) Map WR-01-037 (E5)		Moderate Status						
Coventry Canal	At Huddlesford Junction - Huddlesford, 35m east of the route. Map WR-01-037 (E5)	Ordinary watercourse	Coventry and Ashby Canals (GB70910212) Good Potential	Good Potential (by 2015)	High	-	Coventry and Ashby Canal		Will not be crossed by the route.
Tributary of Fisherwick Brook	At Bowmans Bridge - Huddlesford, 330m east of the route. Map WR-01-037 (E5)	Ordinary watercourse	East Litchfield catchment - tributary of Tame (GB104028047020) Moderate Status	Good Status	Moderate	-	River Tame		Will not be crossed by the route.
Mare Brook	At Fulfen Wood, will be crossed by the route. (SWC-CFA22-003) Map WR-01-037 (E5)	Main River	East Litchfield catchment - tributary of Tame (GB104028047020) Moderate Status	Good Status	Moderate	0.002m³/s	River Tame	1.18km²	
Drain feeder to Fisherwick Brook	At Barn Cottage - Broad Lane, 950m east of the route. Map WR-01-037 (E4)	Ordinary watercourse	East Litchfield catchment - tributary of Tame (GB104028047020) Moderate Status	Good Status	Moderate	-	River Tame		Will not be crossed by the route.

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Drain feeder to Mare Brook	At Thatchmoor Farm - Brookhay, 720m east of the route. Map WR-01-037 (D4)	Ordinary watercourse	River Tame from River Anker to River Trent (GB104028047050) Poor Status	Good Status	Moderate	-	River Tame		Will not be crossed by the route.
Drain feeder to Mare Brook	At Kings Orchard Bridge, 340m east of the route. Map WR-01-037 (D5)	Ordinary watercourse	River Tame from River Anker to River Trent (GB104028047050) Poor Status	Good Status	Moderate	-	River Tame		Will not be crossed by the route.
Tributary of Mare Brook	At Rough Stockings - Streethay, will be crossed by the route. (SWC-CFA22-004) Map WR-01-037 (C6)	Ordinary watercourse	River Tame from River Anker to River Trent (GB104028047050) Poor Status	Good Status	Moderate	$0.004 m^3/s$	River Tame	$1.77 km^2$	
Pond	North of Rough Stockings, will be crossed by the route. (SWC-CFA22-005) Map WR-01-037 (C6)	Not applicable	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.	-	-		

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Drain feeder to Mare Brook	At Streethay House Farm - Streethay, 335m west of the route. Map WR-01-037 (D7)	Ordinary watercourse	River Tame from River Anker to River Trent (GB104028047050) Poor Status	Good Status	Moderate	-	River Tame		Will not be crossed by the route.
Drain feeder to Mare Brook	At East Hill - Hilliards Cross, 100m east of the route. Map WR-01-037 (C5)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.
Tributary of Mare Brook	At Nanscawan Road - Hilliard's Cross, will be crossed by the route. (SWC-CFA22-006) Map WR-01-037 (B6)	Ordinary watercourse	River Tame from River Anker to River Trent (GB104028047050) Poor Status	Good Status	Moderate	0.001m^3/s	River Trent	0.581km^2	
Tributary of Curborough Brook	At Curborough House - Curborough, 745m west of the route. Map WR-01-037 (B7)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Tributary of Mare Brook	At East Hill - west of Wood End Lane, 20m west of the route. Map WR-01-037 (B6)	Ordinary watercourse	River Tame from River Anker to River Trent (GB104028047050) Poor Status	Good Status	Moderate	-	River Trent		Will not be crossed by the route. Under construction/landscaping footprint.
Pond	Pond south of East Hill, 20m west of the route. Map WR-01-037 (B6)	Not applicable	Not assessed by the Environment Agency.	Not assessed by the Environment Agency.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.	-	-		Will not be crossed by the route. Under construction/landscaping footprint.
Tributary of Mare Brook	South of Little Lyntus Wood, will be crossed by the route. (SWC-CFA22-007) Map WR-01-037 (B6)	Ordinary watercourse	River Tame from River Anker to River Trent (GB104028047050) Poor Status	Good Status	Moderate	$0.001 m^3/s$	River Trent	$0.581 km^2$	
Drain Feeder 1 to Trent and Mersey Canal	At Fradley Wood (Manchester Spur) (SWC-CFA22-008) Map WR-01-038 (G5)	Ordinary watercourse	Trent and Mersey Canal, summit to Alrewas (GB70410142) – Good Potential	Good Potential	Low				

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Drain Feeder 2 to Trent and Mersey Canal	At Fradley Wood (Manchester Spur) (SWC-CFA22-009) Map WR-01-038 (G5)	Ordinary watercourse	Trent and Mersey Canal, summit to Alrewas (GB70410142) – Good Potential	Good Potential	Low				
Drain feeder 3 to Trent and Mersey Canal	At Fradley Wood (Manchester Spur) (SWC-CFA22-010) Map WR-01-038 (G5)	Ordinary watercourse	Trent and Mersey Canal, summit to Alrewas (GB70410142) – Good Potential	Good Potential	Low				
Tributary of Curborough Brook	At Curborough Farm, 935m west of the route. Map WR-01-038 (H7)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.
Drain feeder to Curborough Brook	North east of Curborough Farm, 690m east of the route. Map WR-01-038 (H7)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.
Trent and Mersey Canal	At Brokendown Wood (Manchester Spur) (SWC-CFA22-011) Map WR-01-038 (G5)	Ordinary watercourse	Trent and Mersey Canal, summit to Alrewas (GB70410142) Good Potential	Good Potential (by 2015)	Moderate	-	Trent and Mersey Canal		

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Pond	North of Big Lyntus Wood, will be crossed by the route. (SWC-CFA22-012) Map WR-01-038 (G5)	Not applicable	Not assessed by the Environment Agency.	Not assessed by the Environment Agency.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.	-	-	-	
Full Brook - Tributary of Curborough Brook	At Full Brook and Wood End Farm, 430m west of the route. Map WR-01-038 (G6)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.
Drain feeder to Curborough Brook	At Big Lyntus - Car Sprint Course, 370m west of the route. Map WR-01-038 (G6)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.
Tributary of Curborough Brook	At Wood End Lock Cottage, 130m west of the route. Map WR-01-038 (G5)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Curborough Brook	At Wood End Farm, will be crossed by the route. (SWC-CFA22-013) Map WR-01-038 (G6)	Main River	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	High	$0.04m^3/s$	River Trent	$17.04km^2$	
Drain feeder to Curborough Brook	At Wood End Lock Cottage, 135m west of the route. Map WR-01-038 (G6)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.
Drain	At Ravenshaw Cottage, 85m east of the route. Map WR-01-038 (F6)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.
Drain	At Ravenshaw Wood, will be crossed by the route (SWC-CFA22-14) Map WR-01-038 (F6)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		
Tributary of Ashby Sitch (feeder of Bourne Brook)	At Rice's Spinney, 330m east of the route. Map WR-01-038 (E6)	Ordinary watercourse	Pyford Brook Catchment - tributary of Trent (GB104028047250) Moderate Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Drain	At Wharf Farm Barn, 120m east of the route. Map WR-01-038 (E6)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good Status	Good Status (by 2015)	Moderate	-	River Trent		Will not be crossed by the route.
Drain	At Slaish - Ravenshaw Cottage, 220m east of the route. Map WR-01-038 (E6)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good Status	Good Status (by 2015)	Moderate	-	River Trent		Will not be crossed by the route.
Drain	At Black Slough, 200m west of the route Map WR-01-038 (F7)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good Status	Good Status (by 2015)	Moderate	-	River Trent		Will not be crossed by the route. Assumed to be drainage from outfall / balancing pond.
Tributary of Bourne Brook	At Shaw Lane - Kings Bromley Wharf, 610m east of the route. Map WR-01-038 (E6)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good status	Good Status (by 2015)	Moderate	-	River Trent		Will not be crossed by the route.

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Bourne Brook	At John's Gorse, will be crossed by the route. (SWC-CFA22-015) Map WR-01-038 (E7)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good Status	Good Status (by 2015)	High	$0.081m^3/s$	River Trent	$28.57km^2$	
Tributary of Bourne Brook	At John's Gorse, 20m east of the route. Map WR-01-038 (E7)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good Status	Good Status (by 2015)	Moderate	-	River Trent		Will not be crossed by the route.
Tributary of Bourne Brook	At Hanchwood House, 210m east of the route. Map WR-01-038 (E7)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good Status	Good Status (by 2015)	Moderate	-	River Trent		Will not be crossed by the route.
Ben Brook - Tributary of Bilson Brook	At Lysways Lane, 990m west of the route. Map WR-01-038 (E9)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good Status	Good Status (by 2015)	Moderate	-	River Trent		Will not be crossed by the route.
Lake	Hanch Farm, 720m west of the route. Map WR-01-038 (E9)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good Status	Good Status (by 2015)	Moderate	-	River Trent		Will not be crossed by the route.

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Tributary of Bourne Brook	At Hanch Farm, 730m west of the route. Map WR-01-038 (E9)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good Status	Good Status (by 2015)	Moderate	-	River Trent		Will not be crossed by the route.
Drain feeder to Bourne Brook	At Hanch Reservoir, 720m west of the route. Map WR-01-038 (E9)	Ordinary watercourse	Bourne-Bilson Brook Catchment - tributary of Trent (GB104028047270) Good Status	Good Status (by 2015)	Moderate	-	River Trent		Will not be crossed by the route.
Drain	At Harvey's Rough/Shaw Lane Farm. Map WR-01-038 (D8)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Potential	Moderate		River Trent		Will not be crossed by the route.
Tributary of River Trent	At Harvey's Rough. Map WR-01-038 (D8)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Potential	Moderate	$0.001 m^3/s$	River Trent	$0.295 km^2$	Will not be crossed by the route.
Drain feeder to River Trent	At Litchfield Road (B5014), 70m west of the route. Map WR-01-038 (D8)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Tributary of River Trent	North-West of Ashton Hays, will be crossed by the route. (SWC-CFA22-016) Map WR-01-038 (C8)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Potential	Moderate	0.001m³/s	River Trent	0.574km²	
Tributary of River Trent	East of B5014 (SWC-CFA22-017) Map WR-01-038 (C8)	Ordinary watercourse			Moderate				
Tributary of River Trent	At Litchfield Road (B5014). Map WR-01-038 (C8)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Potential	Moderate	0.001m³/s	River Trent	0.574km²	Will not be crossed by the route.
Drain feeder to Trent and Mersey Canal	At Tuppenhurst Farm - Handsacre, 965m east of the route. Map WR-01-038 (C8)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.
Tributary of Shropshire Brook	At Shropshire Brook Road - Handsacre, 1000m west of the route. Map WR-01-038 (B9)	Ordinary watercourse	Longdon/Armitage Catchment - tributary of Trent (GB104028047260) Moderate Status	Good Status	Moderate	-	River Trent		Will not be crossed by the route.

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Drain feeder to Shropshire Brook	At Hood Lane Covert, 975m west of the route. Map WR-01-038 (C10)	Ordinary watercourse	Longdon/Armitage Catchment - tributary of Trent (GB104028047260) Moderate Status	Good Status	Moderate	-	River Trent		Will not be crossed by the route.
Tributary of River Trent	At White Gables, will be crossed by the route. (SWC-CFA22-018) Map WR-01-038 (C8)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Potential	Moderate	-	River Trent		
Drain feeder to River Trent	At Tuppenhurst Farm - Handsacre, 575m east of the route. Map WR-01-038 (C7)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.
Drain feeder to River Trent	At Marsh Barn Farm - Handsacre, 1000m east of the route. Map WR-01-038 (B7)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.
Tributary of River Trent	At Marsh Barn Farm - Handsacre, 1000m east of the route. Map WR-01-038 (B7)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Potential	Moderate	-	River Trent		Will not be crossed by the route.

Water feature[1]	Location description (map reference)[2]	Watercourse classification[3]	Water Framework Directive (WFD) water body name and identifier and overall status	WFD status Objective (by 2027[4] as per River Basin Management Plan (RBMP)[5] unless stated	Receptor Value[6]	Q95[7]	Catchment	Size	Notes
Shropshire Brook - Feeder of Trent and Mersey Canal	At Handsacre, 675m west of route. Map WR-01-038 (B9)	Main River	Longdon/Armitage Catchment - tributary of Trent (GB104028047260) Moderate Status	Good Status	High	-	River Trent		Will not be crossed by the route.
Tributary of the River Trent	At Pipe Place Farm, 730m north of the route. Map WR-01-038 (B8)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Status	Moderate		River Trent		Will not be crossed by the route.
Tributary of the River Trent	At Marsh Barn Farm, 736m north of the route. Map WR-01-038 (B7)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Status	Moderate		River Trent		Will not be crossed by the route.
Tributary of the River Trent	At Old Road Farm. Map WR-01-038 (B9)	Ordinary watercourse	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Status	Moderate		River Trent		Will not be crossed by the route.
River Trent	At the B5014. Map WR-01-038 (B7)	Main River	River Trent from Moreton Brook to River Tame (GB104028047290) Poor Potential	Good Status	High		River Trent		Will not be crossed by the route.

3.2.3 Table 2 summarises licensed surface water abstractions within 1km of the route. Information from Lichfield District Council indicates that there are no unlicensed abstractions from surface water used for potable supply in their records.

Table 2 - Licensed surface water abstractions

Licence identifier (map reference number[8] and Environment Agency reference)	Distance from route	Abstraction source	Maximum annual abstraction quantity	Maximum daily abstraction quantity	Purpose
03/28/22/0042 Map WR-01-037 (F6)	390m west of the route.	Mill Farm, The Darnford Brook.	17,273m^3	818m^3	Spray irrigation - direct
03/28/22/0042 Map WR-01-037 (F6)	390m west of the route.	Mill Farm, The Darnford Brook.	17,273m^3	818m^3	Spray irrigation - storage
03/28/22/0035 Map WR-01-037 (E6)	425m west of the route.	Marsh Farm - Tributary of River Tame.	15,911m^3	727m^3	Spray irrigation - storage
03/28/22/0085/1 Map WR-01-037 (E6)	435m west of the route.	Darnford Lane, Lichfield - Darnford Brook.	6,000m^3	300m^3	Supply to a canal for through flow
03/28/22/0045 Map WR-01-037 (E5)	420m east of the route.	Whittington Farms, Coventry Canal - Point A.	15,000m^3	818m^3	Spray irrigation - direct
03/28/22/0045 Map WR-01-037 (D5)	420m east of the route.	Whittington Farms, Coventry Canal - Point B.	15,000m^3	818m^3	Spray irrigation - direct
03/28/07/0089 Map WR-01-038 (G6)	75m west of the route.	Wood End Farm, Curborough - Pyford Brook.	9,000m^3	500m^3	Spray irrigation - direct
03/28/07/0068 Map WR-01-038 (G6)	30m west of the route.	Curborough Hall Farm (Below Sewage Works).	17,500m^3	540m^3	Spray irrigation - direct
03/28/07/0056 Map WR-01-038 (G5)	215m east of the route.	Alrewas Farm - Pyford Brook.	60,000m^3	1,440m^3	Spray irrigation - direct
03/28/22/0068 Map WR-01-038 (G3)	870m east of Manchester Spur	Fradeley Junction - Coventry Canal	10,230 m^3	1,000 m^3	Spray irrigation - direct

[8] Map references taken from Volume 5: Map Book - Water resources, Maps WR-01-037 and WR-01-038

Licence identifier (map reference number[8] and Environment Agency reference)	Distance from route	Abstraction source	Maximum annual abstraction quantity	Maximum daily abstraction quantity	Purpose
03/28/07/0102 Map WR-01-038 (G5)	215m east of the route.	Alrewas Farm - Pyford Brook.	40,000m^3	960m^3	Spray irrigation - direct
03/28/17/0056 Map WR-01-038 (G5)	215m north-east of the route.	Alrewas Farm - Pyford Brook.	6,365m^3	436m^3	Spray irrigation - direct

3.2.4 Table 3 summarises permitted discharges to surface water within 1km of the route.

Table 3 - Permitted discharges to surface water

Permit number and map reference[9]	Unique identifier	Distance from route	Discharge Type	Receiving Water Body
T/22/35965/S Map WR-01-037 (F4)	22690584	915m east of the route.	Sewage discharge	Tributary of Darnford Brook
Npswqd005076 Map WR-01-037 (E5)	55616437	55m east of the route.	Sewage discharge	Stream to Darnford Brook
T/22/03449/S Map WR-01-037 (E4)	1243674	765m east of the route.	Sewage discharge	Tributary of the River Tame
T/22/02233/S/1 Map WR-01-037 (E5)	1243749	565m east of the route.	Sewage discharge	Darnford Brook (Tame)
T/22/35977/S Map WR-01-037 (E4)	22967764	645m east of the route.	Sewage discharge	Tributary of Darnford Brook
Eprjp3327xf Map WR-01-037 (E5)	97332052	525m east of the route.	Sewage discharge	Tributary of Fisherwick Brook
T/22/30086/O Map WR-01-037 (E6)	1243916	460m west of the route.	Sewage discharge	Mare Brook
T/22/35697/O Map WR-01-037 (E6)	20358046	460m west of the route.	Sewage discharge	Mare Brook

[9] Map references taken from Volume 5: Map Book - Water resources, Maps WR-01-037 and WR-01-038

Permit number and map reference[9]	Unique identifier	Distance from route	Discharge Type	Receiving Water Body
T/22/35384/T Map WR-01-037 (C5)	1246259	75m north-east of the route.	Trade discharge	Mare Brook
T/07/35455/S Map WR-01-038 (H6)	14200771	890m south-west of the route.	Sewage discharge	Curborough Brook
T/22/12269/O Map WR-01-038 (H5)	1245769	90m north-east of the route.	Sewage discharge	Westhill Brook
T/22/36290/S Map WR-01-038 (H4)	35634939	435m north-east of the route.	Sewage discharge	Unnamed tributary of Mare Brook
T/22/36291/S Map WR-01-038 (H4)	35634940	435m north-east of the route.	Sewage discharge	Unnamed tributary of Mare Brook
T/07/36033/R Map WR-038 (G6)	82636837	620m south-west of the route.	Sewage discharge	Full Brook
T/07/36033/R Map WR-038 (G6)	82636838	620m south-west of the route.	Sewage discharge	Full Brook
T/07/36033/R Map WR-038 (G6)	82636836	600m south-west of the route.	Sewage discharge	Full Brook
T/22/00171/S Map WR-01-038 (G4)	1245819	800m east of the Manchester Spur	Sewage discharge	Canal
T/22/35783/S Map WR-01-038 (G4)	20999118	800m east of the Manchester Spur	Sewage discharge	Canal
T/07/35763/S Map WR-01-038 (F8)	20999261	925m south-west of the route.	Sewage discharge	Full Brook and/or land
T/07/03169/S Map WR-01-038 (E8)	1245931	320m south-west of the route.	Sewage discharge	Bourne/Black/Crane Brook
T/07/36041/S Map WR-01-038 (E8)	26660149	465m south-west of the route.	Sewage discharge	Bourne Brook

Permit number and map reference[9]	Unique identifier	Distance from route	Discharge Type	Receiving Water Body
T/07/36339/T Map WR-01-038 (E9)	36970933	820m south-west of the route.	Sewage discharge	Bourne Brook
T/07/36039/T Map WR-01-038 (E9)	90726476	755m south-west of the route.	Trade discharge	Bourne Brook
T/07/36039/T Map WR-01-038 (E9)	90726475	670m south-west of the route.	Trade discharge	Bourne Brook
T/07/35372/S Map WR-01-038 (D6)	8900280	970m north-east of the route.	Sewage discharge	Tributary of Bourne Brook
T/05/36201/S Map WR-01-038 (C8)	32882710	105m south-west of the route.	Sewage discharge	Tributary of River Trent
T/07/02696/O Map WR-01-038 (B8)	1234356	745m north of the route.	Sewage discharge	Trent/Mersey Canal (Tributary)

3.3 Groundwater

3.3.1 There are three groundwater bodies within CFA22:

- Tame Anker Mease – PT Sandstone Birmingham Lichfield (GB40401G301000);
- Tame Anker Mease - Secondary Combined (GB40402G990800); and
- Staffordshire Trent Valley – Mercia Mudstone East and Coal Measures (GB40402G300300).

3.3.2 The Tame Anker Mease – Permo-Triassic Sandstone Birmingham Lichfield water body has poor chemical and quantitative quality and is predicted to have poor chemical and quantitative quality in 2015.

3.3.3 The Tame Anker Mease - Secondary Combined water body has poor chemical quality and good quantitative quality and is predicted to have poor chemical quality and good quantitative quality in 2015.

3.3.4 The Staffordshire Trent Valley Mercia Mudstone East and Coal Measures water body has good chemical and quantitative quality and is predicted to remain at good chemical and quantitative quality in 2015.

3.3.5 Several superficial aquifers are located within the study area. These are: alluvium, river terrace deposits and glaciofluvial deposits, which are all designated as Secondary A aquifers. Head deposits are present which are designated as Secondary Undifferentiated aquifers.

3.3.6 There are two bedrock aquifers within the Whittington to Handsacre study area. The Sherwood Sandstone Group (containing the Kidderminster Formation and the Bromsgrove Sandstone Formation) is designated as a Principal aquifer and the Mercia Mudstone Group is designated as a Secondary B aquifer.

3.3.7 Strata not discussed in this section are considered to be unproductive by the Environment Agency.

3.3.8 The route crosses a groundwater catchment source protection zone (SPZ3) along the route from the border with the Drayton Bassett, Hints and Weeford area (CFA21) to Streethay. The study area encroaches on a groundwater source protection Zone 1 (SPZ1) and SPZ2 between Tewnals Lane and Hanch Farm to the south-east of Handsacre. An SPZ1 is present partially within the study area in the vicinity of Lichfield Trent Valley Station. It is surrounded by an SPZ2 (see Map WR-02-022).

3.3.9 There are five licensed groundwater abstractions within the study area, two of which are used for public water supply.

3.3.10 No unlicensed potable supplies have been identified within the study area.

3.3.11 Table 4 summarises licensed groundwater abstractions within the study area.

Table 4 - Licensed groundwater abstractions

Licence identifier (map reference number[10] and Environment Agency reference)	Distance from route	Abstraction horizon	Maximum annual abstraction quantity	Maximum daily abstraction quantity	Number of boreholes	Purpose
SPZ Groundwater Abstraction. Map WR-02-022 (G5) located 850m south-west of WCML overbridge.	760m west of the route.	Bromsgrove Sandstone Formation.	Information not provided	Information not provided	Information not provided	Public Water Supply.
03/28/07/0097 Seedy Mill - Borehole G (Water Treatment Works) Map WR-02-022 (D6). Located 520m south-west of Bourne Brook viaduct.	520m south-west of the route.	Mercia Mudstone Group overlain by glaciofluvial deposits.	5,117,300m^3	19,190m^3	1	Industrial, Commercial And Public Services - Water Bottling.
03/28/07/0097 Seedy Mill - Borehole H (Water Treatment Works) Map WR-02-022 (D6). Located 520m south-west of Bourne Brook viaduct.	520m south-west of the route.	Mercia Mudstone Group overlain by glaciofluvial deposits.	5,117,300m^3	19,190m^3	1	Industrial, Commercial And Public Services - Water Bottling.

[10] Map references taken from Volume 5: Map Book - Water resources, Map WR-02-022

Licence identifier (map reference number[10] and Environment Agency reference)	Distance from route	Abstraction horizon	Maximum annual abstraction quantity	Maximum daily abstraction quantity	Number of boreholes	Purpose
SPZ Groundwater Abstraction. Map WR-02-022 (D6). Located 660m south-west of Bourne Brook viaduct.	660m south-west of the route.	Mercia Mudstone Group overlain by glaciofluvial deposits.	Information not provided	Information not provided	Information not provided	Public Water Supply.

3.3.12 Table 5 summarises groundwater discharge environmental permits within the study area.

Table 5 - Groundwater discharge environmental permits

Permit number and map reference11	Unique identifier	Distance from route	Discharge Type	Receiving Water Body
3/28/22/0524/1, Whittington Heath Golf Club. Map WR-02-022 (H5), 750m south-east of Darnford Lane overbridge.	1243694	320m east of the route.	Sewage effluent	Groundwater
3/28/22/2319/1, near Ellfield House. Map WR-02-022 (H5), 140m south-east of Darnford Lane overbridge.	1243954	120m east of the route.	Sewage effluent	Groundwater
T/22/35662/T, Darnford Moors Golf Club. Map WR-02-022 (G6), 940m west of Darnford Lane overbridge.	19448935	900m west of the route.	Sewage Discharges - Final/Treated Effluent - Not Water Company.	Land/Soakaway
3/28/22/0534/1, near Huddlesford House. Map WR-02-022 (H4), 720m east of Capper's Lane viaduct.	1243695	720m east of the route.	Sewage effluent	Groundwater
3/28/22/2624, near Fulfen Farm. Map WR-02-022 (G5), 750m west of Capper's Lane viaduct.	1243957	750m west of the route.	Sewage Discharges - Final/Treated Effluent - Not Water Company.	Land/Soakaway
3/28/07/2685, Capper's Lane. Map WR-02-022 (G5), 600m north-west of Capper's Lane viaduct.	1244107	500m west of the route.	Sewage Discharges - Final/Treated Effluent - Not Water Company.	Land/Soakaway

[11] Map references taken from Volume 5:Map Book - Water resources, Map WR-02-022

Permit number and map reference11	Unique identifier	Distance from route	Discharge Type	Receiving Water Body
WQ/72/2279/1, Huddlesford. Map WR-02-022 (G4), 700m north-east of Capper's Lane viaduct.	1243805	550m east of the route.	Sewage effluent	Groundwater
Wq/72/2275, Streethay. Map WR-02-022 (G5), 100m south of A38 overbridge.	1245877	70m west of the route.	Sewage Discharges - Final/Treated Effluent - Not Water Company.	Land/Soakaway
3/28/22/1443/1, Streethay. Map WR-02-022 (G4), 10m west of A38 overbridge.	1245770	10m west of the route.	Sewage effluent	Groundwater
Wq/72/3217, East Hill. Map WR-02-022 (F4), 1.3km north of A38 overbridge.	1245815	350m north-east of the route.	Sewage Discharges - Final/Treated Effluent - Not Water Company	Land/Soakaway
Wq/72/3218, East Hill. Map WR-02-022 (F4), 1.3km north of A38 overbridge.	1245816	350m north-east of the route.	Sewage Discharges - Final/Treated Effluent - Not Water Company	Land/Soakaway
Wq/72/2575, near Fradley South. Map WR-02-022 (F3), 1.6km north-east of A38 overbridge.	1245817	750m north-east of the route.	Sewage Discharges - Final/Treated Effluent - Not Water Company.	Land/Soakaway
3/28/07/1799, near Fradley Junction. Map WR-02-022 (E3), Fradley Wood.	1245878	940m north-east of Manchester spur.	Sewage Discharge - Final/Treated Effluent - Not Water Company.	Land/Soakaway
3/28/07/1798, near Fradley Junction. Map WR-02-022 (E3), Fradley Wood.	1245880	900m north-east of Manchester Spur.	Sewage Discharges - Final/Treated Effluent - Not Water Company.	Land/Soakaway
3/28/07/1797, near Fradley Junction. Map WR-02-022 (E3), Fradley Wood.	1245879	740m north-east of Manchester Spur.	Sewage Discharges - Final/Treated Effluent - Not Water Company.	Land/Soakaway
3/28/16/1436/1, near Tomhay Wood. Map WR-02-022 (E5), 1.1km west of Curborough Brook viaduct.	1245813	600m south-west of the route.	Sewage effluent	Groundwater
3/28/07/1669, west of Tomhay Wood. Map WR-02-022 (E5), 1 km south of Bourne Brook viaduct.	1245932	530m south of the route.	Sewage Discharges - Final/Treated Effluent - Not Water Company.	Land/Soakaway

Permit number and map reference11	Unique identifier	Distance from route	Discharge Type	Receiving Water Body
T/05/36051/Sg, near Trent and Mersey Canal. Map WR-02-022 (D5), 900m north-east of Bourne Brook viaduct.	27246147	800m north-east of the route.	Sewage Discharges - Final/Treated Effluent - Not Water Company.	Land/Soakaway

3.4 Groundwater/surface water interaction

3.4.1 Table 6 summarises springs, sinks and issues (locations where groundwater rises to the surface in a more diffuse way than at a spring) within the study area. Due to the number of ponds and other water features present within the study area, only those either within the land required for the construction or operation of the AP2 revised scheme, or within the calculated zone of influence, and therefore potentially affected by the AP2 revised scheme, have been included in the assessment.

Table 6 - Groundwater/surface water interaction

Location description and map reference[12]	Distance from route	Formation	Elevation	Comments
Drain Map WR-02-022 (G5) will be crossed by Capper's Lane viaduct.	Will be crossed by the route.	Alluvium underlain by Bromsgrove Sandstone Formation.	Not applicable	May receive baseflow from Secondary A and Principal aquifers.
Wyrley and Essington Canal (under restoration) Map WR-02-022 (G5) will be crossed by Capper's Lane viaduct.	Will be crossed by the route.	Also a water dependent habitat. Refer to Table 7 for further information		
Issues north of Fulfen Farm Map WR-02-022 (G5) located 430m west of WCML overbridge.	430m west of the route.	Bromsgrove Sandstone Formation	65mAOD	Not genuine issues. Identified as a culvert exit.
Pond in Fulfen Wood Map WR-02-022 (G5) located 30m north of WCML overbridge.	45m west of the route.	Bromsgrove Sandstone Formation	68mAOD	May receive water from Bromsgrove Sandstone.
Pond in Fulfen Wood Map WR-02-022 (G5) located 230m north-east of WCML overbridge.	150m east of the route.	Bromsgrove Sandstone Formation	65mAOD	May receive water from Bromsgrove Sandstone

[12] Map references taken from Volume 5: Map Book - Water resources, Map WR-02-019 and Volume 5: Map Book - Ecology, Maps EC-01 to EC-04

Location description and map reference[12]	Distance from route	Formation	Elevation	Comments
Tributary of Mare Brook. Map WR-02-022 (G5) located 225m north of WCML overbridge.	Will be crossed by the route.	Bromsgrove Sandstone Formation	Not applicable	May receive water from Bromsgrove Sandstone
Pond at Hill Farm Map WR-02-022 (F4) located 465m south of A38 overbridge.	20m west of the route.	Mercia Mudstone Group	76mAOD	Situated upon elevated topography, therefore unlikely to be groundwater dependent.
Issues Map WR-02-022 (F5) located 1.1km west of A38 overbridge.	1,100m west of the route.	Bromsgrove Sandstone Formation	73mAOD	May receive water from Bromsgrove Sandstone.
Tributary of Mare Brook Map WR-02-022 (G5) located 600m north of A38 overbridge.	Will be crossed by the route.	Bromsgrove Sandstone Formation	Not applicable	May receive baseflow from Principal Aquifer.
Pond 190m north-west of "Rough Stockings". Map WR-02-022 (F4) located 740m north of A38 overbridge.	70m east of the route	Mercia Mudstone Group	65mAOD	May receive water from Mercia Mudstone.
Two ponds 300m north-west of "Rough Stockings". Map WR-02-022 (F4) located 800m north of A38 overbridge.	Will be crossed by the route	Mercia Mudstone Group	67mAOD	May receive water from Mercia Mudstone.
Minor tributary of River Trent. Map WR-02-022 (F4) located 1km north of A38 overbridge.	130m east of the route	Mercia Mudstone Group	Not applicable	May receive baseflow from Secondary B aquifer.
Minor tributary of River Trent. Map WR-02-022 (F4). Located 1.2km north of A38 overbridge.	East adjacent to the route.	Mercia Mudstone Group	Not applicable	May receive baseflow from Secondary B aquifer.
Issues 650m north-east of Curborough Farm Map WR-02-022 (F4) located 1km south of Trent and Mersey Canal viaduct.	135m west of the route.	Mercia Mudstone Group	65mAOD	May receive water from Mercia Mudstone Group.
Pond 20m west of "Little Lyntus" woodland	50m west of the route	Mercia Mudstone Group	Not applicable	May receive water from Mercia Mudstone.

Location description and map reference[12]	Distance from route	Formation	Elevation	Comments
Map WR-02-022 (F4) located 700m south of Trent and Mersey Canal viaduct.				
Issues 300m west of New Bridge. Map WR-02-022 (E3) located 940m east of Trent and Mersey Canal viaducts.	900m north-east of Manchester Spur.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	65mAOD	May receive water from superficial Glaciofluvial Sheet Deposits.
Drain in Fradley Wood Map WR-02-022 (E4) located 190m south of Trent and Mersey Canal viaduct.	Will be crossed by Manchester Spur	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	Not applicable	May receive water from superficial Glaciofluvial Sheet Deposits.
Drain in Fradley Wood Map WR-02-022 (E4) located 100m south of Trent and Mersey Canal viaduct.	Will be crossed by Manchester Spur	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	Not applicable	May receive water from superficial Glaciofluvial Sheet Deposits.
Pond at Woodend Lock (near) LWS. Map WR-02-022 (E4) located 20m south-east of Curborough Brook viaduct.	Will be crossed by the route	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group	Not applicable	May receive water from Glaciofluvial Sheet Deposits.
Trent & Mersey Canal. Map WR-02-022 (E4). Will be crossed by Trent and Mersey Canal viaduct.	Will be crossed by the Manchester Spur.	Also a water dependent habitat. Refer to Table 7 for further information.		
Curborough Brook. Map WR-02-022 (E4). Will be crossed by Curborough Brook viaduct.	Will be crossed by the route.	Also a water dependent habitat. Refer to Table 7 for further information.		
Trent and Mersey Canal Map WR-02-022 (E4) located 20m north-east of Curborough Brook viaduct.	35m east of the route.	Also a water dependent habitat. Refer to Table 7 for further information.		
Drain in Ravenshaw Wood Map WR-02-22 (E5) located 640m north-west of Curborough Brook viaduct.	Will be crossed by the route	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group	Not applicable	May receive baseflow from Secondary A and Secondary B aquifers.
Pond 100m west of Black Slough Wood. Map WR-02-022 (D5) located 740m south-east of Bourne Brook viaduct.	35m north-east of the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	73mAOD	May receive water from Glaciofluvial Sheet Deposits.

Location description and map reference[12]	**Distance from route**	**Formation**	**Elevation**	**Comments**
Drain. By Black Slough Map WR-02-022 (D5) located 50m south of Bourne Brook viaduct.	Will be crossed by the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	Not applicable	May receive baseflow from Secondary A and Secondary B aquifers.
Issues at Rileyhill Farm. Map WR-02-022 (D4) located 950m east of Bourne Brook viaduct	950m east of the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	75mAOD	May receive water from Glaciofluvial Sheet Deposits.
Two ponds 150m north of the junction between the A515 and Wood End Lane. Map WR-02-022 (D5) located 50m south of Bourne Brook viaduct.	90m south-west of the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	80mAOD	May receive water from Glaciofluvial Sheet Deposits.
Pond 260m east of Hanch Hall Farm. Map WR-02-022 (D5) located 260m south-west of Bourne Brook viaduct.	250m south-west of the route. Will be crossed by connection with West Coast Main Line.	Alluvium underlain by Mercia Mudstone Group.	78mAOD	Appears to be a balancing pond for existing railway. Unlikely to be groundwater dependent.
Bourne-Bilson Brook. Map WR-02-022 (D5). Will be crossed by Bourne Brook viaduct.	Will be crossed by the route.	Alluvium and Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	Not applicable	May receive baseflow from Secondary A and Secondary B aquifers.
Pond within John's Gorse. Map WR-02-022 (D5) located 150m north-west of Bourne Brook viaduct.	Will be crossed by the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	79mAOD	Possibly groundwater dependent. Pond outflow feeds into Bourne Brook, no inflow visible on available mapping.
Two ponds 420m south-west of Kings Bromley Wharf Marina. Map WR-02-022 (D5) located 220m north of Bourne Brook viaduct.	200m north-east of the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	79mAOD	May receive water from Glaciofluvial Sheet Deposits.
Drain at Harvey's Rough. Map WR-02-022 (D5). Will be crossed by Harvey's Rough flyover.	Will be crossed by the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	Not applicable	May receive baseflow from Secondary A and Secondary B aquifers.
Pond 220m north-west of Shaw House. Map WR-02-022 (D5) located 50m north-east of Harvey's Rough flyover.	60m north-east of the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	78mAOD	May receive water from Glaciofluvial Sheet Deposits.

Location description and map reference[12]	Distance from route	Formation	Elevation	Comments
Minor tributary of River Trent. Map WR-02-022 (D6) located 320m north-west of Harvey's Rough flyover.	Will be crossed by the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	Not applicable	May receive baseflow from Secondary A and Secondary B aquifers.
Issues 350m west of Ashton Hayes Farm. Map WR-02-022 (D6) located 535m north-west of Harvey's Rough flyover.	270m west of the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	77mAOD	May receive water from superficial Glaciofluvial Sheet Deposits.
Minor tributary of River Trent. Map WR-02-022 (D6) located 590m north-west of Harvey's Rough flyover.	Will be crossed by the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	Not applicable	May receive baseflow from Secondary A and Secondary B aquifers.
Minor tributary of River Trent. Map WR-02-022 (D6) located 630m north-west of Harvey's Rough flyover.	Will be crossed by the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	Not applicable	May receive baseflow from Secondary A and Secondary B aquifers.
Issues 300m north-west of Ashton Hayes Farm. Map WR-02-022 (C6) located 670m north-west of Harvey's Rough flyover.	25m west of the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	75mAOD	May receive water from superficial Glaciofluvial Sheet Deposits.
Issues at Brook Cottages. Map WR-02-022 (C6) located 1km north-west of Harvey's Rough flyover.	455m west of the route.	Mercia Mudstone Group	80mAOD	May receive water from Mercia Mudstone.
Minor tributary of River Trent. Map WR-02-022 (C6) located 1km north-west of Harvey's Rough flyover.	Will be crossed by the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	Not applicable	May receive baseflow from Secondary A and Secondary B aquifers.
Spring at White Gables. Map WR-02-022 (C6) located 1km north-west of Harvey's flyover.	200m west of the route.	Glaciofluvial Sheet Deposits underlain by Mercia Mudstone Group.	75mAOD	May receive water from Glaciofluvial Sheet Deposits.
Spring at Hood Lane Covert. Map WR-02-022 (C6) located 1.7km north-west of Harvey's Rough flyover.	1,000m west of the route.	Mercia Mudstone Group	85mAOD	May receive water from Mercia Mudstone.
Sinks at Brick Kiln Farm. Map WR-02-022 (C6) located 650m south-west of Handsacre (centre).	740m north-west of the route.	Mercia Mudstone Group	75mAOD	May sink into Mercia Mudstone. Possibly an extended culvert.

Location description and map reference[12]	Distance from route	Formation	Elevation	Comments
Issues 100m south of Old Road Farm. Map WR-02-022 (C6). Located 550m north-west of Handsacre (centre).	800m north of the route.	Bromsgrove Sandstone Formation	70-75mAOD	May receive water from Bromsgrove Sandstone.
Issues 200m west of Station Drive Handsacre. Map WR-02-022 (C6) located 250m south-west of Handsacre (centre).	450m north-west of the route.	Mercia Mudstone Group	80mAOD	May receive water from Mercia Mudstone. Possibly an extended culvert.

3.5 Water dependent habitats

3.5.1 Table 7 summarises the potential water dependent habitats within the study area. These have been identified from a review of OS mapping, aerial photography and from the following sources:

- information on designated and potential non-statutory Sites of Biological Importance (SBI) and Biodiversity Action Sites (BAS) from Staffordshire Ecological Records;
- information on statutory designated sites from Natural England; and
- information from ecological surveys carried out in support of the Environmental Impact Assessment (EIA).

3.5.2 The table identifies where a water dependency may exist but the assessment of impact on water dependent ecology receptors is found in SES and AP2 ES Volume 2, CFA Report 22, Section 10.

Table 7 - Description of water dependent habitats

Location	Distance from the route	Designation	Comments
Whittington Heath Golf Club EC- 01-061b, (B6), located 1.1km south-west of Whittington.	Will be crossed by the route.	SBI	Possibly dependent upon groundwater as situated upon permeable strata.
Coventry Canal: Huddlesford to Whittington. EC- 01-062, (F3), stretch of canal between Huddlesford and Whittington.	440m east of the route (at closest point).	SBI	Unlikely to be groundwater dependent as this is an artificial watercourse and is therefore isolated from groundwater.
Wyrley and Essington Canal EC- 01-062, (F5), stretch of canal between Darnform and Huddlesford.	Will be crossed by the route.	Identified by ecology as wet habitat of concern.	Unlikely to be groundwater dependent as this is an artificial watercourse and is therefore isolated from groundwater.

Location	Distance from the route	Designation	Comments
Huddlesford Strip EC- 01-062, (E2), located along Park Lane, running eastwards from Huddlesford towards Burton Road, 530m east of WCML overbridge.	530m east of the route.	BAS	Possibly dependent upon groundwater as situated upon permeable strata.
Coventry Canal and associated habitats. EC- 01-062, (D5), stretch of canal between Whittington and Streethay.	170m east of the route.	Identified by ecology as wet habitat of concern.	Unlikely to be groundwater dependent as this is an artificial watercourse and is therefore isolated from groundwater. Associated habitats most likely dependent upon water from the canal.
Undesignated woodland with drains and a pool. EC- 01-063, (H5), situated approximately 220m south-west of East Hill Business Park, Fradley.	Will be crossed by the route.	Identified by ecology as wet habitat of concern.	Possibly dependent upon groundwater as situated upon permeable strata.
Curborough House (south) Hedgerows. EC- 01-063, (G9), located 1km south of Curborough Brook viaduct.	760m west of the route.	BAS	Unlikely to be groundwater dependent as the hedgerow is located on a road and there is no evidence that the receptor is wet.
Curborough House Hedgerows EC- 01-063, (E7), located 550m south-east of Curborough Brook viaduct.	100m west of the route.	SBI	Unlikely to be groundwater dependent as the hedgerow is located on a road and there is no evidence that the receptor is wet.
Big Lyntus EC- 01-063, (D7), located 95m south of Curborough Brook viaduct.	Adjacent to the route	SBI, Ancient Woodland.	Unlikely to be groundwater dependent as there is no evidence that the receptor is wet.
Kings Bromley Wharf to Fradley Junction, Coventry Canal. EC- 01-063, (C5), located 35m north-east of Curborough Brook viaduct.	35m east of the route. Will be crossed by Manchester Spur	SBI	Unlikely to be groundwater dependent as this is an artificial watercourse and is therefore isolated from groundwater.
Fradley Wood EC- 01-063, (C4), located 100m south of Trent and Mersey Canal viaduct.	280m east of the route. Will be crossed by Manchester spur.	BAS	Possibly dependent upon groundwater as situated upon permeable strata.
Trent and Mersey Canal and associated habitat. EC- 01-063, (C7), will be crossed by Trent and Mersey Canal viaduct.	35m east of the route. Will be crossed by Manchester Spur.	Identified by ecology as wet habitat of concern.	Unlikely to be groundwater dependent as this is an artificial watercourse and is therefore isolated from groundwater.

Location	Distance from the route	Designation	Comments
Curborough Hall Farm Hedgerows. EC- 01-063, (D10), located 300m south-west of Curborough Brook viaduct.	300m south-west of the route.	BAS	Unlikely to be groundwater dependent as the hedgerow is located on a road and there is no evidence that the receptor is wet.
Pool Wood and Fradley Reservoir. EC- 01-063, (A3), located at Fradley Junction, 390m north-east of Trent and Mersey Canal viaduct.	830m north-east of the route. 370m east of Manchester Spur.	SBI	Possibly dependent upon groundwater as situated upon permeable strata. Citation suggests that the receptor is wet as there is a swamp at the western edge of the reservoir.
Wood End Lock (near). EC- 01-063, (C7), located on the outer bend of the Trent and Mersey Canal close to Wood End Farm, will be crossed by Curborough Brook viaduct.	Will be crossed by the route.	SBI	Possibly dependent upon groundwater as situated upon permeable strata.
Curborough Brook and associated habitat. Map: EC- 01-063, (B7), located on the inner bend of the Trent and Mersey Canal, will be crossed by Curorough Brook viaduct.	Will be crossed by the route.	Identified by ecology as wet habitat of concern.	Possibly dependent upon groundwater as situated upon permeable strata.
Ravenshaw Wood, Black Slough and Slash Map: EC- 01-064, (G6), located 470m north-west of Curborough Brook viaduct.	Will be crossed by the route.	SBI, Ancient Woodland.	Possibly dependent upon groundwater as situated upon permeable strata.
Tomhay Wood Map: EC- 01-064, (G9), located 1.3km west of Curborough Brook viaduct.	300m south of the route.	SBI, Ancient Woodland.	Possibly dependent upon groundwater as situated upon permeable strata.
Vicar's Coppice Map: EC- 01-064, (E8), located 65m west of A515 Lichfield Road underbridge.	20m south of the route.	BAS, Ancient Woodland.	Possibly dependent upon groundwater as situated upon permeable strata.
The Roundabout Map: EC- 01-064, (E10), located 745m south-west of A515 Lichfield Road underbridge.	770m south of the route.	BAS	Possibly dependent upon groundwater as situated upon permeable strata and flat topography with ponds present.
John's Gorse, Hanch Wood Map: EC-01-064, (D7), located 240m north-west of A515 Lichfield Road underbridge.	Will be crossed by the route.	SBI, Ancient Woodland.	Possibly dependent upon groundwater as identified as wet woodland in the ecological citation and is situated upon permeable strata.

Location	Distance from the route	Designation	Comments
Unnamed ancient woodland south west of Hanchwood House. Map: EC- 01-064, (C8), located 495m north-west of A515 Lichfield Road underbridge.	Will be crossed by the route.	Ancient Woodland	Unlikely to be groundwater dependent as there is no evidence that the site is wet and there are no groundwater features such as springs in the vicinity.
Riley Hill Map: EC- 01-064, (D2), located 1.2km north-east of A515 Lichfield Road underbridge.	400m south-west of Manchester Spur.	Retained BAS	Possibly dependent upon groundwater as situated upon permeable strata and damp ground is suggested in the citation.
Tuppenhurst Lane (west of) Map: EC- 01-065, (G5). Located 565m north-west of Harvey's Rough flyover.	10m north-east of the route.	SBI	Possibly dependent upon groundwater - described as "A wet area with marshy grassland, swamp". Headwater stream source from west of route.

4 Site specific assessments

4.1 Surface water

4.1.1 The following table summarises the potential impacts and effects to surface water.

Table 8 - Summary of potential impacts to surface water

Surface water feature / receptor[13]	Value of surface water feature[14]	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
Drain feeder to Fisherwick Brook at Mill Farm (SWC-CFA22-001) Map WR-01-037 (E5)	Moderate	Realignment of Darnford Lane (assume local drainage connects) Realignment of Capper's Lane Earthworks Drainage outfall Balancing pond Capper's Lane viaduct.	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off.	Adoption of Environment Agency Pollution Prevention Guidelines (PPG) - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)
		Realignment of Darnford Lane (assume local drainage outfall connects).	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from routine	Drainage has been designed to reduce the rate and volume of run-off from the road and to provide temporary storage for potential spillages.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)

[13] Map references taken from Volume 5: Map Book - water resources, Maps WR-01-037 and WR-01-038.
[14] For examples of receptor value see Table 43 in the SMR addendum Volume 5 Appendix CT-001-000/2.

Surface water feature / receptor[13]	**Value of surface water feature**[14]	**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**
		Realignment of Capper's Lane		discharges or from accidental spillages.					
		Drainage outfall from railway.	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the proposed railway and to provide temporary storage for potential spillages. Balancing pond before outfall to watercourse to restrict run-off rates and reduce the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		All elements (maintenance).	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances used during cold weather and herbicides for managing vegetation on the tracks.	Best practice pollution control guidance will be adopted for maintenance of the AP2 revised scheme.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Operation
Wyrley and Essington Canal (under restoration) at Canal Cottage Cappers Lane	Moderate	Realignment of Capper's Lane Drainage outfall Earthworks	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
(SWC-CFA22-002) Map WR-01-037 (E5)		Capper's Lane viaduct Capper's Lane auto-transformer station.		fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off.	Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.				
Mare Brook at Fulfen Wood (SWC-CFA22-003) Map WR-01-037 (E5)	Moderate	Realignment of Capper's Lane and Broad Lane Culvert Watercourse realignment Drainage outfall Balancing pond Earthworks and drainage.	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off. In-channel construction work has the potential to have a moderate impact on the water environment, flows and the ecology supported, through the disturbance of silt or the direct	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
				contamination by polluting materials.					
		Realignment of Capper's Lane and Broad Lane	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from routine discharges or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the road and to provide temporary storage for potential spillages.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		Drainage outfall from railway.	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the proposed railway and to provide temporary storage for potential spillages. Balancing pond before outfall to watercourse to restrict run-off rates and reduce the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		Culvert.	Moderate adverse	Culvert may impact on the existing water environment, potentially changing flow characteristics and the ecology supported.	Improvements along watercourse either side of culvert, to mitigate loss of open length.	Minor to Minor Beneficial	None required	Minor to Minor Beneficial	Construction (Permanent)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
						Slight to Slight Beneficial (not significant)		Slight to Slight Beneficial (not significant)	
		Watercourse realignment.	Moderate adverse	Deterioration or loss of the existing water environment, flows and the ecology supported.	Opportunities will be taken to retain and if reasonably practicable enhance the overall quality of the watercourses, for example by including meanders and enhanced banks.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
		All elements (maintenance).	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances used during cold weather and herbicides for managing vegetation on the tracks.	Best practice pollution control guidance will be adopted for maintenance of the AP2 revised scheme.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Operation
Tributary of Mare Brook at Rough Stockings - Streethay (SWC-CFA22-004)	Moderate	Mare Brook south culvert Watercourse realignment Mare Brook packaged sub-station.	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids;	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
Map WR-01-037 (C6)				The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off. In-channel construction work has the potential to have a moderate impact on the water environment, flows and the ecology supported, through the disturbance of silt or the direct contamination by polluting materials.	Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.				
		Mare Brook south culvert.	Moderate adverse	Culvert may impact on the existing water environment, potentially changing flow characteristics and the ecology supported.	Improvements along watercourse either side of culvert, to mitigate loss of open length.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
		Watercourse realignment.	Moderate adverse	Deterioration or loss of the existing water environment, flows and the ecology supported.	Opportunities will be taken to retain and if reasonably practicable enhance the overall quality of the watercourses, for example by	Minor to Minor Beneficial	None required	Minor to Minor Beneficial	Construction (Permanent)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
					including meanders and enhanced banks.	Slight to Slight Beneficial (not significant)		Slight to Slight Beneficial (not significant)	
Pond north of Rough Stockings (SWC-CFA22-005) Map WR-01-037 (C6)	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.for impacts assessment.								
Tributary of Mare Brook at Nanscawan Road - Hilliards Cross (SWC-CFA22-006) Map WR-01-037 (B6)	Moderate	Mare Brook north culvert Watercourse realignment Drainage outfall Balancing pond.	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off. In-channel construction work has the potential to have a moderate impact on the	Adoption of Environment Agency PPGs particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
				water environment, flows and the ecology supported, through the disturbance of silt or the direct contamination by polluting materials.					
		Drainage outfall from railway.	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the proposed railway and to provide temporary storage for potential spillages. Balancing pond before outfall to watercourse to restrict run-off rates and reduce the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		Mare Brook north culvert.	Moderate adverse	Culvert may impact on the existing water environment, potentially changing flow characteristics and the ecology supported.	Improvements along watercourse either side of culvert, to mitigate loss of open length.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
		Watercourse realignment.	Moderate adverse	Deterioration or loss of the existing water environment, flows and the ecology supported.	Opportunities will be taken to retain and if reasonably practicable enhance the overall quality of the watercourses, for example by including meanders and enhanced banks.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
		All elements (maintenance).	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances used during cold weather and herbicides for managing vegetation on the tracks.	Best practice pollution control guidance will be adopted for maintenance of the AP2 revised scheme.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Operation
Tributary of Mare Brook South of Little Lyntus Wood (SWC-CFA22-007) Map WR-01-037 (B6)	Moderate	Drainage outfall Balancing ponds Diverted Wood End Lane Watercourse realignment Culvert.	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off.	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
				In-channel construction work has the potential to have a moderate impact on the water environment, flows and the ecology supported, through the disturbance of silt or the direct contamination by polluting materials.	Grey water systems used at main and satellite construction compounds.				
		Drainage outfall from railway.	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the proposed railway and to provide temporary storage for potential spillages. Balancing pond before outfall to watercourse to restrict run-off rates and reduce the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		Drainage outfall from road (assumed drainage from Wood End Lane).	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the road and associated	Drainage has been designed to reduce the rate and volume of run-off from the road and to provide temporary storage for potential spillages.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
				infrastructure or from accidental spillages.					
		Watercourse realignment.	Moderate adverse	Deterioration or loss of the existing water environment, flows and the ecology supported.	Opportunities will be taken to retain and if reasonably practicable enhance the overall quality of the watercourses, for example by including meanders and enhanced banks.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
		Culvert.	Moderate adverse	Culvert may impact on the existing water environment, potentially changing flow characteristics and the ecology supported.	Improvements along watercourse either side of culvert, to mitigate loss of open length.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
		All elements (maintenance).	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances used during cold weather and herbicides for managing vegetation.	Best practice pollution control guidance will be adopted for maintenance of the AP2 revised scheme.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Operation

Surface water feature / receptor[13]	Value of surface water feature[14]	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
Drain Feeder 1 to Trent and Mersey Canal At Fradley Wood (Manchester Spur) SWC-CFA22-008)	Low	Fradley Wood embankment. Assumed modifications to drainage network in this area.	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off.	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)
		Watercourse realignment.	Moderate adverse	Deterioration or loss of the existing water environment, flows and the ecology supported.	Opportunities will be taken to retain and if reasonably practicable enhance the overall quality of the watercourses, for example by including meanders and enhanced banks.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
Drain Feeder 2 to Trent and Mersey Canal	Low	Fradley Wood embankment. Assumed modifications	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works.	Negligible Neutral	None required	Negligible Neutral	Construction (Temporary)

Surface water feature / receptor[13]	**Value of surface water feature**[14]	**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**
At Fradley Wood (Manchester Spur) SWC-CFA22-009)		to drainage network in this area.		materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off.	Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.	(not significant)		(not significant)	
		Watercourse realignment.	Moderate adverse	Deterioration or loss of the existing water environment, flows and the ecology supported.	Opportunities will be taken to retain and if reasonably practicable enhance the overall quality of the watercourses, for example by including meanders and enhanced banks.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
Drain feeder 3 to Trent and Mersey Canal At Fradley Wood (Manchester Spur)	Low	Fradley Wood embankment. Assumed modifications to drainage network in this area.	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids;	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
SWC-CFA22-010)				The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off.	Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.				
		Watercourse realignment.	Moderate adverse	Deterioration or loss of the existing water environment, flows and the ecology supported.	Opportunities will be taken to retain and if reasonably practicable enhance the overall quality of the watercourses, for example by including meanders and enhanced banks.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
Trent and Mersey Canal At Fradley Wood (Manchester Spur) SWC-CFA22-011)	Moderate	Fradley Wood embankment. Brokendown Wood Embankment Trent and Mersey Canal Viaduct.	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
				disturbance of contaminated ground or groundwater; Uncontrolled site run-off.	Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.				
Pond North of Big Lyntus Wood (SWC-CFA22-012) Map WR-01-038 (G5)	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.for impacts assessment.								
Curborough Brook crossing at Wood End Farm (SWC-CFA22-013) Map WR-01-038 (G5)	High	Wood End Lane realignment. Curborough Brook viaduct Ravenshaw Wood embankment Earthworks Drainage outfalls	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off.	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	**Value of surface water feature[14]**	**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**
		Drainage outfall from railway.	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the proposed railway and to provide temporary storage for potential spillages. Balancing pond before outfall to watercourse to restrict run-off rates and reduce the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction - (Permanent)
		Drainage outfall from road (assumed drainage from Wood End Lane).	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the road and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the road and to provide temporary storage for potential spillages.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		All elements (maintenance).	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances used during cold weather and herbicides for managing vegetation on the tracks.	Best practice pollution control guidance will be adopted for maintenance of the AP2 revised scheme.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Operation

Surface water feature / receptor[13]	Value of surface water feature[14]	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
Drain at Ravenshaw Wood (SWC-CFA22-14) Map WR-01-038 (E7)	Low	Earthworks	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off.	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)
Bourne Brook at John's Gorse (SWC-CFA22-015) Map WR-01-038 (E7)	High	Tuppenhurst Lane extension Bourne Brook viaduct Balancing pond Drainage outfall A515 Lichfield Road underbridge	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off.	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
				In-channel construction work has the potential to have a moderate impact on the water environment, flows and the ecology supported, through the disturbance of silt or the direct contamination by polluting materials.	Grey water systems used at main and satellite construction compounds.				
		Drainage outfall from railway.	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the proposed railway and to provide temporary storage for potential spillages. Balancing pond before outfall to watercourse to restrict run-off rates and reduce the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		Drainage outfall from road (assumed drainage from Tuppenhurst Lane extension).	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the road and associated	Drainage has been designed to reduce the rate and volume of run-off from the road and to provide temporary storage for potential spillages.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)

Surface water feature / receptor[13]	**Value of surface water feature[14]**	**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**
				infrastructure or from accidental spillages.					
		All elements (maintenance).	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances used during cold weather and herbicides for managing vegetation on the tracks.	Best practice pollution control guidance will be adopted for maintenance of the AP2 revised scheme.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Operation
Tributary of River Trent North-west of Ashton Hays (SWC-CFA22-016) Map WR-01-038 (C8)	Moderate	Kings Bromley North culvert Embankment	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off. In-channel construction work has the potential to have a moderate impact on the water environment, flows and the ecology supported, through the disturbance of silt or the direct	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
				contamination by polluting materials.					
		Kings Bromley North culvert	Moderate adverse	Culvert may impact on the existing water environment, potentially changing flow characteristics and the ecology supported.	Improvements along watercourse either side of culvert, to mitigate loss of open length.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
Tributary of River Trent East of B5014 (SWC-CFA22-017) Map WR-01-038 (C8)	Moderate	Handsacre East culvert Embankment	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off. In-channel construction work has the potential to have a moderate impact on the water environment, flows and the ecology supported,	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
				through the disturbance of silt or the direct contamination by polluting materials.					
		Handsacre East culvert	Moderate adverse	Culvert may impact on the existing water environment, potentially changing flow characteristics and the ecology supported.	Improvements along watercourse either side of culvert, to mitigate loss of open length.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
Tributary of River Trent at White Gables (SWC-CFA22-018) Map WR-01-038 (C8)	Moderate	Handsacre West drop inlet culvert Balancing pond Drainage outfall	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; Uncontrolled site run-off. In-channel construction work has the potential to have a moderate impact on the	Adoption of Environment Agency PPGs - particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at main and satellite construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature / receptor[13]	Value of surface water feature[14]	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
				water environment, flows and the ecology supported, through the disturbance of silt or the direct contamination by polluting materials.					
		Drainage outfall from railway	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the proposed railway and to provide temporary storage for potential spillages. Balancing pond before outfall to watercourse to restrict run-off rates and reduce the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		Handsacre West drop inlet culvert	Major adverse	Drop inlet culvert may impact on the existing water environment, potentially changing flow characteristics and the ecology supported. May act as a barrier to fish.	Improvements along watercourse either side of culvert, to mitigate loss of open length. Drop inlet design to allow passage of fish if reasonably practicable.	Minor Slight (not significant)	None required	Minor Slight (not significant)	Construction (Permanent)
		All elements (maintenance)	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances	Best practice pollution control guidance will be	Negligible Neutral	None required	Negligible Neutral	Operation

Surface water feature / receptor[13]	Value of surface water feature[14]	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
				used during cold weather and herbicides for managing vegetation on the tracks.	adopted for maintenance of the AP2 revised scheme.	(not significant)		(not significant)	

4.2 Groundwater

4.2.1 Following the methodology outlined in the SMR addendum (see main ES Volume 5: Appendix CT-001-000/2), the hydraulic conductivity values; obtained from available literature values, were used in conjunction with professional judgment to estimate the maximum extent of the zone of influence that is likely to be produced when dewatering of a cutting occurs. The hydraulic conductivity values used are generally in the high range of literature values to provide a realistic factor of safety to the estimated zone of influence. Based on this worst case assumption, the zone of influence is likely to be overestimated, however for the purpose of this preliminary assessment, this approach is considered to be acceptable.

4.2.2 Aquifer properties used for estimating the zone of influence can be found in Table 9.

Table 9 - Aquifer properties

Lithology	Maximum hydraulic conductivity value used in calculations	References
Bromsgrove Sandstone Formation	2.71m/d	BGS Aquifers Properties Manual[15]
Kidderminster Sandstone Formation	33.3m/d	BGS Aquifers Properties Manual
Mercia Mudstone Group-Mudstone and Dolomitic siltstone	0.1m/d	Tellam and Lloyd[16]
Alluvium	864m/d	Hiscock 2005[17]
River Terrace Deposits	51.8m/d	An average of sand values from Domenico and Schwartz 1990[18]
Glaciofluvial Deposits Sand and Gravel	86.4m/d	Hiscock 2005
Glaciolacustrine Deposits- clay and silt	0.0000864m/d	Hiscock 2005
Head Deposits	0.173m/d	Domenico, PA and FW Schwartz, 1990

4.2.3 The zone of influence for the dewatering of the cuttings along the route was calculated at frequent intervals as topography, geology and track level changed, using the methodology outlined in the SMR addendum (see main ES Volume 5: Appendix CT-001-000/2) and the properties in Table 9. Table 10 summarises the estimated zone of influence within the study area for each of the cuttings. In each case, the maximum

[15] British Geological Survey (1997). *The Physical Properties of Major Aquifers in England and Wales*. P199
[16] Tellam J.H. and Lloyd J.W. (1981). *A review of the hydrogeology of British onshore non-carbonate mudrocks*. Quarterly Journal of Engineering Geology and Hydrogeology 1981, v.14; p347-355
[17] Hiscock, K.M. (2005), Hydrogeology: Principles and Practice, Blackwell Science Ltd, Oxford
[18] Domenico, P.A. and F.W. Schwartz, 1990. Physical and Chemical Hydrogeology, John Wiley & Sons, New York

zone of influence value reported has not been applied to the whole extent of the cutting; it is purely illustrative of the worst-case conditions at its deepest section.

Table 10 - Maximum extent of zone of influence in the Whittington to Handsacre study area

Cutting	Geology	Maximum drawdown within cutting	Maximum zone of influence estimated from maximum drawdown	Comments
Swinfen cutting	Kidderminster Formation and Bromsgrove Sandstone Formation	8m	382m	Bulk hydraulic conductivity used
Whittington Common cutting	Bromsgrove Sandstone Formation	4m	68m	-
Streethay cutting	Bromsgrove Sandstone Formation	12m	202m	-
	Mercia Mudstone Group Mudstone and Bromsgrove Sandstone Formation	19m	187m	Bulk hydraulic conductivity used
	Mercia Mudstone Group Mudstone	13m	42m	-

4.2.4 Table 11 summarises the potential impacts to groundwater, abstractions, water dependent habitats and groundwater / surface water interactions.

Table 11 - Summary of potential impacts to groundwater, abstractions, water dependent habitats and groundwater/ surface water interactions

Groundwater receptor[19] (and value) [20]	**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**
Aquifers								
Principal bedrock aquifer: Sherwood Sandstone Group - Bromsgrove Sandstone Formation (high).	Various including: Whittington Heath embankment; Swinfen cutting; Whittington Common cutting; Capper's Lane viaduct; Streethay cutting; Capper's Lane Main Compound and stockpiles; Worksites; Construction traffic route.	Moderate adverse	Dewatering may reduce the groundwater levels within the aquifer. Potential for contaminants to enter groundwater during construction (e.g. suspended solids, leaks from machinery). The large area of the stockpile could reduce infiltration and locally reduce groundwater levels, however this is likely to be minimal and temporary. Foundations required for viaducts have potential to alter groundwater flow regime, however any change is likely to be localised and minimal.	Contamination control measures as required by the draft CoCP Section 16. Sustainable drainage systems (SuDS) such as infiltration trenches will be located where gravity transfer is feasible to facilitate groundwater recharge.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent).

[19] Map references taken from Volume 5: Map Book - Water resources, Map WR-02-022 and Volume 5: Map Book - Ecology, Maps EC-01 to EC-04
[20] For examples of receptor value see Table 43 in the SMR addendum Volume 5 Appendix CT-001-000/2.

Groundwater receptor[19] (and value) [20]	**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**
Secondary B bedrock aquifer: Mercia Mudstone Group (moderate).	Various including: Streethay Cutting; Foundations for viaducts and bridges; Road realignments; embankments; stockpiles; worksites and construction compounds; Retaining walls; Construction traffic route.	Moderate adverse	Dewatering may reduce the groundwater levels within the aquifer. Potential for contaminants to enter groundwater during construction (e.g. suspended solids, leaks from machinery). Reduced infiltration could locally reduce groundwater levels, however this is likely to be minimal and temporary. Foundations required for viaducts have potential to alter groundwater flow regime, however any change is likely to be localised and minimal.	Contamination control measures as required by the draft CoCP Section 16. SuDS such as infiltration trenches will be located where gravity transfer is feasible to facilitate groundwater recharge.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent).
Alluvium Secondary A aquifer (moderate).	Embankments; Viaducts.	Minor adverse	Reduced infiltration could locally reduce groundwater levels, however this is likely to be minimal and temporary. Foundations required for viaducts have potential to alter groundwater flow regime, however any change is likely to be localised and minimal.	None required	Minor Slight (not significant)	None required	Minor Slight (not significant)	None

Groundwater receptor[19] (and value) [20]	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
River Terrace Deposits Secondary A aquifer (moderate).	Curborough embankment	Minor adverse	Reduced infiltration could locally reduce groundwater levels, however this is likely to be minimal and temporary.	None required	Minor Slight (not significant)	None required	Minor Slight (not significant)	None
Glaciofluvial Sheet Deposits Secondary A aquifer (moderate).	Road realignments; embankments; stockpiles; worksites and construction compounds; Foundations for viaducts and bridges; Construction traffic routes.	Moderate adverse	Reduced infiltration could locally reduce groundwater levels, however this is likely to be minimal and temporary. Foundations required for viaducts have potential to alter groundwater flow regime, however any change is likely to be localised and minimal. Potential for contaminants to enter groundwater during construction (e.g. suspended solids, leaks from machinery).	Contamination control measures as required by the draft CoCP Section 16. SuDS such as infiltration trenches will be located where gravity transfer is feasible to facilitate groundwater recharge.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent).
Abstractions								
SPZ Groundwater Abstraction (assumed) at Streethay Lodge (high). 760m west of the route. Map WR-02-022 (G5) located 850m south-west of WCML overbridge.	Streethay cutting	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor[19] (and value)[20]	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
03/28/07/0097 Seedy Mill - Borehole G (Water Treatment Works) (moderate), 520m south-west of the route Map WR-02-022 (D6). Located 520m south-west of Bourne Brook viaduct.	Shaw Lane embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
03/28/07/0097 Seedy Mill - Borehole H (Water Treatment Works) (moderate) 520m south-west of the route. Map WR-02-022 (D6). Located 520m south-west of Bourne Brook viaduct.	Shaw Lane embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
SPZ Groundwater Abstraction (assumed) Seedy Mill (high) 660m south-west of the route. Map WR-02-022 (D6). Located 660m south-west of Bourne Brook viaduct.	Shaw Lane embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Water Dependent Habitats								
Whittington Heath Golf Club (moderate), will be crossed by the route.	Whittington Heath embankment	Minor adverse	Receptor is crossed by the route. Piling activities, reduced infiltration and minor	None required	Minor Slight	None required	Minor Slight	Construction (Temporary)

Groundwater receptor[19] (and value)[20]	**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**
Map EC- 01-061b, (B6), located 1.1km south-west of Whittington.			excavations in vicinity could locally reduce groundwater levels, however this is likely to be minimal and temporary. Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.		(not significant)		(not significant)	
Coventry Canal: Huddlesford to Whittington (moderate), 440m east of the route. Map EC- 01-062, (F3), stretch of canal between Hudllesford and Whittington.	Whittington Common cutting; Streethay cutting; Embankments.	Negligible	Receptor assessed as unlikely to be groundwater dependent.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Wyrley and Essington Canal (high), will be crossed by the route. Map EC- 01-062, (F5), stretch of canal between Darnform and Huddlesford.	Huddlesford embankment; Fulfen Wood embankment; Canal Diversion; Capper's Lane viaduct	Negligible	Receptor assessed as unlikely to be groundwater dependent.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Huddlesford Strip (moderate), 530m east of the route. Map EC- 01-062, (E2), located along Park Lane, running eastwards from Huddlesford	Fulfen Wood embankment; Streethay cutting.	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral	None required	Negligible Neutral	None

Groundwater receptor[19] (and value) [20]	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
towards Burton Road, 530m east of WCML overbridge.					(not significant)		(not significant)	
Coventry Canal and associated habitats (high), 170m east of the route. Map EC- 01-062, (D5), stretch of canal between Whittington and Streethay.	Streethay cutting	Negligible	Receptor assessed as unlikely to be groundwater dependent as this is an artificial watercourse and is therefore isolated from groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Undesignated woodland with drains and a pool (moderate), will be crossed by the route. Map EC- 01-063, (H5), situated approximately 220m south-west of East Hill Business Park, Fradley.	Streethay cutting; Curborough embankment; Road realignments.	Minor adverse	Crossed by the route. Parts of the receptor and the pool are likely to be lost to the scheme and, therefore, have not been assessed. Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater. Reduced infiltration could locally reduce groundwater levels, however this is likely to be minimal and temporary.	None required	Minor Slight (not significant)	None required	Minor Slight (not significant)	Construction (Temporary)
Curborough House (south) hedgerows (moderate), 760m west of the route.	Curborough embankment.	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor[19] (and value)[20]	**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**
EC- 01-063, (G9), located 1km south of Curborough Brook viaduct.								
Curborough House Hedgerows (moderate), 100m west of the route. EC- 01-063, (E7), located 550m south-east of Curborough Brook viaduct.	Curborough embankment.	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Big Lyntus (high), west adjacent to the route. EC- 01-063, (D7), located 95m south of Curborough Brook viaduct.	Curborough embankment; Curborough Brook viaduct; Road realignments; worksites and construction compounds.	Negligible	Receptor assessed as unlikely to be groundwater dependent as there is no evidence that the receptor is wet. Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Kings Bromley Wharf to Fradley Jn, Coventry Canal (moderate), 35m east of the route. Will be crossed by the Manchester Spur. EC- 01-063, (C5), located 35m north-east of Curborough Brook viaduct.	Curborough embankment; Curborough Brook viaduct; Ravenshaw Wood embankment.	Negligible	Receptor assessed as unlikely to be groundwater dependent as this is an artificial watercourse and is therefore isolated from groundwater. Not located within zone of influence therefore unlikely to	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor[19] (and value) [20]	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
			receive adverse impacts from changes to groundwater.					
Fradley Wood (moderate), 280m east of the route. Will be crossed by Manchester Spur. EC- 01-063, (C4), located 100m south of Trent and Mersey Canal viaduct.	Fradley Wood embankment Trent and Mersey Canal viaduct Brokendown Wood embankment Manchester spur.	Minor adverse	Crossed by Manchester Spur. Parts of the receptor are likely to be removed during construction of the AP2 revised scheme Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater. Piling activities, reduced infiltration and minor excavations in vicinity could have a minor impact on the water balance of the site.	None required	Minor Slight (not significant)	None required	Minor Slight (not significant)	Construction (Temporary)
Trent and Mersey Canal and associated habitat (high), 35m east of the route. Will be crossed by the Manchester Spur. EC- 01-063, (C7), will be crossed by Trent and Mersey Canal viaduct.	Curborough embankment; Curborough Brook viaduct; Ravenshaw Wood embankment.	Negligible	Receptor assessed as unlikely to be groundwater dependent as this is an artificial watercourse and is therefore isolated from groundwater. Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Curborough Hall Farm Hedgerows (moderate), 300m south-west of the route	Curborough embankment;	Negligible	Not located within zone of influence therefore unlikely to	None required	Negligible Neutral	None required	Negligible Neutral	None

Groundwater receptor[19] (and value)[20]	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
EC- 01-063, (D10), located 300m south-west of Curborough Brook viaduct.	Curborough Brook viaduct; Ravenshaw Wood embankment.		receive adverse impacts from changes to groundwater.		(not significant)		(not significant)	
Pool Wood and Fradley Reservoir (moderate), 830m north-east of the route. 370m east of Manchester Spur. EC- 01-063, (A3), located at Fradley Junction, 390m north-east of Trent and Mersey Canal viaduct.	Trent and Mersey Canal viaduct Curborough Embankment.	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Wood End Lock (near) (moderate), will be crossed by the route. EC- 01-063, (C7), located on the outer bend of the Trent and Mersey Canal close to Wood End Farm, will be crossed by Curborough Brook viaduct.	Curborough embankment; Curborough Brook viaduct; Ravenshaw Wood embankment.	Minor adverse	Crossed by the route. Parts of the receptor are likely to be lost to the scheme and, therefore, have not been assessed. Reduced infiltration could locally reduce groundwater levels, however this is likely to be minimal and temporary. Foundations required for viaducts have potential to alter groundwater flow regime, however any change is likely to be localised and minimal.	None required	Minor Slight (not significant)	None required	Minor Slight (not significant)	Construction (Temporary)

Groundwater receptor[19] (and value)[20]	**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**
Curborough Brook and associated habitat (moderate), will be crossed by the route. Map: EC- 01-063, (B7), located on the inner bend of the Trent and Mersey Canal, will be crossed by Curorough Brook viaduct.	Curborough embankment; Curborough Brook viaduct; Ravenshaw Wood embankment.	Minor adverse	Reduced infiltration could locally reduce groundwater levels, however this is likely to be minimal and temporary. Foundations required for viaducts have potential to alter groundwater flow regime, however any change is likely to be localised and minimal.	None required	Minor Slight (not significant)	None required	Minor Slight (not significant)	Construction (Temporary)
Ravenshaw Wood, Black Slough and Slash (high), will be crossed by the route Map: EC- 01-064, (G6), located 470m north-west of Curborough Brook viaduct.	Ravenshaw Wood embankment Trent and Mersey Canal West viaducts.	Minor adverse	Will be crossed by the route. Parts of the receptor are likely to be removed during construction of the AP2 revised scheme. Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater. Reduced infiltration and minor excavations in vicinity could have a minor impact on the water balance of the site.	SuDS in the form of infiltration trenches will be located where gravity transfer is feasible to facilitate groundwater recharge. Contamination control measures as required by the draft CoCP Section 16.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)
Tomhay Wood (high), 300m south of the route. Map: EC- 01-064, (G9), located 1.3km west of Curborough Brook viaduct.	Ravenshaw Wood embankment.	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor[19] (and value) [20]	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
Vicar's Coppice (high), 20m south of the route. Map EC- 01-064, (E8), located 65mwest of A515 Lichfield Road underbridge.	Ravenshaw Wood embankment.	Minor adverse	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater. Reduced infiltration and minor excavations in vicinity could have a minor impact on the water balance of the site.	SuDS in the form of infiltration trenches will be located where gravity transfer is feasible to facilitate groundwater recharge. Contamination control measures as required by the draft CoCP Section 16.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)
The Roundabout (moderate), 770m south of the route, Map EC- 01-064, (E10), located 745m south-west of A515 Lichfield Road underbridge.	Ravenshaw Wood embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
John's Gorse, Hanch Wood (high), will be crossed by the route. Map EC-01-064, (D7), located 240m north-west of A515 Lichfield Road underbridge.	Ravenshaw Wood embankment; Bourne Brook viaduct; Shaw Lane embankment	Minor adverse	Crossed by the route. Parts of the receptor are likely to be removed during construction of the AP2 revised scheme. Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	SuDS in the form of infiltration trenches will be located where gravity transfer is feasible to facilitate groundwater recharge.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Groundwater receptor[19] (and value)[20]	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
			Piling activities, reduced infiltration and minor excavations in vicinity could have a minor impact on the water balance of the site.	Contamination control measures as required by the draft CoCP Section 16.				
Unnamed ancient woodland south west of Hanchwood House (moderate), will be crossed by the route. Map EC- 01-064, (C8), 495m north-west of A515 Lichfield Road underbridge	Shaw Lane embankment	Minor adverse	Receptor assessed as unlikely to be groundwater dependent as there is no evidence that the site is wet and there are no groundwater features such as springs in the vicinity	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Riley Hill (moderate) Map EC- 01-064, (D2). Located 1.2km north-east of A515 Lichfield Road underbridge.	Shaw Lane embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Tuppenhurst Lane (west of) (moderate), 10m north-east of the route Map EC- 01-065, (G5). Located 565m north-west of Harvey's Rough flyover.	Lilac embankment. Handsacre retained wall Handsacre East culvert.	Minor adverse	Will be crossed by the route. Parts of the receptor are likely to be removed during construction of the AP2 revised scheme Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater. Piling activities, reduced infiltration and minor	None required	Minor Slight (not significant)	None required	Minor Slight (not significant)	Construction (Temporary)

Groundwater receptor[19] (and value) [20]	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
			excavations in vicinity could have a minor impact on the water balance of the site.					
Groundwater/ Surface Water Interactions								
Drain will be crossed by the route. (moderate) Map WR-02-022 (G5) will be crossed by Capper's Lane viaduct.	Huddlesford embankment Capper's Lane viaduct	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues north of Fulfen Farm, 430m west of the route. (moderate) Map WR-02-022 (G5) located 430m west of WCML overbridge.	Streethay cutting Capper's Lane main compound; Fulfen Wood Watercourse diversion.	Moderate adverse	Assessed as not a groundwater issue, identified as a culvert issue.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Pond in Fulfen Wood, 45m west of the route. (low) Map WR-02-022 (G5) located 30m north of WCML overbridge.	Streethay cutting	Major adverse	Within the land required for the AP2 revised scheme and, therefore, pond assumed to be removed during construction of the AP2 revised scheme.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				
Pond in Fulfen Wood, 150m east of the route. (low) Map WR-02-022 (G5) located 230m north-east of WCML overbridge.	Streethay cutting	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor[19] (and value) [20]	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
Tributary of Mare Brook, will be crossed by the route. (moderate) Map WR-02-022 (G5) located 225m north of WCML overbridge.	Streethay cutting; Fulfen Wood Watercourse diversion; Fulfen Wood culvert. Worksites and construction compounds.	Major adverse	The watercourse is to be diverted where it will follow a new drainage channel to be crossed by Fulfen Wood culvert. The watercourse is within the zone of influence. The potential reduction in groundwater levels may locally reduce the volume of water in the stream. Potential for contaminants to enter groundwater during construction (i.e. suspended solids, leaks from machinery). Reduced infiltration could locally reduce groundwater levels, however this is likely to be minimal and temporary.	SuDS in the form of infiltration trenches will be located where gravity transfer is feasible to facilitate groundwater recharge. Contamination control measures as required by the draft CoCP Section 16.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
Pond at Hill Farm, 20m west of the route. (low) Map WR-02-022 (F4) located 465m south of A38 overbridge.	Streethay cutting;	Major adverse	Within the land required for the AP2 revised scheme and, therefore, pond assumed to be removed during construction of the AP2 revised scheme.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				
Issues, 1,100m west of the route. (moderate)	Streethay cutting	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral	None required	Negligible Neutral	None

Groundwater receptor[19] (and value) [20]	**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**
Map WR-02-022 (F5) located 1.1km west of A38 overbridge.					(not significant)		(not significant)	
Tributary of Mare Brook, will be crossed by the route. (moderate) Map WR-02-022 (G5) located 600m north of A38 overbridge.	Streethay cutting; Mare Brook South culvert; Mare Brook South watercourse diversion.	Major adverse	The watercourse is to be diverted where it will follow a new drainage channel to be crossed by Mare Brook South culvert. The watercourse is within the zone of influence. The potential reduction in groundwater levels may locally reduce the volume of water in the stream. Potential for contaminants to enter groundwater during construction (i.e. suspended solids, leaks from machinery). Reduced infiltration could locally reduce groundwater levels, however this is likely to be minimal and temporary.	SuDS in the form of infiltration trenches will be located where gravity transfer is feasible to facilitate groundwater recharge. Contamination control measures as required by the draft CoCP Section 16.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
Pond 190m north-west of "Rough Stockings", 70m east of the route. (low) Map WR-02-022 (F4) located 740m north of A38 overbridge.	Streethay cutting	Major adverse	Within the land required for the AP2 revised scheme and, therefore, pond assumed to be removed during construction of the AP2 revised scheme.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				

Groundwater receptor[19] (and value)[20]	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
Two ponds 300m north-west of "Rough Stockings", will be crossed by the route. (low) Map WR-02-022 (F4) located 800m north of A38 overbridge.	Streethay cutting; Curborough embankment; Mare Brook South culvert.	Major adverse	Within the land required for the AP2 revised scheme and, therefore, pond assumed to be removed during construction of the AP2 revised scheme.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				
Minor tributary of River Trent, 130m east of the route. (moderate) Map WR-02-022 (F4) located 1km north of A38 overbridge.	Curborough embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Minor tributary of River Trent, east adjacent to the route. (moderate) Map WR-02-022 (F4). Located 1.2km north of A38 overbridge.	Curborough embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues 650m north-east of Curborough Farm, 135m west of the route. (moderate) Map WR-02-022 (F4) located 1km south of Trent and Mersey Canal viaduct.	Curborough embankment; Curborough Dive-under	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor[19] (and value)[20]	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
Pond 20m west of "Little Lyntus" woodland, 50m west of the route. Map WR-02-022 (F4) located 700m south of Trent and Mersey Canal viaduct.	Curborough embankment	Major adverse	Within the land required for the AP2 revised scheme and, therefore, pond assumed to be removed during construction of the AP2 revised scheme.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				
Issues 300m west of New Bridge, 900m north-east of Manchester Spur. (moderate) Map WR-02-022 (E3) located 940m east of Trent and Mersey Canal viaducts.	Curborough Flyover	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Drain in Fradley Wood Map WR-02-022 (E4) located 190m south of Trent and Mersey Canal viaduct.	Curborough Flyover	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Drain in Fradley Wood Map WR-02-022 (E4) located 100m south of Trent and Mersey Canal viaduct.	Curborough Flyover	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Pond at Woodend Lock (near) LWS, will be crossed by the route	Curborough embankment,	Major adverse	Within the land required for the AP2 revised scheme and, therefore, pond assumed to be	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				

Groundwater receptor[19] (and value)[20]	**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**
Map WR-02-022 (E4) located 20m south-east of Curborough Brook viaduct.	Curborough Brook viaduct		removed during construction of the AP2 revised scheme.					
Drain in Ravenshaw Wood, will be crossed by the route. (moderate) Map WR-02-22 (E5) located 640m north-west of Curborough Brook viaduct.	Ravenshaw Wood embankment; Wood End Lane overbridge.	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Pond 100m west of Black Slough Wood, 35m north-east of the route. (low) Map WR-02-022 (D5) located 740m south-east of Bourne Brook viaduct.	Ravenshaw Wood embankment	Major adverse	Within the land required for the AP2 revised scheme and, therefore, pond assumed to be removed during construction of the AP2 revised scheme.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				
Drain by Black Slough will be crossed by the route. (moderate) Map WR-02-022 (D5) located 50m south of Bourne Brook viaduct.	Ravenshaw Wood embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues at Rileyhill Farm 950m east of the route. (moderate)	Ravenshaw Wood embankment;	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral	None required	Negligible Neutral	None

Groundwater receptor[19] (and value) [20]	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
Map WR-02-022 (D4) located 950m east of Bourne Brook viaduct	Shaw Lane embankment.				(not significant)		(not significant)	
Two ponds 150m north of junction of A515 with Wood End Lane, 90m south-west of the route. (low) Map WR-02-022 (D5) located 50m south of Bourne Brook viaduct.	Ravenshaw Wood embankment; Bourne Brook viaduct.	Major adverse	Within the land required for the AP2 revised scheme and, therefore, pond assumed to be removed during construction of the AP2 revised scheme.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				
Pond 260m east of Hanch Hall Farm, 250m west of the route. Will be crossed by connection with West Coast Main Line. (low) Map WR-02-022 (D5) located 260m south-west of Bourne Brook viaduct.	Bourne Brook viaduct	Major adverse	Within the land required for the AP2 revised scheme and, therefore, pond assumed to be removed during construction of the AP2 revised scheme.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				
Bourne-Bilson Brook, will be crossed by the route. (high/ very high) Map WR-02-022 (D5). Will be crossed by Bourne Brook viaduct.	Bourne Brook viaduct Shaw Lane embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Pond within John's Gorse, will be crossed by the route. (low)	Bourne Brook viaduct	Major adverse	Within the land required for the AP2 revised scheme and,	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				

Groundwater receptor[19] (and value)[20]	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
Map WR-02-022 (D5) located 150m north-west of Bourne Brook viaduct.			therefore, pond assumed to be removed during construction of the AP2 revised scheme.					
Two ponds 420m south-west of Kings Bromley Wharf Marina, 200m north-east of the route. (low) Map WR-02-022 (D5) located 220m north of Bourne Brook viaduct.	Shaw Lane Embankment; Bourne Brook viaduct; Worksites and stockpile.	Major adverse	Within the land required for the AP2 revised scheme and therefore pond assumed to be removed during construction of the AP2 revised scheme.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				
Drain, will be crossed by the route. (moderate) Map WR-02-022 (D5). Will be crossed by Harvey's Rough flyover.	Shaw Lane embankment Harvey's Rough flyover	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Pond 220m north-west of Shaw House, 60m north-east of the route. (low) Map WR-02-022 (D5) located 50m north-east of Harvey's Rough flyover.	Harvey's Rough flyover	Major adverse	Within the land required for the AP2 revised scheme and therefore pond assumed to be removed during construction of the AP2 revised scheme.	Refer to Ecology SES and AP2 ES Volume 2, CFA Report 22, Section 10.				
Minor tributary of River Trent, will be crossed by the route. (moderate)	Lilac embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral	None required	Negligible Neutral	None

Groundwater receptor[19] (and value)[20]	**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**
Map WR-02-022 (D6) located 320m north-west of Harvey's Rough flyover.					(not significant)		(not significant)	
Issues 350m west of Ashton Hayes Farm, 270m west of the route. (moderate) Map WR-02-022 (D6) located 535m north-west of Harvey's Rough flyover.	Lilac embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Minor tributary of River Trent, will be crossed by the route. (moderate) Map WR-02-022 (D6) located 590m north-west of Harvey's Rough flyover.	Lilac embankment. Handsacre retaining wall	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Minor tributary of River Trent, will be crossed by the route. (moderate) Map WR-02-022 (D6) located 630m north-west of Harvey's Rough flyover.	Lilac embankment. Handsacre retaining wall Handsacre East culvert	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues 300m north-west of Ashton Hayes Farm, 25m west of the route. (moderate)	Lilac embankment.	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral	None required	Negligible Neutral	None

Groundwater receptor[19] (and value)[20]	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
Map WR-02-022 (C6) located 670m north-west of Harvey's Rough flyover.	Handsacre retaining wall				(not significant)		(not significant)	
Issues at Brook Cottages, 455m west of the route. (moderate) Map WR-02-022 (C6) located 1km north-west of Harvey's Rough flyover.	Lilac embankment. Handsacre retaining wall	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Minor tributary of River Trent, will be crossed by the route. (moderate) Map WR-02-022 (C6) located 1km north-west of Harvey's Rough flyover.	Lilac embankment. Handsacre retaining wall Handsacre West culvert extension.	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Spring at White Gables, 200m west of the route. (moderate) Map WR-02-022 (C6) located 1km north-west of Harvey's flyover.	Lilac embankment. Handsacre retaining wall	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Spring at Hood Lane Covert, 1,000m west of the route. (moderate)	Lilac embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor[19] (and value)[20]	**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**
Map WR-02-022 (C6) located 1.7km north-west of Harvey's Rough flyover								
Sinks at Brick Kiln Farm, 740m north-west of the route. (moderate) Map WR-02-022 (C6) located 650m south west of Handsacre (centre).	Lilac embankment.	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues 100m south of Old Road Farm, 800m north-east of the route. (moderate) Map WR-02-022 (C6). Located 550m north west of Handsacre (centre).	Lilac embankment.	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues 200m west of Station Drive Handsacre, 450m north-west of the route. (moderate) Map WR-02-022 (C6) located 250m south west of Handsacre (centre)	West Coast Main Line embankment	Negligible	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

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Environmental topic:	Water resources and flood risk assessment	WR
Appendix name:	Water resources assessment	003
Community forum area:	022	022

Contents

1 Introduction **1**

1.1 Structure of the water resources and flood risk assessment appendices 1

1.2 Scope of this assessment 1

1.3 Location 2

2 Flood risk assessment methodology **4**

2.1 Source-pathway-receptor model 4

2.2 Flood risk categories 4

2.3 National Planning Policy Framework 5

2.4 Local flooding planning policy documents 6

2.5 Historical sources of flooding 6

2.6 Flood risk approach 7

3 Design criteria **11**

3.1 Principal design criteria 11

3.2 Flood risk design approach statement 11

3.3 Cross drainage design approach statement 12

4 Data sources **13**

5 The AP2 revised scheme **14**

5.1 Permanent works 14

5.2 Temporary works 17

6 Existing flood risk **18**

6.2 River flooding 18

6.3 Surface water/overland flow 20

6.4 Groundwater 22

6.5 Sewer systems 22

6.6 Artificial sources 23

6.7 Summary 24

7 Flood risk management measures **25**

7.1 River flood risk 25

7.2 Surface water flood risk 25

7.3 Risk of flooding from groundwater 26
7.4 Risk of flooding from sewer systems 26
7.5 Risk of flooding from artificial sources 26
8 Post development flood risk assessment 27
8.1 River flooding 27
8.2 Surface water/overland flow 31
8.3 Groundwater 34
8.4 Sewer systems 35
8.5 Artificial sources 35
8.6 Summary 37
9 Conclusions 38
9.2 Residual flood risk to the AP2 revised scheme 39
9.3 Residual effects of the AP2 revised scheme on flood risk 41
10 References 42

List of figures

Figure 1 - Location Plan 3

List of tables

Table 1 - Flood risk category matrix for all flooding sources 5
Table 2 - Whittington to Handsacre river flood risk 18
Table 3 - Whittington to Handsacre sources of surface water flooding 21
Table 4 - Whittington to Handsacre river flood risk 27
Table 5 - River flood risks to the other design elements 28
Table 6 - River flood risk to temporary works 29
Table 7 - Surface water flood risks to other design elements of the AP2 Scheme 32
Table 8 - Sources of surface water flooding to temporary works 33
Table 9 - Summary of Flood Risk Receptors showing the overall magnitude of impact and significance of effects 38

1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

1.1.1 The water resources and flood risk assessment appendices comprise four parts. The first of these is a route-wide appendix (Appendix WR-001-000).

1.1.2 Three specific appendices for each community forum area (CFA) are also provided. For the Whittington to Handsacre area (CFA22) these are:

- a water resources assessment (SES and AP2 Appendix WR-002-022); and
- a Flood Risk Assessment (FRA) i.e. this appendix; and
- a river modelling report (SES and AP2 Appendix WR-004-015).

1.1.3 Maps referred to throughout the water resources and FRA appendices are contained in the Volume 5 Water resources Map Book.

1.2 Scope of this assessment

1.2.1 This FRA considers the assessment of flood risk in this study area, which is defined as the area within 1km of the route within CFA22. The assessment has been carried out in accordance with the requirements of the National Planning Policy Framework (NPPF)[1], which 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 without increasing flood risk elsewhere.

1.2.2 This FRA presents baseline (current day) flood risk and post-construction flood risk as a result of the AP2 revised scheme and has been written to demonstrate the relative change in flood risk as a result of the AP2 revised scheme. Whilst all change in risk status is highlighted, the focus of the document is on the change in risk status to local receptors, particularly existing infrastructure.

1.2.3 A risk-based methodology has been adopted through the application of the source-pathway-receptor model. This model has been used to identify the cause of 'sources' of flooding to and from a development. The identification is based on a review of local conditions and consideration of the effects of climate change.

1.2.4 In order for there to be a flood risk, all the elements of the model (a flood source, a pathway and a receptor) must be present. Furthermore, effective mitigation can be provided by removing one element of the model, for example by removing the pathway or receptor.

1.2.5 Receptors may include people and their properties, business and infrastructure, and the built and natural environment within the range of the flood source which are connected to the source of flooding by a pathway.

[1] Department for Communities and Local Government (2012) *National Planning Policy Framework*

1.2.6 This FRA has been completed to inform the Environmental Statement (ES) for the works, which will be a key part of the hybrid Bill submission required for the AP2 revised scheme. The hybrid Bill is necessary for powers to build the railway, powers to buy land and for planning consent.

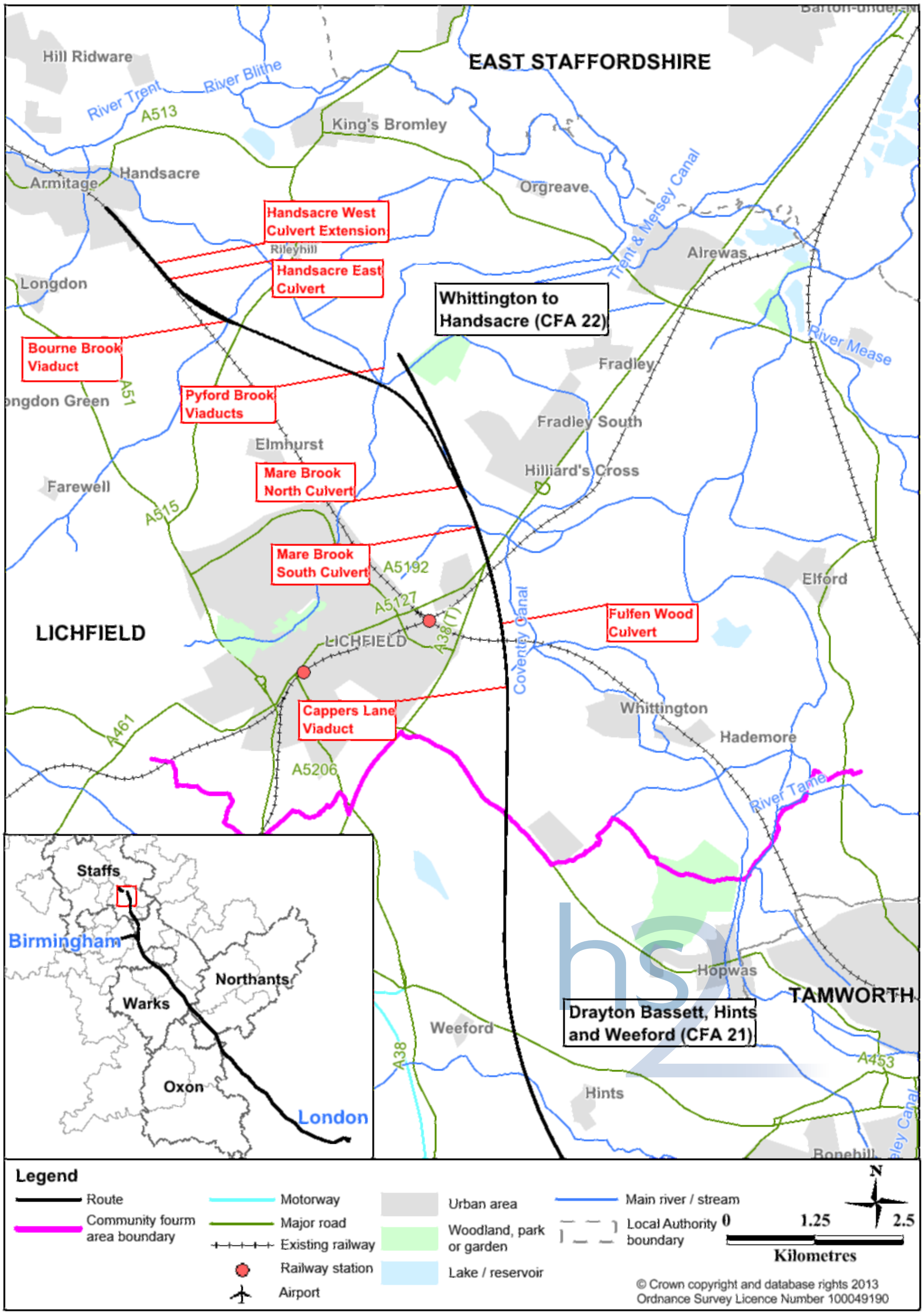
1.2.7 The scheme will cross numerous surface water features within this study area, which are the Mare Brook, Curborough Brook, Bourne Brook and associated tributaries, including tributaries of the River Trent.

1.3 Location

1.3.1 In this FRA, the study area covers an 11.9km section of the AP2 revised scheme in Staffordshire, where it passes to the east of Lichfield. It extends from the A51 in the south at Whittington Heath, passing over the A38 east of Lichfield and up to Handsacre in the north. The study area includes land within the communities of Whittington, Lichfield, Fradley South, Alrewas, Kings Bromley and Handsacre.

1.3.2 A location plan of the AP2 revised scheme within this study area is shown on Figure 1.

Figure 1 - Location Plan



2 Flood risk assessment methodology

2.1 Source-pathway-receptor model

2.1.1 Flood risk is assessed using the source-pathway-receptor model. In this model, individual sources of flooding within the study area are identified. The primary source of flooding is rainfall, which is a direct source in the short term (surface water flooding) and can lead to flooding from watercourses (river flooding) and overloaded man-made collection systems (sewers) in the short or medium term. Stored rainfall, either naturally in aquifers (groundwater) and natural lakes or artificially impounded reservoirs and canals can lead to flooding when the storage capacity of the system is exceeded. A final source of flooding arises from tidal effects and storm surges caused by low pressure systems over the sea. However, given the inland location of this study area, this final source of flooding does not pose a risk.

2.1.2 For there to be a risk of flooding at an individual receptor there must be a pathway linking it to the source of flooding. The pathways within the study area are assessed by reviewing national datasets that show the spatial distribution of flood risk. The associated risk magnitude is then categorised.

2.1.3 In general, receptors considered in this assessment include the AP2 revised scheme and existing development within 1km of the route. However, any receptors beyond this where a significant impact was expected were considered in this assessment. The AP2 revised scheme includes all associated temporary and permanent infrastructure. Areas of interest are identified through comparison of the national spatial datasets with the design drawings. Where a risk is identified, mitigation is required as part of the design to prevent an increase in flood risk in line with recommendations in the NPPF.

2.1.4 The vulnerability of each receptor is classified using Table 2 of the NPPF Technical Guidance Document[2].

2.1.5 The assessment then considers the vulnerability of the receptor with reference to the flood risk category of the source using Table 3 of the NPPF Technical Guidance Document and assesses whether the scheme has any potential to influence or alter the risk of flooding to each receptor. The AP2 revised scheme will ensure that there is no adverse effect on the risk of flooding to third party receptors, and therefore, where such potential exists, mitigation is proposed based on further analysis.

2.1.6 The FRA defines the baseline flood risk and vulnerability of receptors. This is used to define the value, importance and significance of effects which is provided within the ES.

2.2 Flood risk categories

2.2.1 The level of flood risk is categorised by assessing the design elements against the datasets for each source. A matrix showing the flood risk category associated with each flooding source is presented in Table 1.

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[2] Department for Communities and Local Government (2012) *National Planning Policy Framework Technical Guidance*.

Table 1 - Flood risk category matrix for all flooding sources

Source of flooding	**Flood risk category**				
	No risk	**Low**	**Medium**	**High**	**Very high**
Watercourse[3]		Flood Zone 1	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
Surface water overland flow[4]	No flood risk shown on uFMfSW	Between the 1 in 1000 and 1 in 100 annual probability on the uFMfSW	Between the 1 in 100 and 1 in 30 annual probability on the uFMfSW	uFMfSW shows risk greater than 1 in 30 annual probability.	
Groundwater[5]		Very low-low	Moderate	High-very high	
Drainage and sewer systems[6]	No sewer in vicinity of site	Surcharge point >20m from site and no pathways	Surcharge point within 20m of site and restricted pathways	Sewer network crosses site and pathways exist	
Artificial sources[7]	Outside of inundation mapping/no pathway exists	Within inundation mapping/pathway exists			

2.3 National Planning Policy Framework

2.3.1 This assessment of flood risk makes use of the NPPF which is the Government's planning policy in relation to development and flood risk. It is set out within the NPPF that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. The NPPF requires that proposed development located within Flood Zones 2 and 3 is assessed in relation to flood risk. This includes both flood risk to the development and any increases in flood risk elsewhere as a result of the development, with an allowance for climate change.

2.3.2 Methods used to ensure that development is at the lowest possible risk and that the development is safe without causing an increased risk elsewhere includes the application of the Sequential and Exception Tests. However, the Sequential Test has been considered as part of the overview FRA for the AP2 revised scheme presented in Volume 3 of the ES and hence has not been repeated in this FRA.

Flood zone classification

2.3.3 The NPPF splits the Environment Agency's Flood Map into three separate Flood Zones. These Flood Zones should be used in determining the appropriateness of proposed development uses and they represent flooding without flood defences in place.

[3] River flood risk taken from the Environment Agency Flood Zone mapping or hydraulic modelling carried out for this FRA.
[4] Surface water flood risk taken from the Environment Agency updated Flood Maps for Surface Water (uFMfSW).
[5] Groundwater flood risk taken from local flood risk assessment reports.
[6] Identified using the Severn Trent Water's assets network and the South Staffordshire Water's assets network.
[7] Risk from reservoir flooding identified using the Environment Agency reservoir inundation mapping, canal flooding taken from identifying proximity of the AP2 Scheme to canals from Ordnance Survey mapping.

2.3.4 The Flood Zones are defined as:

- Flood Zone 1 – Areas with a 'low probability' of flooding and where the annual probability of flooding is lower than 0.1% for either river or sea flooding. The NPPF imposes no constraints upon the type of development within Flood Zone 1;
- Flood Zone 2 – Areas with a 'medium probability' of flooding and where the annual probability of flooding is between 0.1 and 1.0% for river flooding or between 0.5 and 0.1% for sea flooding. The NPPF recommends that Flood Zone 2 is suitable for most types of development with the exception of 'highly vulnerable' land uses; and
- Flood Zone 3 – Areas with a 'high probability' of flooding and where the annual probability of flooding is 1.0% or greater for river flooding or 0.5% or greater for sea flooding. The NPPF recommends that appropriate development is based upon a further classification of Flood Zone 3: 3a high probability and 3b functional floodplain (where water has to flow or be stored in times of flood).

2.4 Local flooding planning policy documents

2.4.1 The local policies for this study area with implications in relation to flood risk are:

- Lichfield District Local Plan 1998[8] – Policy E15. Policy E15 states that flood protection will not generally support development in areas at risk of flooding, unless suitable preventative measures are undertaken. The policy states that development that would result in the loss of maintenance access to watercourses, the loss of natural floodplain, in adverse effects on river defences, or in substantial changes in the characteristics of surface water run-off, will not be permitted.

2.4.2 The Lichfield District Council Strategic Flood Risk Assessment (SFRA)[9] and the Staffordshire Preliminary Flood Risk Assessment (PFRA)[10] aid the Council in preparing sustainable policies for the long-term management of flood risk and improving existing emergency planning procedures. The SFRA is used as an evidence base to promote the location of future development primarily in low flood risk areas. This SFRA has been used to inform this FRA.

2.5 Historical sources of flooding

2.5.1 The historical flooding which has occurred either at the location of the route or in close proximity have been determined as part of this FRA. These areas of historical flooding have been identified because places which have flooded in the past may be more susceptible to flooding in the future. Two sources of data relating to historical flooding have been used: local authority information (the relevant SFRA and PFRA) and extents of historical sources of river flooding as provided by the Environment Agency.

[8] Lichfield District Council, (1998). *Lichfield District Local Plan*
[9] Lichfield District Council (2008) *Lichfield* Strategic Flood Risk Assessment. Completed by Halcrow Group Ltd.
10 Staffordshire County Council (2011) Staffordshire Preliminary Flood Risk Assessment. Completed by Royal Haskoning on behalf of Staffordshire County Council.

2.6 Flood risk approach

River flooding approach

Crossing locations

2.6.1 To determine the river flood risk at locations where the route will cross watercourses and to identify any changes in flood risk as a result of the AP2 revised scheme, either existing hydraulic models have been used where available or new hydraulic models have been constructed. Where new models were required flows have been determined in line with current flood estimation guidelines[11].

Flow estimation

2.6.2 The watercourses which will be crossed by the route within this study area have no known detailed modelling available. Where Flood Zones are associated with these watercourses, the outlines have been determined through the use of broad scale topographic data, which are considered to be a rough guide when determining areas at risk of flooding and hence have not be used for the design of engineering works. There are other watercourses which have no associated Environment Agency-derived Flood Zones. Flows for these watercourses, at the location of the proposed crossings, have been determined for the 1 in 20 (5%), 1 in 100 (1%), 1 in 100 (1%) with a 20% allowance for climate change and 1 in 1000 (0.1%) annual probability events.

2.6.3 A quick estimation of flow was produced at the crossing locations using the Revitalised Flood Hydrograph model (ReFH) where the contributing catchments were represented within the Flood Estimation Handbook (FEH) CD-ROM[12]. A FEH calculation record for the estimation of flow using ReFH is provided in the river modelling report (Volume 5, WR-004-015).

2.6.4 Small catchments (normally less than approximately 0.5km^2), such as at the two River Trent tributaries (SWC-CFA22-017; SWC-CFA22-018), are not represented on the FEH CD-ROM and hence it is not possible to either produce a catchment boundary or determine catchment descriptors (required for the estimation of flow) from this source. For crossings where the watercourse is not represented within the FEH CD-ROM, a scaling method based on area, in line with the flood estimation guidelines was carried out. Contributing catchment areas at crossing locations were determined using topographic and Ordnance Survey (OS) mapping; in areas of uncertainty slightly larger catchments were defined as a conservative approach. The flows estimated through the use of ReFH for catchments in the northern study areas of the AP2 Scheme were used to determine a scaling factor. The greatest flow per km2 was used as a scaling factor for the catchments in this study area which were manually determined. An error allowance of 10% was also applied to reduce the risk of underestimating flows.

Modelling approach

2.6.5 Suitable hydraulic models were not available at all crossings and so new hydraulic models were built utilising the high resolution Light Detection and Ranging (LiDAR)

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[11] Environment Agency (2012) *Flood estimation guidelines*.
[12] Centre for Ecology and Hydrology (2009) *FEH CD-ROM Version 3*, ©NERC (CEH).

data provided for the AP2 revised scheme. Further detail in relation to the hydraulic modelling is included in the river modelling report (Volume 5, WR-004-015).

2.6.6 There are several road embankments and other raised infrastructure across the watercourses which will potentially provide constriction to flows. The modelled Digital Terrain Model (DTM) had to be modified to allow for flows through culverts underneath these embankments. In the absence of any survey data of these road embankment culverts, a channel opening of 5m was incorporated at each of these embankments.

2.6.7 The inflow boundaries were mostly applied as steady state flows with unsteady state flows applied for certain watercourses. For watercourses with floodplain attenuation such as ponds and lakes or significant obstructions to flow (e.g. due to embankments), the inflows were modelled using unsteady state hydrographs. These models were run at longer durations covering the period of the hydrograph and attenuation. The resulting baseline (current) models were run for the 1 in 100 (1%) annual probability with an allowance climate change and 1 in 1000 (0.1%) events over a range of durations depending upon the flow conditions.

2.6.8 The AP2 revised scheme models included either viaducts or culverts depending on the scheme design. The railway embankments were represented by modifying the modelled DTM at those locations. The 1 in 100 (1%) annual probability with an allowance for climate change peak flood levels upstream of the crossings were compared to the baseline (current) levels to assess the change in flood risk. The 1 in 1000 (0.1%) annual probability peak levels were extracted to inform the vertical alignment of the track.

River flood risk elsewhere along the route

2.6.9 In addition to watercourse crossings, there are sections of the route which are located in areas potentially at risk of river flooding. These areas have been identified through the use of the Environment Agency Flood Zone mapping. This mapping has been used in preference to SFRA mapping as it is considered more up to date and hence likely to best reflect areas at risk. River flood risk to these sections of the route needs to be determined both to prevent an unacceptable risk to the AP2 revised scheme and to prevent it increasing flood risk as result of a reduction in floodplain storage.

Summary of river flooding approach

2.6.10 Due to the number of river crossings, varying complexities, and the amount of data and information available for each, at some locations the modelling approach is highly specific. These locations have been reported as such and further information is included in the river modelling report (Volume 5, WR-004-015).

Surface water flood risk

2.6.11 The baseline (current) assessment of surface water flood risk was completed using the updated Flood Maps for Surface Water (uFMfSW). The maps utilised for this assessment are listed as:

- High chance - the area that has a chance of flooding greater than 1 in 30 (3.3%);

- Medium chance - the area that has a chance of flooding between 1 in 100 (1%) and 1 in 30 (3.3%);
- Low chance - the area that has a chance of flooding between 1 in 1000 (0.1%) and 1 in 100 (1%); and
- Very low chance - the area that has a chance of flooding less than 1 in 1000 (0.1%).

2.6.12 This mapping identified sections of the route which currently are at specific risk from surface water flooding. The risk classification assigned at each location is dependent on which uFMfSW the receptor is located within.

2.6.13 The AP2 revised scheme has the potential to interrupt surface water flow which would require mitigation to prevent an increase in flood risk. In addition, other design elements such as landscaping will alter the permeability of the ground and hence modify sections of the surface water catchments. The assessment involved determining the land drainage catchments, surface water run-off from these catchments and the capacity of Sustainable Drainage Systems (SuDS) and culverts.

2.6.14 Land drainage catchments were identified using topographic data (primarily 5m contours, or 1m contours on small or unclear catchments). The assumption was made that linear features such as roads and railways do not act as a cut off for overland flow.

2.6.15 The calculation of greenfield run-off rates from existing catchments was undertaken using the online SuDS tool[13]. A growth factor of 30% was applied to the 1 in 100 (1%) annual probability rainfall event to determine the flow during this event with an allowance for climate change. A factor of 62% (based on calculations using the Flood Studies Supplementary Report 14[14]) was applied to the 1 in 100 (1%) annual probability rainfall event to determine the flow during the 1 in 1000 (0.1%) annual probability event.

2.6.16 Run-off from modified sections of the catchment as a result of the AP2 Scheme (e.g. landscape areas) which alter the permeability was determined using the Institute of Hydrology 124[15] methodology with a value of 0.5 for the soil parameter and a safety factor of 1.2.

2.6.17 Storage volumes were calculated using the online SuDS tool assuming that landscape areas will be impermeable. The storage volumes required were taken to be the sum of the attenuation and long term storage as a conservative approach.

2.6.18 The calculations for the proposed drainage design have been completed in line with the requirements in Volume 1, Section 9.

Groundwater flood risk

2.6.19 Groundwater bodies and aquifers present within a 1km buffer of the route have been identified and named on available web-based mapping data provided for the purposes of the AP2 revised scheme.

[13] HR Wallingford, 2013. UK Sustainable Drainage Guidance and Tool. The greenfield runoff estimation for sites tool. http://geoservergisweb2.hrwallingford.co.uk/uksd/greenfieldrunoff.aspx.
[14] Institute of Hydrology (1983). *The Flood Studies Supplementary Report Number 14*.
[15] Institute of Hydrology (2004). *Flood Estimation for Small Catchments Report number 124*,

2.6.20 Field investigations have not yet been undertaken due to limited access to land and the need to integrate investigative requirements from several disciplines.

Sewer systems flood risk

2.6.21 The risk of flooding from the sewer network has also been addressed in this FRA. The sewer network data was provided for this assessment by the relevant water company, Severn Trent Water, to determine locations of the route and other design elements which will be located at areas of risk.

Other sources of flood risk

2.6.22 Reservoir flood risk was assessed using the reservoir inundation maps as shown on Volume 5: Map Book, Maps WR-01-037 and 038. The purpose was to identify areas along the route that were at risk of flooding if any reservoirs in the vicinity were to fail.

2.6.23 Canals have been identified as another source of potential flood risk, and so canals that will be crossed by certain sections of the route have been identified in the assessment.

3 Design criteria

3.1 Principal design criteria

3.1.1 The AP2 revised scheme will provide a safe and reliable high speed rail link which will be compatible with the existing rail network and also HS1.

3.1.2 The AP2 revised scheme will provide a 'passenger' only service and not 'freight' operation.

3.1.3 The design shall seek to ensure that any impacts as a result of its development will be designed out or minimised as far as practicably possible.

3.2 Flood risk design approach statement

3.2.1 The overall project seeks to ensure that there will be no increase in flood risk to any existing receptors as a result of the AP2 revised scheme. This will be achieved by ensuring that overall flood storage capacity is maintained including an allowance for climate change.

3.2.2 In line with the NPPF technical guidance, increases in peak rainfall intensity and peak river flow of 20%, as a result of climate change, have been allowed for as per the period 2085 to 2115. This 20% increase has been used for the purposes of assessing flood risk. However, the hydraulic modelling involves sensitivity testing which includes a 20% increase, in addition to the 20% allowance for climate change.

3.2.3 All underbridge and viaduct crossings will be designed to allow the 1 in 100 (1%) annual probability flow (with allowance for climate change) to pass underneath. Upstream water levels will not be increased and a minimum of 600mm freeboard will be provided to the bridge soffits above this level which will allow for debris should flooding occur. On main rivers, where possible, a freeboard of 1m has been allowed.

3.2.4 Main river underbridges and viaducts will also accommodate river maintenance requirements and generally allow for a 5.3m vertical clearance above the floodplain ground level.

3.2.5 Culverts have been designed to convey the 1 in 100 (1%) annual probability flow (with allowance for climate change), with a freeboard of 300mm as a minimum applied for the culvert design. The design has also taken into account submerged inverts and the inclusion of mammal ledges.

3.2.6 River crossings will minimise any requirement for replacement floodplain storage areas.

3.2.7 The proposed rail infrastructure will be protected against inundation in the 1 in 1000 (0.1%) annual probability flood event. This will be achieved through ensuring a freeboard of 1m on the 1 in 1000 (0.1%) annual probability flood level. The railway drainage will be designed to have capacity up to the 1 in 100 (1%) annual probability peak rainfall event. However, the design will also ensure that the flood level does not exceed 1m below the track level during the 1 in 1000 (0.1%) annual probability rainfall event.

3.2.8 All drainage will be attenuated in order that peak surface water run-off from the proposed infrastructure is no greater than the existing current day baseline run-off under the 1 in 100 (1%) annual probability peak rainfall event.

3.2.9 All drainage will be designed to ensure that disruption to existing groundwater flood flows will be kept to a minimum, both during and following construction of the permanent works.

3.3 Cross drainage design approach statement

3.3.1 The drainage design will ensure that there is no increase in run-off to the receiving watercourse as a result of the AP2 revised scheme.

3.3.2 Surface and ground water drainage shall be provided so as to ensure that water levels do not rise above a 1m freeboard below the rail level.

3.3.3 The route will be designed to ensure safe operation of trains during a 1 in 1000 (0.1%) annual probability event.

3.3.4 As part of the drainage design an allowance of 30% has been added to design events for climate change.

4 Data sources

4.1.1 Consistent with the requirements of the NPPF, this assessment considers the risk of flooding from rivers, overland flow (surface water), rising groundwater, overwhelmed drainage and sewer systems, and artificial sources such as reservoirs, lakes and canals.

4.1.2 The route will lie entirely outside the extent of flooding from the sea and therefore the risk of flooding from tidal sources is not considered in this assessment.

4.1.3 The primary datasets for each source of flooding used to assess the design elements are:

- OS 1:10,000 mapping;
- topographic survey commissioned for the purposes for the AP2 Scheme (200mm grid resolution LiDAR survey, in DTM and digital surface model format);
- Environment Agency Flood Zone mapping and historic flood mapping;
- Environment Agency website for reservoir inundation mapping;
- Lichfield SFRA9;
- Staffordshire PFRA[10];
- Environment Agency national surface water flood mapping datasets specifically the Midlands uFMfSW; and
- Severn Trent Water asset mapping.

4.1.4 A high-level review of the risk of flooding and potential impacts is undertaken on the basis of these datasets across all flood sources. Where this review indicates potentially significant impacts on the risk of flooding, or a risk of flooding to the line, further investigation is undertaken, specifically hydraulic modelling for the areas at risk from river flooding.

5 The AP2 revised scheme

5.1 Permanent works

5.1.1 The general design of the AP2 revised scheme is described in Volume 1. The following section describes the main features of the AP2 revised scheme in this study area, including the main flood risk mitigation measures.

Overview

5.1.2 The route initially crosses Whittington Heath Golf Club proceeding in a northerly direction. It then passes over Lichfield Road and then under Darnford Lane just to the east of Whittington Hill Farm. With Lichfield to the west, the route curves to the west passing over a minor watercourse, an under-restoration canal, Capper's Lane, then over Broad Lane, and the West Coast Mainline. The route then continues to the east of Streethay, passing over the South Staffordshire Railway Line and the A38.

5.1.3 The line passes to the west of the Fradley Business Park, crossing over Wood End Lane, whereupon the route curves tighter towards the west, crossing over Curborough Brook (via the Pyford Brook viaduct), and through Ravenshaw Wood. As the route crosses over Kings Bromley footpath 0.392 it curves back toward the north, crossing over the existing A515 Lichfield Road, Bourne Brook and the WCML. The AP2 revised scheme will connect with the WCML to the south of Handsacre.

A51 Tamworth Road to Cappers Lane

5.1.4 The AP2 revised scheme enters this area in a cutting approximately 7.5m deep under the A51 at Whittington Heath Golf Club. This section of the AP2 revised scheme will be in cutting or on embankment with underpasses for Whittington Footpath 16 and Lichfield Road and an overbridge for Darnford Lane, as the route starts to fall towards the Trent valley.

5.1.5 Key features of this section, which is approximately 2km long, will include (see SES and AP2 ES Volume 2: Maps CT-06-123b, F6 to CT-06-124, C6):

- an approximately 4km cutting (continued from Drayton Bassett, Hints and Weeford area (CFA21)) with a maximum depth of up to 15m (7.5m at the A51 Tamworth Road overbridge);
- an embankment for approximately 735m reaching a maximum height of 10m, with an underbridge for the Lichfield Road, which will remain on its existing alignment;
- a cutting for approximately 480m to a maximum depth of 4m crossed by the Darnford Lane overbridge,approximately40m north of the existing road;
- an embankment approximately 230m long up to Capper's Lane viaduct, with a maximum height of 5m;
- Capper's Lane viaduct at a maximum height of 7m high and 130m in length with noise barriers over the brook floodplain and the Wyrley and Essington Canal realignment; and
- a short embankment approximately 90m in length and a height of 1m.

5.1.6 Approximately 300m of the Wyrley and Essington Canal will be permanently realigned to the south of its existing alignment.

Cappers Lane to Streethay

5.1.7 The AP2 revised scheme will continue north in cutting, up to a maximum depth of 19m to pass beneath the WMCL, SSL and the A38. This section will be approximately 2.2km long (see SES and AP2 Volume 2: CFA22 Map Book, Maps CT-06-124, C6 to CT-06-126, H4). Key features of this section include:

- a cutting, Streethay Cutting, of approximately 2.4km with a maximum depth of 19m as it passes Hill Farm with retaining walls in its lower parts along most of its length for protection against groundwater ingress incorporating:
  - a culvert over the realigned Fulfen Wood watercourse; and
  - an overbridge for Capper's Lane realignment approximately 5m above ground level.
- an overbridge to enable the AP2 revised scheme to pass beneath the WCML (see SES and AP2 ES Volume 2: Map CT-06-125, I5), with the minimum necessary headroom to limit the depth of cutting needed for the AP2 revised scheme;
- an overbridge to maintain access for Hill Farm and provide continuity for Streethay Footpath 6 (see SES and AP2 ES Volume 2 Map CT-06-125, F4 to E6); and
- overbridges for the SSL and the A38 Rykneld Street and its slip roads which will be retained at their existing height.

5.1.8 Realignment of Fulfen Wood watercourse to enable the watercourse to pass under the HS2 route includes ground reprofiling to prevent potential surface water flow into the Streethay cutting (see SES and AP2 ES Volume 2: Map CT-06-125, I8 to G4) and culverts under the realigned Capper's Lane and WCML.

Streethay to the Trent and Mersey Canal

5.1.9 The AP2 revised scheme continues north predominantly on embankment, up to a maximum of 10.2m in height. This area includes the grade separated junction for the Phase Two line to the north-west. The length of this section will be approximately 2.4km. Key features of this section include (see SES and AP2 ES Volume 2: CFA22 Map Book, Maps CT-06-125, H4 to CT-06-127, C8).

5.1.10 The Curborough embankment of approximately 2.3km long comprises two parts. The first section is approximately 1.1km in length (see SES and AP2 ES Volume 2: Map CT-06-126, J4 to CT-06-127, H7) with a maximum height of approximately 11m, and incorporates an underpass for the realigned Alrewas Footpath 31 including a culvert for the diversion of Mare Brook South under the HS2 route. Approximately 1km south of Wood End Lane, this embankment widens to accommodate four tracks on the approach to the junction with the Phase Two western leg.

5.1.11 This junction and a short length of the route for the western leg of the Phase Two route (Manchester Spur) form part of the AP2 revised scheme. The Manchester Spur includes:

- a diveunder structure, approximately 200m long to carry the Manchester Spur over the southbound connection from the WCML at Handsacre utilising retaining walls where adjacent tracks are at different heights (see SES and AP2 ES Volume 2: Map CT-06-127, I7);
- an embankment approximately 1kmlong with a maximum height of 12m to form the Manchester Spur including an underpass for the realigned Wood End Lane;
- a 100m long viaduct over the Trent and Mersey Canal (See SES and AP2 ES Volume 2: CT-06-127, D4); and
- an embankment approximately 200m long and a maximum of 7m in height. At this point the Phase One works terminate (see SES and AP2 ES Volume 2: CT-06-127, B3).

5.1.12 The Curborough embankment continues and curves north-west for a further 1.2km and includes separation of the tracks through the junction with the Manchester Spur which descends to approximately ground level at this point.

- a viaduct approximately 65m long and a maximum height of 6m over Curborough Brook with noise barriers (see SES and AP2 ES Volume 2: Map CT-06-127, C7); and
- an embankment, Ravenshaw Wood embankment, approximately 2.3km long commencing at ground level incorporating an overbridge for the realigned Wood End Lane.

Trent and Mersey Canal to the WCML

5.1.13 The Hs2 route continues through Ravenshaw Wood and Black Slough on low embankments which gradually rise to a maximum height of 11m. The tie-in with the WCML will be provided via a grade separated junction to the south of Handsacre. The approximate length of this section is 4.7km. Key features of this section include:

- Ravenshaw Wood embankment 2.3km in length, continuing from the previous section (see SES and AP2 ES Volume 2: Map CT-06-127, C8; to Map CT-06-129, G7), which for the most part is approximately 1m in height rising to approximately 10m at its northern end. The embankment runs through the southerly parts of Ravenshaw Wood and Black Slough incorporating Kings Bromley Footpath 0.392 underpass and an underbridge for the A515 constructed over the route of the existing road (see SES and AP2 ES Volume 2: Map CT-06-129, G7);
- a viaduct approximately 125m long over Bourne Brook (see SES and AP2 ES Volume 2: Map CT-06-129,F7 to G7);
- an embankment, Shaw Lane embankment, approximately 550m long and approximately 13m high with a retaining wall on the west side (see SES and AP2 ES Volume 2: Map CT-06-129, F7 to C6);
- a junction between the WCML and HS2, with the two easternmost tracks of the WCML realigned approximately 40m to the east of their current position at

the point where HS2 will cross the WCML. Realignment will be for approximately 1.6km from the A515 Lichfield Road to the southern end of Handsacre, with the existing rail earthworks widened;

- the 130m long Harvey's Rough flyover carrying the HS2 tracks over the two realigned WCML tracks to join;
  - an embankment, approximately 1km long, descending from 8m high to the same level as the existing WCML – the HS2 tracks would then converge with the central WCML tracks with the railway junction having six tracks for approximately 1km until the tie-in point (see Volume 2: CT-06-129, C6); and
  - a short length of the two western WCML tracks will be realigned approximately 2m to the west and will require a low retaining wall.

5.2 Temporary works

5.2.1 All contractors will be required to comply with the environmental management regime for the AP2 revised scheme, which will include:

- Code of Construction Practice (CoCP); and
- Local Environmental Management Plans (LEMP).

5.2.2 The key requirements of the draft CoCP in relation to flood risk are:

- making appropriate use of the Environment Agency's flood warning service;
- preparing site specific flood risk management plans for temporary works at risk of flooding from river, surface water and groundwater sources;
- considering flood risk when planning temporary sites and storing materials;
- obtaining consent, as required, for works affecting a watercourse;
- removing or stopping and sealing of drains and sewers taken out of use;
- not discharging of site run-off to ditches, watercourses, drains or soakaways without agreement of the appropriate authority;
- ensuring hoarding and fencing in areas at risk of flooding will be permeable to floodwater, unless otherwise agreed with the Environment Agency or Lichfield District Council (the Local Lead Flood Authority in this study area); and
- implementing precautions to be taken to prevent damage to services and to avoid pollution during service diversions, excavations and ground penetration.

5.2.3 The temporary works will include both main and satellite construction compounds. These compounds will be utilised for office accommodation, local storage for plant and materials, car parking, material processing facilities and welfare facilities.

5.2.4 Areas adjacent to these compounds may be used for temporary storage of topsoil stripped as part of the works.

5.2.5 Temporary worker accommodation will also be required for the AP2 revised scheme.

6 Existing flood risk

6.1.1 Through the use of the Environment Agency historical flood maps, there are no areas of historical flooding that will be either crossed by the route or will be within 1km of the route.

6.1.2 The Lichfield SFRA[9] historical flood maps indicate there is one recorded incident of flooding in the vicinity of the route. The event caused inundation 150m west of the route at Streethay. The source of this flooding is unknown. Apart from the above recorded incident, there are no further areas of historical flooding which either cross the route or are within 1km of the route centreline. This includes flood events from rivers, surface water, artificial sources, canals or unknown sources.

6.1.3 The Staffordshire PFRA[10] has also been used to identify potential locations of flooding in the vicinity of the route. This mapping indicates that historical events have occurred in the vicinity of the proposed Capper's Lane viaduct crossing. These events have been classed as exceptional, however not affecting any properties.

6.2 River flooding

6.2.1 River flood risk is the risk of flooding posed by rivers and streams. The risk in CFA22 is from Mare Brook, Curborough Brook, Bourne Brook and associated tributaries. Flood maps indicating the areas at risk from river flooding are shown in Volume 5: Map Book - Water resources, Maps WR-05 and WR-06.

6.2.2 The assessment of baseline (current) flood risk involved identifying watercourse crossings and the associated risk through the use of the Environment Agency Flood Zones. The results of this assessment are provided in Table 2. The watercourse identifier references have been taken from Volume 5: Map Book - Water resources Maps WR-01-037 and 038.

Table 2 - Whittington to Handsacre river flood risk

Watercourse identifier and map reference	Crossing name	Watercourse	1 in 100 (1%) + climate change flow	Risk level	Receptor vulnerability
SWC-CFA22-001 Volume 5: Map WR-01-037, E5.	Capper's Lane viaduct	Ordinary Watercourse(tributary of Fisherwick Brook)	$1.22m^3/s$	Very high	More vulnerable
SWC-CFA22-003 Volume 5: Map WR-01-037, E5.	Fulfen Wood culvert	Main river (Mare Brook)	$3.12m^3/s$	Very high	Less vulnerable
SWC-CFA22-004 Volume 5: Map WR-01-037, C6.	Mare Brook south culvert	Ordinary Watercourse (tributary of Mare Brook)	$0.47m^3/s$	Very high	Less vulnerable
SWC-CFA22-006 Volume 5: Map WR-01-037, B6.	Mare Brook north culvert	Ordinary watercourse (tributary of Mare Brook)	$0.44m^3/s$	Very high	Less vulnerable

Watercourse identifier and map reference	Crossing name	Watercourse	1 in 100 (1%) + climate change flow	Risk level	Receptor vulnerability
SWC-CFA22-007 Volume 5: Map WR-01-037, B6.	Curborough embankment	Ordinary watercourse is sourced in close proximity to the AP2 revised scheme	Not calculated	Low	Less vulnerable
SWC-CFA22-010 Volume 5: CFA22 Map Book, Map WR-01-038, G5.	Pyford Brook viaducts	Main river (Curborough Brook)	8.46m^3/s	Very high	Less vulnerable
SWC-CFA22-012 Volume 5: Map WR-01-038, E7.	Bourne Brook viaduct	Ordinary Watercourse (Bourne Brook)	12.73m^3/s	Very high	Less vulnerable
SWC-CFA22-015 Volume 5: Map WR-01-038, D8.	Harvey's Rough flyover	Ordinary watercourse is sourced in close proximity to the AP2 revised scheme	Not calculated	Low	Less vulnerable
SWC-CFA22-017 Volume 5: Map WR-01-038, C8.	Handsacre east culvert	Ordinary watercourse (tributary of River Trent)	0.12m^3/s	Very high	Less vulnerable
SWC-CFA22-018 Volume 5: Map WR-01-038, C8.	Handsacre west culvert extension	Ordinary watercourse (tributary of River Trent)	0.27m^3/s	Very high	More vulnerable

6.2.3 The Environment Agency Flood Zone mapping indicates four main areas at risk from flooding:

- the southern extent of the study area at the location of the Capper's Lane viaduct (Volume 5: Map WR-01-037, E5);
- at the location of the Fulfen Wood culvert (Volume 5: Map WR-01-037, E5);
- at the location of the Pyford Brook viaducts (Volume 5: Map WR-01-038, G5); and
- to the northern extent of the study area at the location of the Bourne Brook viaduct (Volume 5: Map WR-01-038, E7).

6.2.4 These crossing locations fall within Flood Zone 3. However, given that the route will cross the watercourse, they will also be located within Flood Zone 3b (very high risk).

6.2.5 The Environment Agency flood mapping covers watercourses with catchments greater than 0.5km2, and hence small catchments are often not represented. This includes the two tributaries of Mare Brook (Volume 5: Map WR-01-037, C6, SWC-CFA22-004; Volume 5: Map WR-01-037, B6, SWC-CFA22-006), and the two tributaries of the River Trent (Volume 5: Map WR-01-038, C8, SWC-CFA22-017; Volume 5: Map WR-01-038, C8, SWC-CFA22-018).

6.2.6 Hydraulic modelling was carried out to provide a more accurate representation of river flood risk along the route, specifically at locations where the route will cross a watercourse. The modelling provided flood extents for the 1 in 100 (1%) annual probability event with a 20% allowance for climate change and for the 1 in 20 (5%) annual probability event. Flood levels were also determined for the 1 in 1000 (0.1%) annual probability event to ensure that the proposed track will not be at risk during this event. The flood extents and levels as determined through hydraulic modelling are detailed in the river modelling report (Volume 5: WR-004-015).

6.2.7 The Environment Agency flood mapping indicates that the Mare Brook South culvert, the Mare Brook north culvert, the Handsacre east culvert and the Handsacre west culvert extension are all located within Flood Zone 1. However, following hydraulic modelling completed for this assessment they are all redefined as Flood Zone 3b. Therefore, the risk classification given at these locations are very high.

6.2.8 The two ordinary watercourses located south of Gorse Farm (Volume 5: Map WR-01-037, B6, SWC-CFA22-007) and south of Bromley Hayes (Volume 5: Map WR-01-038, D8, SWC-CFA22-015) have not been hydraulically modelled. These watercourses start and flow away from the route, therefore the route will not cross the watercourse. Any overland flow that will pass into this watercourse will be intercepted by the proposed drainage system.

6.2.9 The vulnerability classification as shown in Table 2 above has been taken from the NPPF and relates to the vulnerability of existing development in areas currently at risk from river flooding. 200m downstream of the Capper's Lane viaduct are two properties that are within or adjacent to the 1 in 1000 (0.1%) annual probability flood extent and hence would be at an increased risk as a result of higher flood levels. These properties are both residential and hence are considered more vulnerable in line with NPPF. Immediately upstream of the Handsacre West culvert extension crossing there are numerous residential properties adjacent to the watercourse. Given their close proximity, this location has been considered as more vulnerable. At the other crossings, a less vulnerable classification has been assigned because the land use is agricultural.

6.2.10 The other locations along the route not identified in Table 2 are considered to be at either a low risk or no risk of river flooding.

6.3 Surface water/overland flow

6.3.1 This section is an examination of the existing flood risk posed by rainfall falling on the ground surface, referred to as surface water flooding. It is examined in terms of the water flowing over the ground surface that has not entered a natural drainage channel or artificial drainage system.

6.3.2 The areas at risk from surface water flooding are shown on map Volume 5: Maps WR-01-037 and 38. Table 3 details the risk to the development from this source of flooding.

Table 3 - Whittington to Handsacre sources of surface water flooding

Description of surface water flooding location and map reference	Description of possible influence to the AP2 Scheme	Risk
Whittington Heath Volume 5: Map WR-01-037, G6 and G7.	To the west of the route there are areas at risk from surface water flooding. This is predominately at low risk, although there is an isolated area at high risk associated with a localised depression.	High
North west of Whittington in the vicinity of the Wyrley and Essington Canal Volume 5: Map WR-01-037, E6.	Two areas at risk from surface water flooding will be crossed by the route. These areas are associated with watercourses and area at a low, medium and high risk. However the high risk areas are narrow and are associated with watercourses.	High
North east of Streethay, west of the Coventry Canal Volume 5: Map WR-01-037, D5, C5 and C6.	Two areas at risk from surface water flooding will be crossed by the route. One area is associated with a watercourse and is at a low, medium and high risk, the other is not associated with a watercourse and is at a low and medium risk. There are also small isolated areas at risk surrounding the route, associated with ponds, at a low, medium and high risk.	High
South west of Fradley South Volume 5: Map WR-01-038, H5.	The route will be located on an area at risk from surface water flooding associated with a watercourse, at a low, medium and high risk. There is also an area to the west of the route identified to be at a low and medium risk of surface water flooding.	High
West of Fradley South Volume 5: Map WR-01-038, G5.	There are isolated areas at risk from surface water flooding both east and west of the route, not associated with a watercourse, at a low and medium risk. There are two areas at risk of surface water flooding will also be crossed by the route, associated with two watercourses (one of which is Curborough Brook). These area are at a low, medium and high risk.	High
To the north of wood end farm and Vicar's Coppice Volume 5: Map WR-01-038, E7 and F6.	Numerous isolated areas susceptible to surface water flooding, not associated with a watercourse, will be crossed by the route and are located parallel to the north and south of the route. These areas are at a low, medium and high risk.	High
From the west of the A515 to John's Gorse Volume 5: Map WR-01-038, E7.	An area at risk from surface water flooding, associated with a watercourse, will be crossed by the route, at a low, medium and high risk.	High
to the west of Ashton Hays Farm to Handsacre Volume 5: Map WR-01-038, D5 and C5.	An area at risk runs parallel to the south of the route and also will be crossed by the route, associated with a watercourse, at a low, medium and high risk.	High

6.3.3 There are eight locations along the route in this study area which have been identified to be at risk from surface water flooding from the Environment Agency uFMfSW. At the majority of these locations the risk of surface water flooding ranges from low to high. However, as a conservative approach the highest level of risk has been assigned. Therefore, at all locations the risk is considered high.

6.3.4 In line with the risk category matrix provided in Table 1, and the data available for this FRA, all other locations along the route within this study area are classed to be at no risk from surface water flooding.

6.4 Groundwater

6.4.1 Groundwater flood risk has been qualitatively assessed based on hazard identification and evaluation using the conceptual understanding of the ground conditions at the location of the AP2 revised scheme. The assessment of the current groundwater flood risk is based on the presence or otherwise of an aquifer and the relative depth of groundwater level, as well as historical information on the occurrence of groundwater flooding incidents.

6.4.2 The solid geology is predominantly classified as a Secondary B aquifer. Superficial Deposits are classified as Secondary A aquifers, Secondary B aquifers and Unproductive Strata.

6.4.3 Only very limited data on groundwater levels has been made available within the study area. However, it is considered that groundwater flow is likely to be towards watercourses and groundwater, especially within the alluvium may be within 2m of ground level.

6.4.4 The SFRA9 and PFRA[10] do not record any instances of groundwater flooding and therefore the risk is assessed as low.

6.5 Sewer systems

6.5.1 Sewer infrastructure is a potential source of flood risk in the event of a failure. Due to the nature of the closed sewer system, sewer flooding will only be caused if there is a blockage or a leak or if there is a rainfall event greater than the design capacity of the network.

6.5.2 The risk to the route from the sewer network has been determined based on the location of development in relation to the network and the proximity and potential flow paths from inspection covers. Flow paths have been assessed through the use of LiDAR and OS mapping.

6.5.3 Three locations have been identified to be a potential risk from the sewer network, being located south of Fradley Park, north of Ravenshaw Wood, and east of Handsacre (Volume 5: Map WR-01-038, H5, F6 and C8). At these locations the route will cross and/or there are inspection covers located within the vicinity of the route. However the topography indicates at these locations there are no flow paths to the AP2 revised scheme. Therefore the risk from the sewer network at these locations is low.

6.5.4 Three further locations have been identified, all located east of Whittington DMS (Volume 5: Map WR-01-037, H5 and I5). At these locations the route will be located approximately 30m from three inspection covers, and the topography indicates there are restricted pathways to the route due to the topography and proposed design. If surcharging occurs at these locations, flood water either side of the route would flow along the drainage channels and into the associated watercourse (SWC-CFA22-006). Therefore the risk from the sewer network at these locations is medium.

6.6 Artificial sources

6.6.1 Artificial sources of flood risk describe a mechanism whereby flooding would be the result of failure of infrastructure that impounds water such as in a canal or reservoir.

6.6.2 The Wyrley and Essington Canal (Volume 5: Map WR-01-037, E5, SWC-CFA22-002) will be crossed by the proposed Cappers Lane viaduct. Through the use of LiDAR data it is considered that the Wyrley and Essington Canal, at the location of the crossing, is raised above surrounding ground level and hence there is a risk of structural breaching when the water level is maintained at the design level. If breaching occurs however, flood water would flow along the corridor of the watercourse at this location (Volume 5: Map WR-01-037, E5, SWC-CFA22-001) and so not adversely affect the route. If overtopping occurs, flood water would flow along the same route as the drain near this location (Volume 5: Map WR-01-037, E5, SWC-CFA22-001).

6.6.3 The Trent and Mersey Canal (Volume 5: CFA22 Map Book, Map WR-01-038, G5, SWC-CFA22-010) will be crossed twice by the AP2 revised scheme, at the Trent and Mersey Canal East viaducts and Trent and Mersey Canal West viaducts. Through the use of LiDAR data it is considered that the Trent and Mersey Canal, at the two locations crossing the route, are not raised above surrounding ground level and hence there is no risk of structural breaching when the water level is maintained at the design level. If overtopping occurs at either of these locations, flood water would flow into the proposed drainage system along the toe of the viaduct embankments and discharge to the Curborough Brook (Volume 5: CFA22 Map Book, Map WR-01-038, G5, SWC-CFA22-010).

6.6.4 Water levels within canals are maintained and therefore it is unlikely that overtopping would occur. In line with the risk category matrix in Table 1 the risk of flooding from this source is considered low.

6.6.5 The Environment Agency reservoir inundation mapping identifies that the area surrounding the Capper's Lane viaduct crossing is at risk of flooding following reservoir failure. This area is at risk if Swinfen Lake was to fail. However, Swinfen Lake is over 3km upstream of the AP2 revised scheme with roads in between the reservoir and the route which will act as constrictions to the flow and reduce velocities. Due to the low velocities of the flood water it is considered that flooding would be a low hazard at the location of the route. At this location, the inundation extent covers a greater extent than the Flood Zone mapping.

6.6.6 The reservoir inundation mapping also shows that the area surrounding the Pyford Brook viaducts crossing is at risk of flooding following reservoir failure. This area is at risk if Stowe Pool or Minster Pool were to fail. However, both reservoirs are over 3km upstream of the AP2 revised scheme with roads in between the reservoir and the route which will act as constrictions to the flow and reduce velocities. Due to the low velocities of the flood water it is considered that flooding would be a low hazard at the location of the route. At this location, the inundation extent covers a greater extent than the Flood Zone mapping.

6.6.7 Due to the strict regulations and high maintenance associated with reservoirs, breaching is considered unlikely. In line with the risk category matrix in Table 1 the risk of flooding from this source is considered low.

6.7 Summary

6.7.1 The AP2 revised scheme will cross eight watercourses and therefore it is concluded that the AP2 revised scheme will be within areas that are classified as being potentially at a very high risk from river flooding in this study area. There are two areas in the study area where the land use has been categorised as more vulnerable, they are downstream of the Capper's Lane viaduct crossing, and immediately upstream of the Handsacre West culvert extension. All other land uses at risk in this study area (which could be impacted as a result of the AP2 Scheme) are classed as less vulnerable.

6.7.2 There are eight locations along the route which have been identified to be at risk from surface water flooding. The risk at these locations generally ranges from low to high, although as a conservative approach the highest level of risk has been assigned. Therefore, all locations have been categorised as at a high risk.

6.7.3 The risk presented by groundwater flooding is considered to be low.

6.7.4 At three locations the AP2 revised scheme will cross the sewer network and an inspection cover is located within 120m of the route although there are no known flow paths to the route. At three further locations the sewer network crosses the route and there are inspection covers located on the route. At these locations there are restricted flow paths to the AP2 revised scheme. Therefore, the route is at a medium risk of flooding from water and sewer networks.

6.7.5 Water levels within canals are continually maintained and hence the chance of overtopping or breaching when were levels raise above the design level and thus flood risk from this source is considered low. Similarly due to the strict monitoring and maintenance requirements, the risk of reservoir flooding to the AP2 revised scheme is considered low.

7 Flood risk management measures

7.1 River flood risk

Flood risk to AP2 revised scheme

7.1.1 The AP2 revised scheme will be raised above the 1 in 1000 (0.1%) annual probability flood level at floodplain crossings. Therefore, the mitigation measures included in the design have ensured that there are no instances where the AP2 revised scheme would be at significant risk of river flooding, and consequently no specific mitigation is required.

Impact of AP2 revised scheme

7.1.2 At all floodplain crossings, replacement floodplain storage would be provided upstream of the AP2 revised scheme for losses in floodplain storage, including viaduct piers, embankments and all associated development.

Fulfen Wood watercourse

7.1.3 The realignment of the Fulfen Wood watercourse to enable the watercourse to pass under the HS2 route includes ground reprofiling to prevent flood risk to the Streethay cutting from potential surface water flow, including flooding from the watercourse.

7.1.4 The realignment includes culverts under the realigned Capper's Lane and WCML which will be designed in accordance with the Flood Risk DAS to ensure there is no impact on flood risk.

Other watercourse crossings

7.1.5 The hydraulic modelling for the other seven watercourse crossings in this study has shown that the AP2 revised scheme will have a negligible impact on river flood risk. Areas of land have been identified as suitable to provide replacement floodplain storage, therefore reducing the impact. Any replacement floodplain storage at the locations of negligible impact is likely to provide betterment.

Mitigation for temporary works

7.1.6 The temporary works have the potential to result in an increased river flood risk and be at risk of flooding from this source. The proposed mitigation and measures to prevent an unacceptable risk of river flooding for the temporary works includes signing up to the Environment Agency flood warning system for the "Lower Tame - Low-lying land and roads between Hopwas and the National Arborteum near Alrewas" and the "Burton Trent - Low-lying land and roads between Kings Bromley to Clay Mills". Any temporary crossings will be designed to prevent an increased flood risk through ensuring sufficient capacity during the 1 in 100 (1%) annual probability event; an indication of the flows which will be considered are included in Table 2.

7.2 Surface water flood risk

Flood risk to AP2 revised scheme

7.2.1 In this study area, areas categorised as being at a high risk of surface water flooding are generally associated with the watercourses identified in the river flooding sections in this report. At these locations the scheme design will ensure that the track is situated above the 1 in 1000 (0.1%) annual probability event flood level with a 1m freeboard. Therefore as long as there is no blockage of these structures, a low surface water flood risk to the track is anticipated at these locations.

7.2.2 At the three locations where the route potentially crosses surface water flow paths, the track will either be raised on an embankment and/or the track drainage system will direct surface water flow away from the AP2 revised scheme. Therefore, as long as the collection systems and surface water culverts are designed with sufficient capacity, there should be no backing up, and no expected risk of flooding to the AP2 revised scheme.

Impact of AP2 revised scheme

7.2.3 Potential increases in peak discharge rates of surface water run-off will be attenuated prior to discharging to the receiving watercourse. Any additional surface water to be discharged will be at a trickle rate to prevent exceeding the current capacity of the receiving watercourse.

7.3 Risk of flooding from groundwater

Flood risk to AP2 revised scheme

7.3.1 The risk from groundwater flooding to the AP2 revised scheme has been assessed as low and, therefore, no specific management measures are considered necessary.

Impact of the AP2 revised scheme

7.3.2 The AP2 revised scheme is no anticipated to have an impact on groundwater flooding and, therefore, no specific management is considered necessary.

7.4 Risk of flooding from sewer systems

7.4.1 There will be a medium risk of flooding from sewer systems to the AP2 revised scheme, and there are no anticipated effects on the risks of flooding from drainage systems within the study area arising from the AP2 revised scheme. Therefore, no specific mitigation would be required.

7.5 Risk of flooding from artificial sources

Flood risk to AP2 revised scheme

7.5.1 There are no instances where the AP2 revised scheme would be at significant risk of flooding from artificial sources, and consequently no specific mitigation is required.

Impact of the AP2 revised scheme

7.5.2 The AP2 revised scheme in this study area is at risk of flooding resulting from the complete failure of three reservoirs. However, the replacement floodplain storage provided to mitigate the potential effects of river flooding would serve to either fully or partially offset any potential effects of the AP2 revised scheme on flooding from this source. Due to the low probability of such flooding occurring, and the likely low significance of any impacts arising from the AP2 revised scheme, it is not considered appropriate to provide additional mitigation for this scenario.

8 Post development flood risk assessment

8.1 River flooding

8.1.1 The key design elements of the AP2 revised scheme with potential flood risk considerations have been modelled for this FRA. The modelling methodology and results specific for each watercourse crossing are included in the river modelling report (Volume 5: WR-004-015) which is presented in the annex to this FRA. A summary of the results are presented in Table 4. The watercourse identifier references have been taken from Volume 5: Map Book - Water resources Maps WR-01-037 and 038.

Table 4 - Whittington to Handsacre river flood risk

Watercourse identifier and map reference	Crossing name	1 in 100 (1%)+ climate change flow	Change in flood level 1 in 100 (1%) +climate change	Change in flood level 1 in 1000 (0.1%)	AP2 revised scheme 1 in 1000 (0.1%) level	Length of impacted upstream reach[16]
SWC-CFA22-001 Volume 5: Map WR-05-062, G5	Capper's Lane viaduct	1.22m3/s	7mm	27mm	63.231m AOD	<60m
SWC-CFA22-004 Volume 5: Map WR-05-063, I5	Mare Brook South culvert	0.47m3/s	-6mm	15mm	64.212m AOD	0m
SWC-CFA22-006 Volume 5: Map WR-05-063, G5	Mare Brook North culvert	0.44m3/s	-73mm	-92mm	64.488m AOD	0m
SWC-CFA22-007 Volume 5: Map WR-01-037, B6.	Curborough embankment	Not modelled because the AP2 revised scheme does not cross a watercourse at this location.				
SWC-CFA22-010 Volume 5Map WR-05-063, C7	Pyford Brook viaducts	8.46m3/s	14mm	9mm	65.336m AOD	40m
SWC-CFA22-012 Volume 5: Map WR-05-064, D7	Bourne Brook viaduct	12.73m3/s	-9mm	7mm	73.833m AOD	0m
SWC-CFA22-015 Volume 5: Map WR-01-038, D8.	Harvey's Rough flyover	Not modelled because the AP2 revised scheme does not cross a watercourse at this location.				

[16] Length of reach upstream of the AP2 revised scheme along which flood levels during the 1 in 100 (1%) annual probability+ climate change are greater than 10mm.

Watercourse identifier and map reference	Crossing name	1 in 100 (1%)+ climate change flow	Change in flood level 1 in 100 (1%) +climate change	Change in flood level 1 in 1000 (0.1%)	AP2 revised scheme 1 in 1000 (0.1%) level	Length of impacted upstream reach[16]
SWC-CFA22-017 Volume 5: Map WR-05-065, H6	Handsacre East culvert	0.12m3/s	-42mm	-31mm	71.775m AOD	0m
SWC-CFA22-018 Volume 5Map WR-05-065, G6	Handsacre West culvert extension	0.27m3/s	-77mm	-64mm	72.315m AOD	0m

8.1.2 The hydraulic modelling indicates that at six of the eight crossing structures modelled, the AP2 revised scheme will have a negligible impact on flood levels during the 1 in 100 (1%) annual probability with an allowance for climate change. There are no increases in downstream peak flood levels as a result of the AP2 revised scheme at all of these seven crossings.

8.1.3 The Fulfen Wood watercourse will be diverted and land including the area of the current floodplain will be re-profiled to ensure surface water flows toward the realigned watercourse and away from the cutting. The design will ensure the scheme does not have a significant impact on flood risk.

8.1.4 The results at the Pyford Brook viaduct crossing in Table 4 show that the AP2 revised scheme will have a minor impact on flood level immediately upstream of the crossing. At the Wood End Lane and upstream of this road there is a negligible impact on flood risk. The viaduct soffit will be in excess of 8m above the 1 in 1000 (0.1%) AP2 Scheme peak flood level, so the modelling also confirms the track will not be at risk of river flooding. Further details relating to the hydraulic modelling of the Pyford Brook viaduct is detailed in the river modelling report (Annex 5: WR-004-015).

8.1.5 Watercourses pose a river flood risk to the other design elements in this study area. The areas at risk from river flooding are shown on Volume 5: Map Book - Water resources, Maps WR-05-061 to 065 and are based on the hydraulic modelling results rather than Environment Agency Flood Zone mapping. The river flood risks to these works are included in Table 5.

Table 5 - River flood risks to the other design elements

Works at risk	Watercourse identifier and map reference	Location description	Description of the works and flood risk	Risk
Highways Earthworks Landscaping	SWC-CFA22-004 Volume 5: Map WR-05-062, E6	Fulfen Wood	Landscaping works and the earthworks for Fulfen Wood North Embankment will encroach into the areas as identified to be at risk during the 1 in 20 (5%) annual probability event. An access road will be located adjacent to the watercourse (SWC-CFA22-003) at this location	Very high

Works at risk	Watercourse identifier and map reference	Location description	Description of the works and flood risk	Risk
Highways Earthworks Landscaping	SWC-CFA22-004 Volume 5: Map WR-05-063, I5	Mare Brook south culvert	Landscaping works and the earthworks for Streethay Embankment will encroach into the areas as identified to be at risk during the 1 in 20 (5%) annual probability event. An access road will be located adjacent to a tributary of Mare Brook at this location.	Very high
Highways Earthworks Landscaping	SWC-CFA22-006 Volume 5: Map WR-05-063, G5	Mare Brook north culvert	Landscaping works, an access road and the earthworks for Streethay Embankment will encroach into the areas as identified to be at risk during the 1 in 20 (5%) annual probability event. The access road includes two proposed culverts along the watercourse at this location. An access track will be located adjacent to the watercourse at this location.	Very high

8.1.6 The proposed access road through the Capper's Lane viaduct is located in areas at risk to river flooding. It has been assumed to be at-grade with the current topography and therefore not impacting on flood flow spilling from the watercourse.

8.1.7 Proposed access road from Streethay and the access track by Mare Brook North culvert will be located in areas at risk of river flooding however these roads and the track will not be embanked and hence it is considered to have an insignificant impact on river flood risk.

8.1.8 The proposed access road that crosses the ordinary watercourse (SWC-CFA22-006) just downstream from the Mare Brook North culvert crossing will be embanked. At this location two culverts are proposed, which have not been included in the hydraulic modelling. If these culverts are designed to convey the same flow as the Mare Brook North culvert upstream of these two proposed culverts, then there will not be a significant impact on flood risk.

8.1.9 In addition to the road culverts outlined in Table 5, there are further culverts proposed in this study area. However, these culverts are required for the surface water drainage system which forms part of the proposed works, rather than for existing watercourses. The capacity requirements for these culverts are addressed as part of the drainage design.

8.1.10 Temporary works as required for the construction phase are also located in areas at risk from river flooding. The temporary works at risk are listed in Table 6.

Table 6 - River flood risk to temporary works

Watercourse identifier and map reference	Receptor	Comment	Risk
SWC-CFA22-001 Volume 5: Map WR-05-062, G5	Ordinary watercourse (tributary of Fisherwick Brook)	Capper's Lane viaduct (north) compound and temporary site access/haul route and fencing will be located in the area at risk during the 1 in 20 (5%) annual probability event.	Very high
SWC-CFA22-003 Volume 5: Map WR-01-037, E5 and E6	Main river (Mare Brook)	Capper's Lane compound, a material transfer stockpile area and a temporary material compound will be located in the area at risk during the 1 in 20 (5%) annual probability event.	Very high

Watercourse identifier and map reference	Receptor	Comment	Risk
SWC-CFA22-004 Volume 5Map WR-01-037, C5 and C6	Ordinary watercourse (tributary of Mare Brook)	A temporary bridge/culvert crossing, a temporary material stockpile and a temporary site access/haul route and fencing will be located in the area at risk during the 1 in 20 (5%) annual probability event.	Very high
SWC-CFA22-006 Volume 5: Map WR-01-037, B6	Ordinary watercourse (tributary of Mare Brook)	Temporary site access/haul road and fencing, and temporary material stockpiles will be located in the area at risk during the 1 in 20 (5%) annual probability event.	Very high
SWC-CFA22-010 Volume 5: Map WR-01-038, G5	Main River (Curborough Brook)	Temporary site access/haul road and fencing, and a temporary bridge/culvert will be located in the area at risk during the 1 in 20 (5%) annual probability event.	Very high
SWC-CFA22-012 Volume 5: Map WR-01-038, E7 and E8	Main river (Bourne Brook)	Two temporary site access/haul roads and fencing, a temporary culvert/bridge, A515 Lichfield Road underbridge main compound, and a material transfer stockpile area are located in the area at risk during the 1 in 20 (5%) annual probability event.	Very high
SWC-CFA22-017 Volume 5: Map WR-01-038, C8	Ordinary watercourse (tributary of River Trent)	Temporary site access/haul road and fencing, and a temporary earthworks stockpile area will be located in the area at risk during the 1 in 20 (5%) annual probability event.	Very high
SWC-CFA22-018 Volume 5: Map WR-01-038, C8	Ordinary watercourse (tributary of River Trent)	Temporary site access/haul road and fencing, and a temporary earthworks stockpile area will be located in the area at risk during the 1 in 20 (5%) annual probability event.	Very high

8.1.11 There are eight locations of temporary works that are located in areas at risk from river flooding. The areas at risk have been identified through the hydraulic modelling completed for this assessment.

8.1.12 Hydraulic modelling is not considered necessary for the temporary works because the works will be constructed in line with the CoCP and thus the design will consider river flood risk. Therefore temporary works will not result in an increased flood risk to any existing receptors.

8.1.13 The hoarding and fencing around a site for security purposes has the potential to alter flow paths and thus impact on flood risk at the three locations identified in Table 6. However, the CoCP states that hoarding and fencing in areas at risk of flooding will be permeable to floodwater, unless otherwise discussed with the Environment Agency or Local Lead Flood Authority. This will ensure that the floodplain continues to function effectively for storage and conveyance of floodwater.

8.1.14 The temporary works other than those outlined in Table 6 are considered to be at a low risk of river flooding.

8.2 Surface water/overland flow

8.2.1 The proposed track will result in increased run-off rates due to a reduction in infiltration capacity. Therefore, the entire length of the track may be at risk from this source and could increase risk elsewhere.

8.2.2 In addition the track drainage has the potential to increase flood risk in receiving watercourses if not attenuated. In this study area there are ten proposed balancing ponds, these are located as follows:

- to the west of the route in Whittington Heath (Volume 2:CFA 22, Map CT-06-123b, C7);
- to the south east of Capper's Lane viaduct crossing (Volume 2: CFA22 , Map CT-06-124, D6);
- south east of the Fulfen Wood culvert crossing (Volume 2: CFA22 , Map CT-06-125, H5);
- north of the Mare Brook north culvert crossing (Volume 2: CFA22 , Map CT-06-126, F4);
- three in the vicinity of the Wood End Lane underbridge (Volume 2: CFA22 , Map CT-06-127, G5, H8 and I7);
- one to the west of the Wood End Lane diversion (Volume 2: CFA22, CT-06-128, G10);
- adjacent to the Bourne Brook viaduct crossing (Volume 2: CFA22 , Map CT-06-129, F6); and
- east of the route at Handsacre west culvert extension crossing (Volume 2: CFA22 Map Book, Map CT-06-130a, E6).

8.2.3 The outfall from these balancing ponds will be attenuated to ensure that run-off rates are not increased above existing levels to prevent an increase in risk.

8.2.4 The route has the potential to interrupt surface water movement, which could result in an increase in surface water flood risk. The Environment Agency uFMfSW indicates that the AP2 revised scheme will interrupt three surface water flow paths in this study area.

8.2.5 To the north east of Streethay there is an overland flow path. However, surface water at this location flowing away from the AP2 Scheme will discharge into the tributary of Mare Brook (Volume 5: CFA22, Map WR-01-037, C5) and hence will flow as existing. Surface water flow paths towards the AP2 Scheme, at this location, will be collected prior to being discharged via a proposed balancing pond if necessary to the tributary of Mare Brook (SWC-CFA22-004). Although there will be an interruption to surface water movement at this location; it is considered there will be no impact on surface water flood risk as a result of the AP2 revised scheme at this location.

8.2.6 Between the north of Wood End Farm and Vicar's Coppice there are two areas with numerous isolated areas at risk from surface water flooding. This potentially indicates two overland flow path although these appear to be flowing away from the AP2 revised scheme will discharge into the Trent and Mersey Canal and hence will flow as existing (Volume 5: CFA22 , Map WR-01-038, E7 and F6). Surface water flow paths towards the AP2 revised scheme, at these locations, will be collected in drainage ditches alongside the route. Although there will be an interruption to surface water movement at this location; it is considered there will be no impact on surface water flood risk as a result of the AP2 revised scheme at this location.

8.2.7 The potential impact of the AP2 revised scheme on surface water movement, not identified as above, will be incorporated within the scheme design. Therefore, the works will have no impact on surface water flood risk.

8.2.8 There are other design elements of the AP2 revised scheme which will be at risk from surface water flooding. The surface flood risks to the other design elements, as identified from the Environment Agency uFMfSW are included in Table 7.

Table 7 - Surface water flood risks to other design elements of the AP2 Scheme

Works at risk	Location description and map reference	Description of possible influence to the AP2 Scheme	Risk
Highways Earthworks	Area at Capper's Lane Viaduct	Proposed access roads and embankment works are located in areas at low, medium and high risk of surface water flooding. This area is associated with SWC-CFA22-001.	High
Earthworks Landscaping	Fulfen Wood culvert Volume 5: Map WR-01-037, E5 and E6.	Landscaping works and the earthworks for Fulfen Wood north embankment will be located in areas at low, medium and high risk of surface water flooding. This area is associated with a watercourse (SWC-CFA22-003).	High
Earthworks Landscaping	North-east of Streethay, west of the Coventry Canal Volume 5: Map WR-01-037, C5.	Landscaping works and the earthworks for Streethay embankment are located in an area at a low and medium risk of surface water flooding, not associated with a watercourse.	Medium
Highways	Mare Brook south culvert Volume 5: Map WR-01-037, F4.	An access road from Rough Stockings is located in an area at high risk from surface water flooding, this is associated with a watercourse, a tributary of SWC-CFA22-004.	High
Highways Earthworks Landscaping	East of Curborough House Volume 5: Map WR-01-037, A6 and B6.	Landscaping works, an access track, the earthworks for Streethay embankment and a realigned PRoW are located in areas at a low, medium and high risk of surface water flooding, associated with a watercourse (SWC-CFA22-006).	High
Earthworks	Pyford Brook viaducts Volume 5: Map WR-01-038, G5.	Earthworks for Pyford Brook east embankment and Pyford Brook west embankment are located in an area at a low, medium and high risk of surface water flooding, associated with a watercourse (SWC-CFA22-010).	High
Highways Earthworks	Ravenshaw Wood to Vicar's Coppice Volume 5: Map WR-01-038, F6 and E7.	Earthworks for Ravenshaw Wood embankment and a realigned footpath and bridleway are located in areas at a low and medium risk of surface water flooding, not associated with a watercourse.	Medium

8.2.9 There are seven locations where other design elements are located in areas susceptible to surface water flooding. In general these areas range from low to high risk and as a conservative approach the highest level of risk has been assigned. Therefore, five of the seven locations are categorised as being at a high risk and two being at a medium risk of surface water flooding.

8.2.10 The other design elements not listed in Table 7 are considered to be at no risk from surface water flooding in line with the flood risk category matrix.

8.2.11 All other design elements, including those additional to Table 7, have the potential to increase surface water run-off rates through reduced infiltration capacity. The design for the AP2 revised scheme includes surface water run-off management (such as drainage channels and balancing ponds) to prevent an increased risk of flooding from this source both on site and in neighbouring areas.

8.2.12 Table 8 details the risk to the temporary design elements from surface water flooding.

Table 8 - Sources of surface water flooding to temporary works

Description of surface water flooding location and map reference	Description of possible influence on temporary design elements	Risk
In the vicinity of the Capper's Lane viaduct crossing Volume 5: Map WR-01-037, E5 and E6	Capper's Lane viaduct (west) compound, Capper's Lane overbridge satellite compound and temporary site access/haul route and fencing will be located in areas at a low, medium and high risk of surface water flooding associated with a watercourse (SWC-CFA22-001).	High
In the vicinity of the Fulfen Wood crossing Volume 5: Map WR-01-037, E5 and E6	A temporary material stockpile will be located in areas at a low, medium and high risk of surface water flooding associated with a watercourse (SWC-CFA22-003).	High
North east of Streethay, east of the Coventry Canal Volume 5: Map WR-01-037, C5	A temporary material stockpile is located in an area at a low and medium risk of surface water flooding, not associated with a watercourse.	Medium
In the vicinity of the Mare Brook south culvert crossing Volume 5: Map WR-01-037, C5 and C6	A temporary bridge/culvert crossing, a temporary material stockpile and a temporary site access/haul route and fencing will be located in an area at a low, medium and high risk of surface water flooding, associated with a watercourse (SWC-CFA22-004).	High
East of Curborough House Volume 5: Map WR-01-037, B6	Temporary site access/haul road and fencing, and temporary material stockpiles will be located in areas at a low, medium and high risk of surface water flooding, associated with a watercourse (SWC-CFA22-006).	High
South of Fradley Wood Volume 5: CFA22 Map Book, Map WR-01-037, A6	A temporary material stockpile will be located in an area at a low and medium risk of surface water flooding, not associated with a watercourse.	Medium
In the vicinity of the Pyford Brook viaducts crossing Volume 5: Map WR-01-038, G5 and G6	Temporary haul road and fencing, and a temporary bridge/culvert will be located in areas at a low, medium and high risk of surface water flooding, associated with a watercourse (SWC-CFA22-010).	High

Description of surface water flooding location and map reference	Description of possible influence on temporary design elements	Risk
Ravenshaw Wood to Vicar's Coppice Volume 5: CFA22 Map Book, Map WR-01-038, F6	Temporary site access/haul road and fencing, and a temporary earthworks stockpile will be located in areas at a low and medium risk of surface water flooding, not associated with a watercourse.	Medium
In the vicinity of the Bourne Brook viaduct crossing Volume 5: Map WR-01-038, E7 and E8	A temporary crane platform and a material transfer stockpile area, are located in areas at a low and medium risk of surface water flooding. This area is associated with a watercourse (SWC-CFA22-012).	Medium
In the vicinity of the Handsacre east culvert crossing, and the Handsacre West culvert extension crossing Volume 5 Map WR-01-038, D8 and C8	A temporary site access/haul road and temporary earthworks stockpiles will be located in areas at a low, medium and high risk of surface water flooding.	High

8.2.13 There are ten locations of temporary design elements in this study area which have been identified to be at risk from surface water flooding from the Environment Agency uFMfSW. A conservative approach has been taken in categorising risk as outlined earlier in this section. Therefore, in line with the flood risk category matrix (Table 1) a high risk of surface water flooding has been categorised at six locations and a medium risk at four locations.

8.2.14 Construction and satellite compounds have the potential to interrupt surface water flow paths. However, there are no satellite compounds in this study area that will interrupt surface water flow paths which are identified on the Environment Agency uFMfSW.

8.2.15 In line with the risk category matrix provided in Table 1, all other locations for temporary works within this study area are classed to be at no risk from surface water flooding.

8.2.16 The works will be completed in line with the CoCP and hence the design of the temporary works will prevent an unacceptable level of surface water flood risk on site.

8.2.17 Temporary works not identified to be at risk on the uFMfSW also have the potential to increase flood risk from this source in neighbouring areas as a result of reduced ground permeability. Therefore, in line with the draft CoCP, surface water will be managed at all locations of temporary works, including areas not identified to be at risk from surface water in Table 8. This will ensure that the temporary works are at an acceptable level of risk and do not cause an increased risk elsewhere from surface water flooding.

8.3 Groundwater

8.3.1 Developments may increase the risk of groundwater flooding where a barrier to groundwater flow in constructed across the natural flow path. The presence of such a barrier may impede groundwater flow causing levels to increase up gradient; if these levels rise to the ground surface groundwater flooding may occur.

8.3.2 A review of the AP2 revised scheme in this CFA does not indicate that any barriers to flow will be introduced that will affect a significant aquifer thickness.

8.3.3 It is therefore concluded that the scheme will not increase the risk of groundwater flooding.

8.4 Sewer systems

8.4.1 The route will cross the sewer network at two locations and will be located within approximately 120m of an inspection cover. However, topography in the area indicates that there are no flow paths for flooding to the AP2 revised scheme from this source.

8.4.2 At three locations the route crosses the sewer network and there are inspection covers at the location of the route. At these locations however the inspection covers will be relocated to the foot of the embankment of the route. Flood water either side of the route would flow along the track drainage channels and into the associated watercourse (Volume 5: Map WR-05-063, G5, SWC-CFA22-006).

8.4.3 The works will be completed in line with the CoCP and hence will ensure that the AP2 revised scheme and neighbouring areas will not be at an increased flood risk from this source. One such measure outlined in the draft CoCP requires the removal or stopping and sealing of drains and sewers taken out of use. Similarly as outlined in the draft CoCP, precautions will also be taken to prevent damage to services and to avoid pollution during service diversions, excavations and ground penetration.

8.5 Artificial sources

8.5.1 At locations where the route crosses canals or areas at risk of flooding as a result of reservoir failure, there is potential that the AP2 revised scheme may either increase risk from this source, or divert flood water causing new areas to be put at risk.

Reservoirs

8.5.2 The Environment Agency reservoir inundation maps indicate that if Swinfen Lake fails, flooding would occur at the location and surrounding area of the Capper's Lane viaduct (Volume 5: Map WR-01-037, E5). There are no other design elements in this area at risk of flooding from this source. The temporary works at risk are Capper's Lane viaduct (north) compound, Capper's Lane viaduct (west) compound and a temporary site access/haul route and fencing. The reservoir inundation mapping covers a greater extent than the river Flood Zone mapping and therefore there is potential that the AP2 revised scheme may slightly alter flow paths at this location.

8.5.3 As outline in Section 6.6, if Stowe Pool or Minster Pool were to fail, flooding would occur at the location and surrounding area of the Pyford Brook viaducts (Volume 5Map WR-01-037, G5). The other design elements at risk in this location are the Pyford Brook east embankment and the Pyford Brook west embankment. The temporary work elements at risk are a site access/haul road, fencing, and a temporary bridge/culvert. The reservoir inundation mapping covers a greater extent than the river Flood Zone mapping and therefore there is potential that the AP2 revised scheme may slightly alter flow paths at this location.

8.5.4 In line with the risk category matrix (Table 1) the flood risk to all elements of the AP2 revised scheme from reservoir failure is considered low.

8.5.5 The CoCP indicates that areas at risk of flooding should be considered when planning sites and storing materials. The flood risk areas are likely to be taken from the river flood risk maps, however at the locations at risk from reservoir inundation in this study area, the reservoir inundation maps are greater than the areas at risk from river flooding. Therefore, the management of the temporary works at risk from this source should consider the impact of risk of flooding as a result of reservoir failure, although it is not anticipated that these proposed works would have a significant impact on flood flow routes and hence flood risk to other receptors.

8.5.6 There are no other locations within this study area that are at risk of flooding from reservoir failure as shown on the Environment Agency reservoir inundation maps. It is therefore concluded that the AP2 revised scheme, including the route, other design elements and temporary works, will be at a low risk of flooding from this source (Table 1) and will not result in an increased risk elsewhere.

Canals

8.5.7 The proposed route involves development that crosses the Wyrley and Essington Canal (Volume 5: Map WR-01-037, G5) in this study area.

8.5.8 The other design elements to the north of this canal, specifically a balancing pond and access road are at risk should overtopping occur.

8.5.9 The temporary works at risk are those at Capper's Lane viaduct (north) compound, Capper's Lane viaduct (west) compound and a site access route/haul route. Capper's Lane viaduct (west) compound would be at a higher elevation than the canal, and hence is not considered to be at risk. Capper's Lane viaduct (north) compound is located at a lower elevation than the minor embankment to the south of the canal and hence will be at risk following overtopping from the canal. There are no other temporary works at risk from this source of flooding.

8.5.10 The proposed route involves development that crosses the Trent and Mersey Canal (Volume 5: Map WR-01-037, G5 and F5) in this study area.

8.5.11 The other design elements to the south of this canal, specifically two balancing ponds and associated access roads, Pyford Brook east embankment and Pyford Brook west embankment are at risk should overtopping occur.

8.5.12 The temporary works at risk are those at Trent and Mersey Canal East viaducts (south-east and north-east) compounds, Trent and Mersey Canal West viaducts (south-west and north-west) compounds and a temporary site access route/haul route. Trent and Mersey Canal East viaducts (south-east) compound and Trent and Mersey Canal West viaducts (south-west) compound would be at a higher elevation than the canal, and hence is not considered to be at risk. Trent and Mersey Canal East viaducts (north-east) compound and Trent and Mersey Canal West viaducts (north-west) compound would be located at a lower elevation than this minor embankment to the north of the canal and hence will be at risk following overtopping from the canal. There are no other temporary works at risk from this source of flooding.

8.5.13 The canal crossing requires a minimum soffit height for navigational purposes and this soffit would be sufficiently high to prevent any impact on flow. Similarly the works will be undertaken in line with the CoCP and hence will ensure the works are at an acceptable level of risk and that the AP2 revised scheme will not cause an increased risk elsewhere.

8.5.14 In line with the risk category matrix in Table 1, the risk to the other design elements and the temporary works is low. These works will be completed in line with the CoCP and hence will not impact on flood risk from this source.

8.6 Summary

8.6.1 The AP2 revised scheme will be located in areas at risk from river flooding, including at eight watercourse crossings where a very high risk has been assigned. However, the hydraulic modelling completed at these eight locations identifies that at six of the crossings the impact of the AP2 revised scheme is negligible.

8.6.2 All elements of the AP2 revised scheme will cross areas susceptible to surface water flooding. In general, at each of the areas the risk ranges from low to high, although as a conservative approach the highest level of risk has been assigned resulting in many of the areas being categorised as being at a high risk from surface water flooding. However, the AP2 revised scheme will mitigate surface water run-off to ensure that the works are at an acceptable level of flood risk and do not result in an increased risk elsewhere.

8.6.3 The AP2 revised scheme will involve development within an area at a low risk from groundwater flooding. However, the design involves measures to ensure that the development is an acceptable level of risk and that the AP2 revised scheme does not increase flood risk from this source.

8.6.4 There is a medium risk to the AP2 revised scheme including the route, other design elements and the temporary works of flooding from the sewer network. However, the works will be completed in line with the CoCP and hence will ensure that the AP2 revised scheme and neighbouring areas will not be at an increased flood risk from this source.

8.6.5 Water levels within canals are continually maintained and hence the chance of overtopping and thus flood risk from this source is considered low. Similarly due to the strict monitoring and maintenance requirements, the risk of reservoir flooding to the development is considered low. The design ensures that the AP2 revised scheme will not result in an increased risk from this source both to the development and elsewhere.

9 Conclusions

9.1.1 The AP2 revised scheme, including the route, other design elements and the temporary works, are to be located within areas at risk from flooding from a range of sources. However, the temporary works will be designed to and will follow the CoCP such that development will be at an acceptable level of risk and will not cause an increased risk elsewhere. The proposed mitigation as part of the permanent works will also ensure that the AP2 revised scheme will be at an acceptable level of flood risk and will not result in an increased risk elsewhere.

9.1.2 The magnitude of impact and significance of effects have been based on the Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR, see Volume 5: Appendix CT-001-000/1). Table 9 shows a summary of the sources of flood risk within this study area and the associated magnitude of impact and significance of effects.

9.1.3 In terms of river flooding, the magnitude of impact in this study area of the AP2 revised scheme with the floodplain replacement storage is negligible and significance of effects neutral.

9.1.4 Although there are areas of the AP2 revised scheme at no, low, medium and high risk from surface water flooding, overall the risk from this source is categorised as high, as a conservative approach. However, the overall magnitude of impact is negligible and the significance is neutral. This has been determined because the design of the permanent works will be in line with the design criteria outlined in Section 11 of this report and that the temporary and construction works assessed as part of this FRA are in line with the draft CoCP.

9.1.5 Groundwater flood risk has been assessed as low within the CFA.

9.1.6 The risk from sewer flooding is medium within this study area, and the overall magnitude is negligible with a neutral significance. This has been determined because the design of the permanent works will be in line with the design criteria outlined in Section 11 of this report and that the temporary and construction works assessed as part of this FRA are in line with the draft CoCP.

9.1.7 In this study area artificial sources of flooding (both from reservoir failure and canals) have also been categorised as low, resulting in a low significance of effect.

Table 9 - Summary of Flood Risk Receptors showing the overall magnitude of impact and significance of effects

Flood Risk Receptor	Risk Category	Magnitude of Impact	Significance of effects
Areas at risk from river flooding	Very High	Negligible	Neutral
Areas at risk from surface water flooding	High	Negligible	Neutral
Areas at risk from groundwater flooding	Low	Negligible	Neutral
Areas at risk from drainage and sewer flooding	Medium	Negligible	Neutral
Areas at risk of flooding from artificial sources	Low	Negligible	Neutral

9.2 Residual flood risk to the AP2 revised scheme

9.2.1 Residual flood risks arise in situations that are not included in standard design scenarios, for example when a culvert becomes blocked causing flooding upstream. All design is generally undertaken assuming that existing infrastructure is functioning under normal conditions. Consequently, there may be areas where the potential severity of flooding may exceed the design standard under certain circumstances.

Residual flood risks from river sources

Capper's Lane viaduct

9.2.2 There is one existing hydraulic structure downstream of the Capper's Lane viaduct. However, the viaduct would be at a significant height above the floodplain, and hence the residual risks of flooding over and above the design event, and the risk of blockage, would not be significant.

Fulfen Wood watercourse

9.2.3 There are two existing structures in the vicinity of the Fulfen Wood watercourse. These structures are a railway crossing upstream of the proposed culvert and the Coventry Canal crossing downstream of the proposed watercourse diversion. The existing upstream structure is located upstream of the AP2 revised scheme but will be redundant following the diversion of the watercourse and, therefore will not pose any residual risk There is a potential that blockage at the downstream Coventry Canal crossing will impact on flood levels at the location of the AP2 revised scheme. Even though the risk of flooding from a downstream blockage is unknown, the railway track would be at a significant height above the floodplain and hence the risk to the track is considered low.

Mare Brook South culvert

9.2.4 There is one hydraulic structure in the vicinity of Mare Brook south culvert. This existing structure is the A38 road crossing and is located downstream of the AP2 revised scheme. There is potential that blockage at this existing road crossing will impact on flood levels at the location of the AP2 revised scheme. Even though the risk of flooding from a downstream blockage is unknown, the track would be at a significant height above the floodplain and hence the risk to the track is considered low.

Mare Brook North culvert

9.2.5 There is one hydraulic structure in the vicinity of Mare Brook north culvert. This existing structure is the A38 road crossing and is located downstream of the AP2 revised scheme. There is potential that blockage at this existing road crossing will impact on flood levels at the location of the AP2 revised scheme. Even though the risk of flooding from a downstream blockage is unknown, the track would be at a significant height above the floodplain and hence the risk to the track is considered low.

Pyford Brook viaducts

9.2.6 There are existing hydraulic structures in the vicinity of the Pyford Brook viaducts. The existing structures are the Wyrley and Essington Canal crossing, and also the Wood

End Lane road crossing, both upstream of the AP2 revised scheme. However, the viaduct would be at a significant height above the floodplain, and hence the residual risks of flooding over and above the design event, and the risk of blockage, would not be significant.

Bourne Brook viaduct

9.2.7 There are existing hydraulic structures in the vicinity of the Bourne Brook viaduct. The existing structures are a railway crossing, and also the Lichfield Road Crossing, both located upstream of the AP2 revised scheme. However, the viaduct would be at a significant height above the floodplain, and hence the residual risks of flooding over and above the design event, and the risk of blockage, would not be significant

Handsacre East culvert

9.2.8 There are hydraulic structures in the vicinity of the Handsacre East culvert. The existing structures are the B5014 road crossing, and also the Trent and Mersey Canal crossing. At this location however, the track would be at a significant height above the floodplain so that the risk of flooding from failure or blockage of these structures would be considered low.

Handsacre West culvert extension

9.2.9 There are hydraulic structures in the vicinity of the Handsacre west culvert extension. The existing structures are the B5014 road crossing, and also the Trent and Mersey Canal crossing. At this location however, the track would be at a significant height above the floodplain so that the risk of flooding from failure or blockage of these structures would be considered low.

Residual flood risks from surface water sources and minor watercourses

9.2.10 All culverts within the AP2 revised scheme are designed with a minimum internal headroom of 300mm above the design flood water level to minimise the risk of blockage. Therefore, there are not expected to be any significant increases in risk of flooding at dry valley crossings arising from potential blockage of culverts.

Residual flood risks from groundwater

9.2.11 Groundwater levels rise and fall relatively slowly, and therefore any change in the risk of flooding from this source would be the result of below ground intervention. The risk of groundwater flooding already considered in this FRA presents an absolute risk, and there are no significant residual risks arising from this source.

Residual flood risks from the sewer network

9.2.12 Blockage of underground sewer networks can cause surcharge and associated flooding. At locations where the existing sewer infrastructure will need diverting, any replacement infrastructure would be to at least the same standard as existing. Consequently, no additional residual risk to the AP2 revised scheme would be expected as a result of drainage system failure.

Residual flood risks from artificial and surface sources

9.2.13 This assessment considers the potential for total failure of reservoirs and canals, which is deemed to be the most extreme case of flooding from these sources.

Therefore, it is considered that there are no further residual risks from artificial sources of flood risk.

9.3 Residual effects of the AP2 revised scheme on flood risk

9.3.1 All culverts within the AP2 revised scheme will be designed to convey the 1 in 100 year (1% annual probability) flow including an allowance for climate change with a minimum internal headroom of 300mm above the design flood water level (to minimise the risk of blockage). Consequently, there would be negligible increase in upstream residual flood risks arising from the introduction of culverts within the AP2 revised scheme.

9.3.2 All viaducts within the AP2 revised scheme will also be designed to allow the 1 in 100 (1%) annual probability flow with an allowance for climate change to pass underneath. As a minimum the design will ensure a 600mm freeboard will be provided to the bridge soffits above this level, and on main rivers where possible, a freeboard of 1m will be allowed. These freeboards will allow for debris and hence prevent a significant increase in residual risk in upstream areas as a result of the AP2 revised scheme.

10 References

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Contents

1 **Overarching modelling approach** **5**
1.1 Introduction 5
1.2 Hydrology 5
1.3 Hydraulics 6
1.4 Assumptions and limitations 10
2 **Modelling at watercourse crossings** **12**
2.1 Overview 12
2.2 Culverts 14
2.3 Capper's Lane viaduct 16
2.4 Pyford Brook viaduct 19
2.5 Bourne Brook Viaduct 23
3 **FEH proformas** **27**
3.1 Overview 27
3.2 Capper's Lane viaduct, Mare Brook south culvert and Mare Brook north culvert 27
3.3 Permeable catchment assessment - Capper's Lane viaduct and Mare Brook south culvert 34
3.4 Pyford Brook viaduct, Bourne Brook viaduct, Handsacre east culvert and Handsacre west culvert extension 48
3.5 Supporting information 60

List of figures

Figure 1 - Location plan 13
Figure 2 - Crossing location plan and flood extents for Capper's Lane viaduct 16
Figure 3 - Cross section with flood levels for Capper's Lane viaduct 18
Figure 4 - Baseline peak velocity contours and scheme impact on velocities for 1 in 100 (1%) climate change event at Capper's Lane viaduct 19
Figure 5 - Crossing location plan and flood extents for Pyford Brook viaduct 20
Figure 6 - Cross section with baseline flood levels at Pyford Brook viaduct 22

Figure 7 - Baseline peak velocity contours and scheme impacts on velocities for the 1 in 100 (1%) climate change event at Pyford viaduct 22
Figure 8 - Crossing location plan and flood extents for Bourne Brook viaduct 23
Figure 9 - Cross section with flood levels for Bourne Brook viaduct 25
Figure 10 - Baseline peak velocity contours and scheme impacts on velocities for 1 in 100 (1%) climate change at Bourne Brook viaduct 25

List of tables

Table 1 - River models at watercourse crossings 12
Table 2 - Modelled peak levels at culvert crossings 15
Table 3 - Hydrology results: model inflows to Capper's Lane viaduct 17
Table 4 - Modelled peak levels for Capper's Lane viaduct 18
Table 5 - Hydrology results: model inflows to Pyford Brook 20
Table 6 - Modelled peak levels for Pyford Brook viaduct 22
Table 7 - Hydrology results: model inflows for Bourne Brook viaduct 24
Table 8 - Modelled peak levels for Bourne Brook viaduct 25

1 Overarching modelling approach

1.1 Introduction

1.1.1 This section of the AP2 revised scheme will cross numerous watercourses with the potential for affecting flood risk. Hydraulic modelling has been carried out to assess the current (baseline) river flood risks at each of these watercourse crossings and the potential impacts of the proposed culvert and viaduct structures. Therefore, the primary objective of this assessment was to assess the impact of the proposed scheme on river flood risk.

1.1.2 The outcome of this assessment will aid the design to determine the type and dimension of structures required to convey the watercourse flows; and mitigation measures for any remaining residual flood risk.

1.1.3 A hydraulic modelling assessment of flood risk was undertaken for watercourses affected by this section of the AP2 revised scheme. These watercourses were grouped into seven community forum areas (CFA) in this section of the AP2 revised scheme. Existing hydraulic models of the watercourses have been utilised where available; and new river hydraulic models were built for the other watercourses. This report describes the hydraulic modelling processes and outcomes of this assessment.

1.1.4 The main conclusions from this modelling report form the basis of the river flood risk section in the Flood Risk Assessment for CFA22 – Whittington to Handsacre (SES and AP2 Appendix WR-003-022). These conclusions are also reported within the Water Resources and Flood Risk Assessment section of Volume 2 of the SES and AP2 Environmental Statement (ES).

1.2 Hydrology

1.2.1 Watercourses with existing hydraulic models adopted standard Flood Estimation Handbook (FEH) techniques for hydrological assessment. The hydrology of these models was reviewed for suitability for use in this study.

1.2.2 For the watercourses with no existing hydraulic models, hydrological assessments were undertaken in this assessment to determine the design flows.

1.2.3 The hydrological catchments of the watercourses to each of the route crossings have been determined from the FEH CD-ROM[1] for watercourses represented in this data set. For the purposes of this assessment it was assumed that catchment boundaries as represented in the FEH CD-ROM were correct, therefore a detailed assessment of catchment boundaries has not been completed. The catchment descriptors have also been taken from the FEH CD-ROM and updated for urban expansion to 2012, using Equation 6.8 in Volume 5 of the FEH[2]. This is a standard industry technique.

1.2.4 River flows at watercourse crossing locations were determined using the Revitalised Flood Hydrograph (ReFH) method[3] in the first instance. In line with the current Environment Agency flood estimation guidance4, the ReFH method is deemed

[1] Centre for Ecology and Hydrology (2009) *FEH CD-ROM Version 3, ©NERC (CEH).*
[2] Centre for Ecology & Hydrology. (1999). *Flood Estimation Handbook – Volume 5: Catchment Descriptors*.
[3] Centre for Ecology & Hydrology. (2007). *The revitalised FSR/FEH rainfall-run-off method: Supplementary Report No. 1*.

acceptable for the majority of catchments along the route and is the most time efficient method for determining flows for studies where numerous flows are required.

1.2.5 The ReFH method is not considered acceptable for all catchments, in this case those classed as highly permeable. Based on the FEH CD-ROM catchment descriptors, a number of the catchments are classed as highly permeable and hence in line with current Environment Agency guidelines[4], an alternative method was required. Therefore at these locations, the FEH Statistical method, with a permeable adjustment was utilised, as recommended in the guidelines.

1.2.6 Not all watercourses crossed by the route were represented in the FEH CD-ROM, therefore the catchment boundaries could not be determined using the FEH CD-ROM. In these instances, catchment boundaries have been determined through the use of topographic data from Light Detection and Ranging (LiDAR) data and Ordnance Survey (OS) mapping at a 1:10,000 scale. At locations of uncertainty, a slightly larger catchment has been assumed as a conservative approach. Flows for these catchments were determined through a conservative area scaling method. Based on the flows estimated for FEH CD-ROM represented catchments, a maximum flow rate of 1.4 and 2.6m3/s per km2 was calculated for the 1 in 100 (1%) annual probability and 1 in 1000 (0.1%) annual probability events respectively. These flows rates, along with a 10% error allowance (to prevent an underestimation of flow), were used as scaling factors.

1.2.7 The estimated peak flows were used as either a constant inflow boundary or as a full hydrograph. The peak flows estimated using this method were for the 1 in 20 (5%) annual probability, 1 in 100 (1%) annual probability and 1 in 1000 (0.1%) annual probability events. Flow during the 1 in 100 (1%) annual probability event with an allowance for climate change was estimated by factoring the 1 in 100 (1%) annual probability flow by 20%.

1.3 Hydraulics

General approach

1.3.1 The hydraulic modelling approach depended on the characteristics of the particular watercourse and floodplain hydraulics. The approach of either steady or unsteady modelling was based on whether there were rapid increases or decreases in flows, flood storage areas or structure impacts on channel/floodplain flows. The modelling approach also varied based on requirements of assessing the flow routes either in one-dimension (one dimensional) or two-dimension (two dimensional).

[4] Environment Agency (2012) *Flood estimation guidelines (197_08).*

1.3.2 The modelling approach adopted in this study was as follows:

- if the modelling was utilised for sizing the culvert crossings on watercourses with no significant floodplain attenuation or structure impacts, steady state one dimensional modelling was adopted;
- if there was significant floodplain attenuation and/or structure impacts on channel/floodplain flows, one dimensional hydrodynamic modelling was adopted; and
- if there was significant floodplain attenuation and/or structure impacts on channel/floodplain flows, and a requirement for accurately defining the flood extents, two dimensional or a one dimensional-two dimensional linked modelling was adopted.

1.3.3 Existing models were first reviewed to assess their suitability for use. If more recent data such as topography was available the models were updated accordingly. If the level of detail within the model, such as the floodplain, was not appropriate, the model was upgraded accordingly.

1.3.4 The hydraulic modelling approach was based on the Environment Agency guidelines[5].

1.3.5 Two industry standard modelling packages have been utilised as part of this assessment: ISIS (version 3.6) and TUFLOW (version 2012). ISIS is software developed by Halcrow mainly used for one dimensional hydraulic modelling of river flooding. TUFLOW is software developed by BMT WBM[6] for two dimensional hydraulic modelling of river, estuarine and coastal flooding.

Hierarchical approach

1.3.6 Any existing Environment Agency models for the watercourses were used to assess the current and future flood risk impacts of the route crossing any watercourses.

1.3.7 For watercourses without existing hydraulic models, the modelling process was carried out in a phased manner to assess the baseline flood risk and impacts of the proposed scheme. In the first phase, the watercourses with culverted crossings were modelled as simple unsteady one dimensional hydraulic models, to assess the adequacy of culverts in conveying flood flows. In the second phase, watercourses for both culverted and viaduct crossings were modelled as two dimensional hydrodynamic models to define the flood extents and assess the impacts of the various structures on flood risk. The two dimensional model outputs were then used to inform the design team of flood risk.

1.3.8 All the models were run for the 1 in 100 (1%) annual probability with an allowance for climate change and 1 in 1000 (0.1%) annual probability. Some of the models were run for the 1 in 20 (5%) annual probability where the potential impacts on flood risk could affect vulnerable receptors.

[5] Environment Agency. (August 2009). *Requirements for completing computer river modelling for flood risk assessments – Guidance for developers (Version 3.0)*
[6] BMT WBM. (2010). *TUFLOW User Manual*

1.3.9 The 1 in 100 (1%) annual probability with an allowance for climate change peak water levels for the baseline and proposed scheme were compared upstream and downstream of the crossing to assess the impact on flood risk. The scheme impact on flood risk and the width of the 1 in 100 (1%) annual probability with an allowance for climate change flood extents, defined the type of structure to be used at the crossings i.e. culvert, underbridge or viaduct and the dimensions of the structure. The structure type was selected based on its adequacy in conveying flood flows without significantly affecting flood risk.

1.3.10 The peak water levels for the 1 in 1000 (0.1%) annual probability event confirmed whether the vertical alignment met the design criteria (refer to 'Section 3 - Design Criteria' of the Flood Risk Assessment (SES and AP2 Appendix WR-003-022).

Input data

1.3.11 The topographic data used was LiDAR data that was flown in 2012, covering the extent of the AP2 revised scheme, providing data as fine as up to 0.2m horizontal resolution. This data was used to create digital terrain models (DTM) for use within the hydraulic models. In most cases, the DTM has been resized to a 1m resolution for suitability in two dimensional models. For watercourses without existing hydraulic models, there were no topographic surveys available and hence river sections and floodplain topography were derived from these DTM.

1.3.12 For existing models, the floodplain topography was updated with this DTM. The channel topography in these models was taken from topographic surveys undertaken previously.

1.3.13 Inflows to the watercourses were taken from the hydrological assessments as discussed in Section 0 of this report.

1.3.14 The data for the proposed scheme model scenario was taken from the scheme drawings.

One dimensional modelling

1.3.15 In the first phase, one dimensional ISIS models were constructed representing a 200m to 300m reach of the watercourse. The purpose of these models was to assess the adequacy of culverted crossings in conveying flows. These models used the LiDAR data to define extended cross sections which included the channel and floodplain topography. The roughness of the channels and floodplains is defined by the Manning's roughness parameter. The Manning's roughness values were based on the particular land use type as observed from aerial photographs. Steady state flows were applied as upstream inflow boundaries and a normal depth boundary was applied at the downstream extent. The normal depth boundary was based on the bed slope of the topography at that location and is considered suitable for the purpose of the modelling.

1.3.16 The AP2 revised scheme model included rectangular conduit units to represent the structures at the crossings. There were two types of culverts adopted: a minimum culvert size of 2m by 1.5m and a maximum culvert size of 4m by 2m. The dimensions adopted here represent the flow area of the culvert rather than the full dimensions of the culvert that would need to be larger to accommodate depressed inverts and mammal ledges as appropriate. The lengths of the culverts were based on the width of the route crossings as defined in the scheme design.

Two dimensional modelling

1.3.17 In the second phase, unsteady state two dimensional TUFLOW models were built to accurately define the flood extents and floodplain attenuation. The two dimensional models were built on a 5m cell resolution with LiDAR data used to create the DTM, which defined the floodplain and channel topography.

1.3.18 It should be noted that components within a 2D TUFLOW model such as SXZ, HX, Z-polygon, Z-Shape polygons, etc., are based on naming conventions as defined in the TUFLOW manual6.

1.3.19 The Manning's roughness values of the channels and floodplains were based on the particular land use type as observed from aerial photographs.

1.3.20 The inflow to each watercourse was applied upstream using a TUFLOW boundary condition polyline layer, linking it to a flow time series within a boundary condition database. The flow type is either constant flow or hydrograph flow, depending on the attenuation within the floodplain. A flow-head (HQ) polyline layer was used for the downstream boundary, based on the slope of the floodplain at that location; which was considered suitable for the scale and level of detail of the modelling. The models have been run at a two second timestep for varying durations.

1.3.21 The proposed scheme model was built by adding either culvert or viaduct structures to the baseline model at the watercourse crossings.

1.3.22 Viaduct structures have been modelled by adding route embankments as Z-polygon or Z-Shape polygon layers with an opening at the viaduct crossing. The Z-polygon or Z-Shape polygon layers are Geographic Information System (GIS) polygons with elevations. Where piers were modelled, they were represented as flow constriction (FC) shape layers. The soffit levels were not added into the model. This was because the 1 in 1000 (0.1%) annual probability modelled peak flood levels, along with sufficient clearance, will form the basis of designing the soffit heights. (Refer to 'Section 3 - Design Criteria' of the Flood Risk Assessment (SES and AP2 Appendix WR-003-022)).

1.3.23 Culvert structures have been modelled by adding a one dimensional network layer representing the extent of the culvert, the length of which was determined by the width of the route at the crossing point (including embankment earthworks and any landscaping). Inverts were defined at the inflow and outflow points of the culvert extracted from the LiDAR DTM for the area. This one dimensional network layer was connected to the two dimensional domain with a SXZ point link, a GIS point used in the modelling software for one dimensional-two dimensional linking. An embankment was modelled across the route as a Z- polygon layer, covering the extent of the upstream floodplain at the route crossing so that all flow was routed through the culvert.

One dimensional-two dimensional linked modelling

1.3.24 In certain cases where existing one dimensional models were not representing complex channel-floodplain interactions accurately, dynamically linked one dimensional-two dimensional models were constructed. The channel component was represented in one dimensional and the floodplain component in two dimensional. These models were built using ISIS-TUFLOW.

1.3.25 The flows between the one dimensional and two dimensional model components were controlled via a GIS polyline layer (HX layer), the spill levels of which are defined by the channel bank levels or DTM levels.

1.3.26 In the proposed scheme scenarios, the viaduct structures are represented as discussed earlier in the two dimensional modelling section (Section 1.3.22 of this report).

Sensitivity assessments

1.3.27 Sensitivity assessments have been undertaken on various parameters of the models to reflect the uncertainties and impacts on modelled flood levels. Assessments have been carried out on inflows and culvert blockages. In the case of viaduct crossings, sensitivity was undertaken on inflows.

1.3.28 Sensitivity assessment on inflows was carried out by varying the 1 in 100 (1%) annual probability with an allowance for climate change and the 1 in 1000 (0.1%) annual probability flows by 20%. This was undertaken for the baseline and post-scheme scenarios, unless stated otherwise.

1.3.29 Sensitivity assessment has also been carried out on proposed scheme scenarios with culvert structures by adding 10% blockage. Resulting models have been run for the 1 in 100 (1%) annual probability with an allowance for climate change and the 1 in 1000 (0.1%) annual probability events.

1.4 Assumptions and limitations

Hydrology

1.4.1 The catchment boundaries and descriptors as taken from the FEH CD-ROM are correct and accurately represent the catchments in reality.

1.4.2 For catchments not classed as highly permeable, the ReFH method results in the most accurate estimation of flow at the location of the crossings in comparison to other methods.

1.4.3 The FEH Statistical method with permeable adjustment results in the most accurate estimation of flow for catchments classed as highly permeable.

1.4.4 The area scaling method, which is based on area, results in conservative flow estimates for catchments which are not represented in the FEH CD-ROM (refer to Section 0 of this report for detail).

1.4.5 There are no external influences on flow at the location of the crossing, such as significant abstractions or discharges.

1.4.6 A 20% allowance for climate change on peak flow rates has been adopted for the 1 in 100 (1%) annual probability with an allowance for climate change event.

Hydraulic modelling

1.4.7 Only river flood risk was considered during the hydraulic modelling in this assessment.

1.4.8 For watercourses without existing hydraulic models, the watercourse geometry was extracted from the LiDAR DTM with the channel width defined by the 5m cell resolution of the two dimensional model. Therefore, the watercourse geometry is not well defined, the consequence of which is an underestimate of the channel conveyance and hence, an overestimation of the floodplain inundation.

1.4.9 There will be certain watercourses with road crossing structures upstream or downstream of a route crossing, causing a significant impact on hydraulics. Ordnance Survey mapping and aerial photography were used to assess the location of the structures. The inverts of any culvert structure were assumed to be the channel bed levels from the LiDAR DTM; and structure widths as the width of the channel.

1.4.10 The models involving viaducts and underbridges, the structure was represented by the piers and embankments/abutments. The scheme drawings were used to obtain the footprint of the piers and the dimensions incorporated into the model. The soffits of the viaducts/underbridges were not modelled as the design approach for the structures is to include a suitable clearance between peak flood level and the structure soffit.

2 Modelling at watercourse crossings

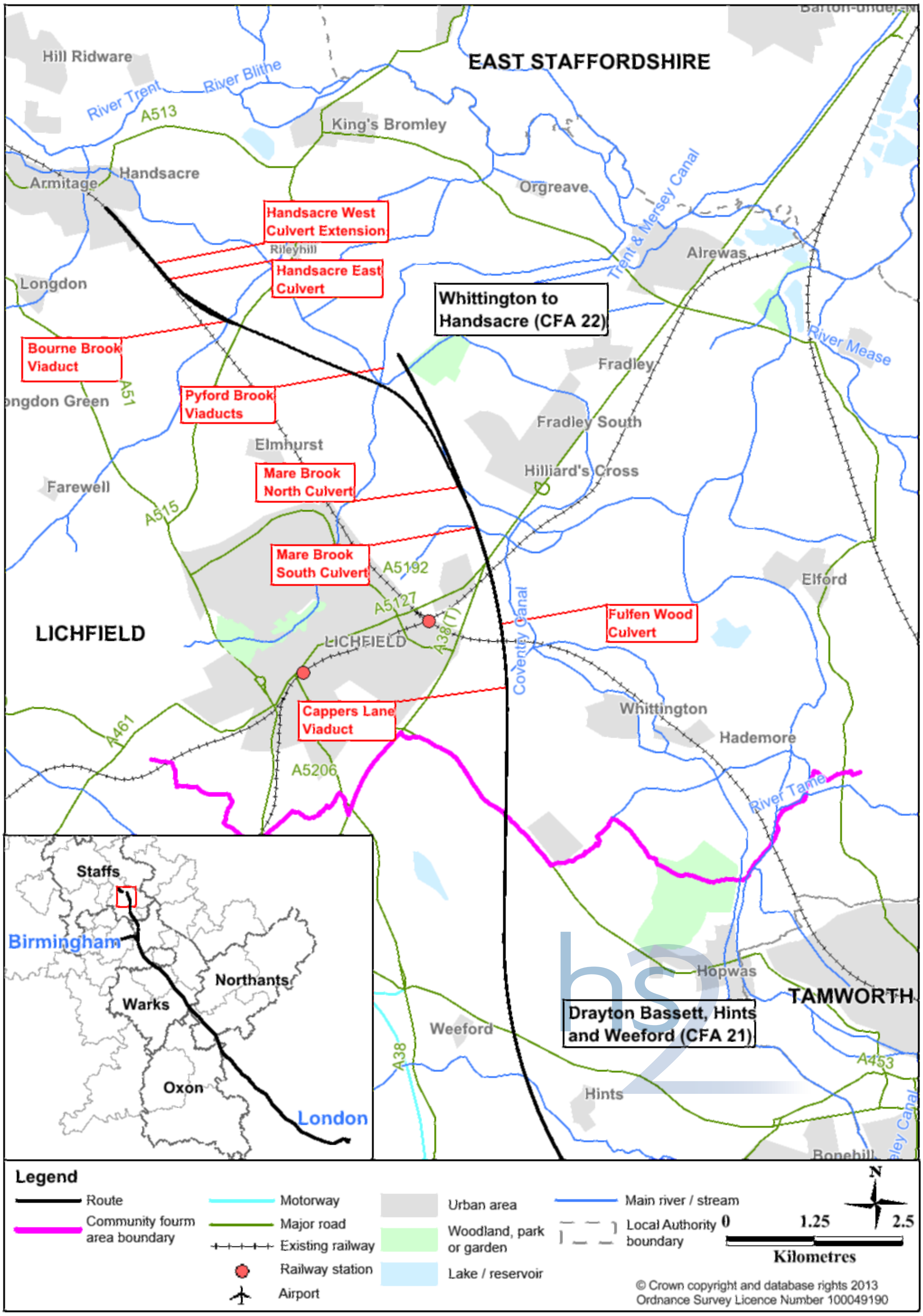
2.1 Overview

2.1.1 River modelling undertaken at the various watercourse crossings for this study area are summarised in Table 1, along with the modelling methodologies adopted. Figure 1 identifies the location of each of these structures.

Table 1 - River models at watercourse crossings

Crossing name	Watercourse identifier	Watercourse	Hydrology	Hydraulic modelling
Capper's Lane viaduct	SWC-CFA22-001 Volume 5: CFA22 Map Book, Map WR-05-062, G5	Ordinary Watercourse (tributary of Fisherwick Brook)	FEH Statistical	Two dimensional hydrodynamic
Fulfen Wood culvert	SWC-CFA22-003 Volume 5: CFA22 Map Book, Map WR-05-062, E6	Main River (Mare Brook)	Area scaling method	Two dimensional hydrodynamic
Mare Brook south culvert	SWC-CFA22-004 Volume 5: CFA22 Map Book, Map WR-05-063, I5	Ordinary Watercourse (tributary of Mare Brook)	FEH Statistical	Two dimensional hydrodynamic
Mare Brook north culvert	SWC-CFA22-006 Volume 5: CFA22 Map Book, Map WR-05-063, G5	Ordinary watercourse (tributary of Mare Brook)	ReFH	Two dimensional hydrodynamic
Pyford Brook viaduct	SWC-CFA22-010 Volume 5: CFA22 Map Book, Map WR-05-063, C7	Main River (Curborough Brook)	ReFH	Two dimensional hydrodynamic
Bourne Brook viaduct	SWC-CFA22-012 Volume 5: CFA22 Map Book, Map WR-05-064, D7	Ordinary Watercourse (Bourne Brook)	ReFH	Two dimensional hydrodynamic
Handsacre east culvert	SWC-CFA22-017 Volume 5: CFA22 Map Book, Map WR-05-065, H6	Ordinary watercourse (tributary of River Trent)	ReFH	One dimensional steady state
Handsacre west culvert extension	SWC-CFA22-018 Volume 5: CFA22 Map Book, Map WR-05-065, G6	Ordinary watercourse (tributary of River Trent)	ReFH	One dimensional steady state

Figure 1 - Location plan



2.1.2 It should be noted that the Curborough Brook is also known as Pyford Brook. The viaduct structure crossing this watercourse is named Pyford Brook viaduct.

2.1.3 A summary of the modelling of the culverts is provided in Section 2.1.2 of this report. The modelling, including details of the specific modelling methodologies, hydraulic constraints and any assumptions on each of the watercourse crossings, is described in detail for each of the viaduct structures from Sections 2.3 to 2.5.

2.2 Culverts

2.2.1 One dimensional ISIS models were built for watercourses at structures Handsacre east culvert and Handsacre west culvert extension. Two dimensional TUFLOW models were built for watercourses at the following structures; Mare Brook south culvert and Mare Brook north culvert. A two dimensional TUFLOW model was built for the Fulfen Wood watercourse for the baseline scenario only. In the scheme scenario, the Fulfen Wood watercourse will be diverted and land re-profiled to ensure the scheme has minimal impact on flood risk. Therefore, it was not considered necessary to model this Fulfen Wood scheme. The models built for the baseline and proposed scheme scenarios used the general methodologies for one dimensional and two dimensional modelling as discussed in Section 1.3 of this report.

2.2.2 The methodologies applied for the hydrological assessments for structures Mare Brook south culvert, Mare Brook north culvert, Handsacre east culvert and Handsacre west culvert extension are provided in the FEH proformas in Section 0 of this report.

2.2.3 For the Fulfen Wood watercourse, the catchment does not appear to be correctly represented in the FEH CD-ROM due to the large developed areas in the upstream reaches. Potentially a large proportion of the catchment covers the developed area of Lichfield, as well as the rural area downstream of a culvert outlet prior to reaching the proposed crossing. The surface water drainage network to the culvert, on the watercourse crossed by the route at this location, is unknown and hence it not possible to determine the extent of Lichfield that would drain to this location. Therefore the manually derived catchment has been determined based on a conservative approach which resulted in a catchment area of 2.6km2. The flow has been estimated using the area scaling method, taking a scaling factor of one (based on the other catchments for which ReFH was used to determine flows), which is considered conservative, for the 1 in 100 (1%) annual probability event with a 20% allowance for climate change. This method considers that the flow at this location is likely to be an overestimate, however has been considered suitable for this assessment given a conservative approach is preferable.

2.2.4 At the Mare Brook north culvert crossing, the route crosses the watercourse splitting its catchment into two, the western and eastern sub-catchments. The catchment flowing west of the route will be diverted south via the western watercourse up to a point where it then crosses the route by the Mare Brook north culvert. The catchment flowing east of the crossing will also be diverted south via the eastern watercourse which will rejoin the western watercourse at the Mare Brook north culvert crossing. The hydrological assessment for the watercourse at Mare Brook north culvert is described in Section 0 of this report. The total flow estimate for the catchment to Mare Brook north culvert was split with 46.5% of the flow in the eastern sub-catchment and 53.5% in the western sub-catchment. Therefore, the catchment flows were applied separately as two constant inflow boundaries to the hydraulic model, feeding into the eastern and western watercourses respectively. The watercourses were represented by GIS polylines (Z-lines) with elevations providing the same bed slope as the original watercourse. The route embankment was represented by GIS polygons with elevations (Z-Shape layers) and one dimensional culvert was added at the crossing (refer to Section 1.3.23 of this report for modelling details).

2.2.5 The structures adopted at the various culvert crossings along with their impacts on peak flood levels is summarised in Table 2. The structure dimensions of width (W), height (H) and length (L) in metres are also provided in this table. The exception in this case is for Fulfen Wood watercourse, for which there is not structure at the crossing for reasons discussed earlier.

Table 2 - Modelled peak levels at culvert crossings

Structure	Watercourse identifier	Structure dimensions (WxHxL)	Flood event	Peak flood level (mAOD)		Change in flood level (mm)	Length of impact upstream reach[7] (m)
				Baseline	Scheme		
Fulfen Wood watercourse without crossing structure	SWC-CFA22-003	4m x 2m x 77m	1 in 20 (5%)	63.834	No output	No output	No output
			1 in 100 (1%) climate change	63.862	No output	No output	
			1 in 1000 (0.1%)	63.896	No output	No output	
Mare Brook south culvert	SWC-CFA22-004	2m x 1.5m x 70m	1 in 20 (5%)	64.136	64.129	-7	No impact
			1 in 100 (1%) climate change	64.152	64.146	-6	
			1 in 1000 (0.1%)	64.197	64.212	15	
Mare Brook north culvert	SWC-CFA22-006	2m x 1.5m x 79m	1 in 20 (5%)	64.531	64.473	-58	No impact
			1 in 100 (1%) climate change	64.553	64.480	-73	
			1 in 1000 (0.1%)	64.580	64.488	-92	
Handsacre east culvert	SWC-CFA22-017	2m x 1.5m x50m	1 in 20 (5%)	71.742	71.695	-47	No impact
			1 in 100 (1%) climate change	71.775	71.733	-42	
			1 in 1000 (0.1%)	71.806	71.775	-31	
Handsacre west culvert extension	SWC-CFA22-018	2m x 1.5m x40m	1 in 20 (5%)	72.253	72.175	-78	No impact
			1 in 100 (1%) climate change	72.315	72.238	-77	
			1 in 1000 (0.1%)	72.379	72.315	-64	

2.2.6 The culverts Mare Brook north culvert, Mare Brook south culvert, Handsacre east culvert and Handsacre west culvert extension showed decreases in peak levels for the

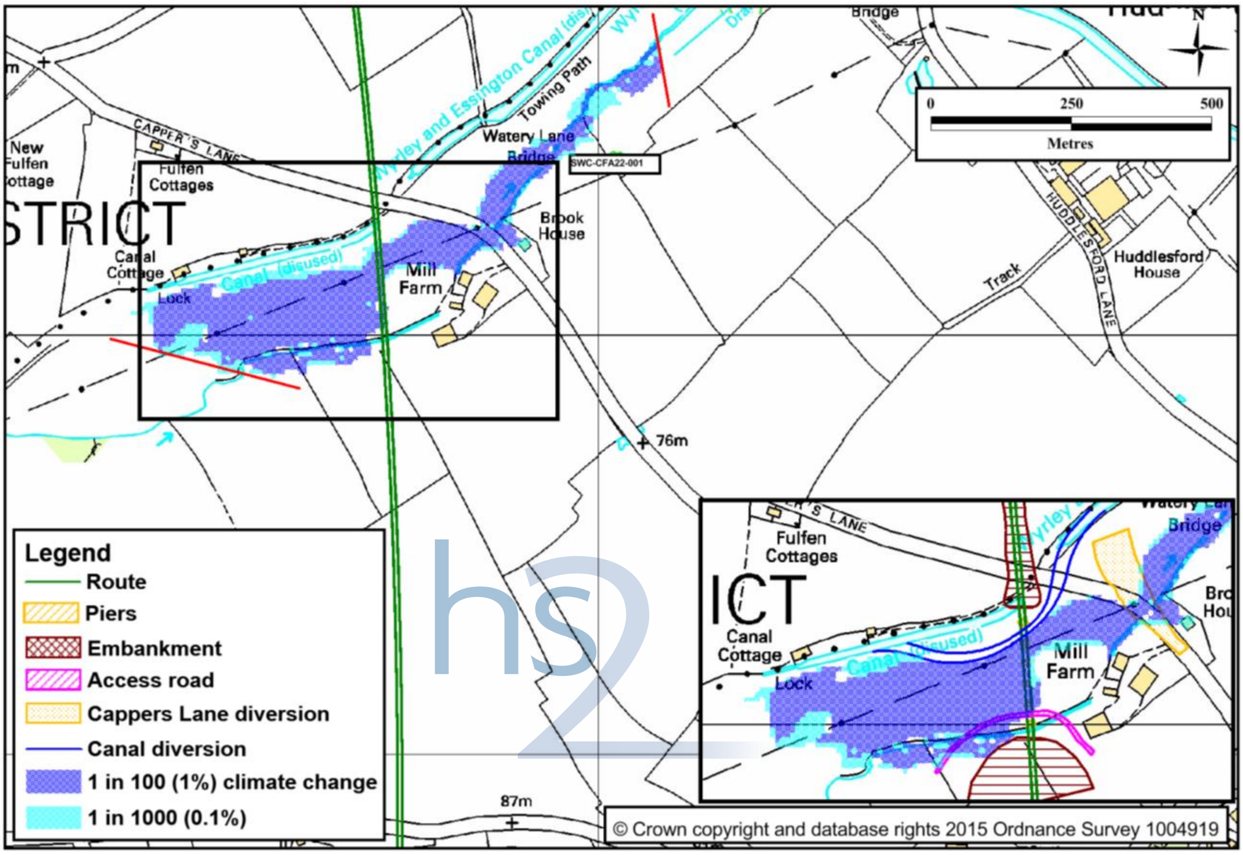
[7] Length of reach upstream of the scheme along which flood levels during the 1 in 100 (1%) annual probability with an allowance for climate change event are greater than 10mm.

1 in 100 (1%) annual probability with an allowance for climate change event. This showed that the culverts modelled provided flow capacity in excess of that required to convey flood flows and hence results in a reduction in peak levels. Therefore, these culverts do not increase flood risk. It should be noted that changes in peak levels are localised at the structure with minimal changes elsewhere on the watercourse.

2.3 Capper's Lane viaduct

2.3.1 The crossing will consist of the viaduct structure of 128m width on the watercourse SWC-CFA22-001 (Volume 5: CFA22 Map Book, Map WR-05-062, G5). This watercourse flows from west of the crossing and continues east within the model extents shown in Figure 2. There is an access road running from west of the crossing to the east, located south of the viaduct opening. The Capper's Lane road east of the crossing has been diverted as shown in Figure 2.

Figure 2 - Crossing location plan and flood extents for Capper's Lane viaduct



Hydrology

2.3.2 The river inflow hydrology was defined using the FEH Statistical method for permeable catchments. The peak flow from the hydrology calculation was used as a constant inflow into the model. This was to ensure that the defined peak flow across the route was maintained. The details of the hydrological assessment are provided in the FEH proformas within Section 0 of this report. The flows into the model are summarised in Table 3.

Table 3 - Hydrology results: model inflows to Capper's Lane viaduct

Watercourse identifier	Environment Agency Flood Zone	1 in 20 (5%) flow (m3/s)	1 in 100 (1%) climate change flow (m3/s)	1 in 1000 (0.1%) flow (m3/s)	Modelled structure
SWC-CFA22-001	3	0.92	1.22	3.32	Viaduct

Hydraulics

2.3.3 The TUFLOW model was built on a 5m cell resolution. The two dimensional domain covered the floodplain of the watercourse, the extents of which were defined by the available LiDAR data. The inflow to the watercourse was applied upstream using a boundary condition polyline layer, linking it to a steady state flow time series within a boundary condition database. The downstream boundary was an HQ polyline layer based on the slope of the floodplain at that location; which was 0.001 in this case. The resulting baseline model was run at a two second timestep for the duration of 15 hours.

2.3.4 Two flood levels were identified for each of the annual probability flood events as shown in the cross section figure. This is due to the fact that the watercourse modelled runs along a steep verge at one side, which when overtopped flood water flows down and onto the floodplain next to the disused Wyrley and Essington Canal. The floodplain peak levels have been quoted for this crossing as the major proportion of the flood flows occur along the floodplain.

2.3.5 The viaduct structure was modelled by adding FC shape layers which represented the piers. The suggested pier dimension was 2m, however for simplicity a percentage blockage of 50% and a form loss coefficient was added to the cells in the location of the piers. The embankments on either side of the viaduct were modelled as Z-polygon layers. The soffit levels were not added into the model because the vertical alignment of the route at this location is significantly above the 1 in 1000 (0.1%) annual probability modelled peak flood levels.

2.3.6 The Wyrley and Essington Canal realignment was modelled by adding a Z-line to represent the right bank. The access road was not explicitly modelled in the scheme scenario. The access road was assumed to follow the current land profile.

2.3.7 There are three key hydraulic constraints to this model. Firstly, it was assumed that the Capper’s Lane embankment just downstream of the crossing will have a significant impact on flood risk. This was based on the LiDAR DTM and its close proximity to the crossing. There was no available information on the type and dimensions of the Capper’s Lane culvert structure and hence it was not modelled explicitly. A Z - polyline layer was added to represent the flow route through the Capper’s Lane culvert structure. The elevations were set at the channel bed levels and the structure width was set to the width of the channel. The model results reported later show that the Proposed Scheme has minimal impact on flood risk which is localised to the crossing. The impact of the Proposed Scheme on flood risk would not be impacted by the hydraulic impacts of Capper's Lane embankment. The vertical alignment of the route and the soffit levels would be sufficient higher than the 1 in 1000 (0.1%) annual probability modelled peak flood levels. Therefore, any uncertainty in the Capper's Lane culvert structure would not have an impact of the design of the Proposed Scheme.

2.3.8 Secondly, the Coventry Canal downstream would potentially have an impact on the hydraulics of the watercourse. However, the downstream impact of the Coventry Canal and associated culvert underneath was not modelled due to the lack of culvert dimensions. However, it is unlikely to have a significant impact on flood levels at the crossing, as the Capper's Lane embankment immediately downstream of the HS2 crossing (and upstream of the Coventry Canal) would have a predominant impact.

2.3.9 Thirdly, the watercourse is located on high ground with the left floodplain sloping down to the disused Wyrley and Essington Canal. Any overtopping on the left bank of the watercourse would divert floodwaters down into the left floodplain.

2.3.10 The baseline floodplain width at the crossing is 88m for a 1 in 100 (1%) annual probability with an allowance for climate change event. The cross section with peak flood levels is shown in Figure 3. The modelled peak levels along with scheme impacts is summarised in Table 4. The baseline peak velocities and scheme impacts for the 1 in 100 (1%) annual probability with an allowance for climate change event is also provided in Figure 4.

Figure 3 - Cross section with flood levels for Capper's Lane viaduct

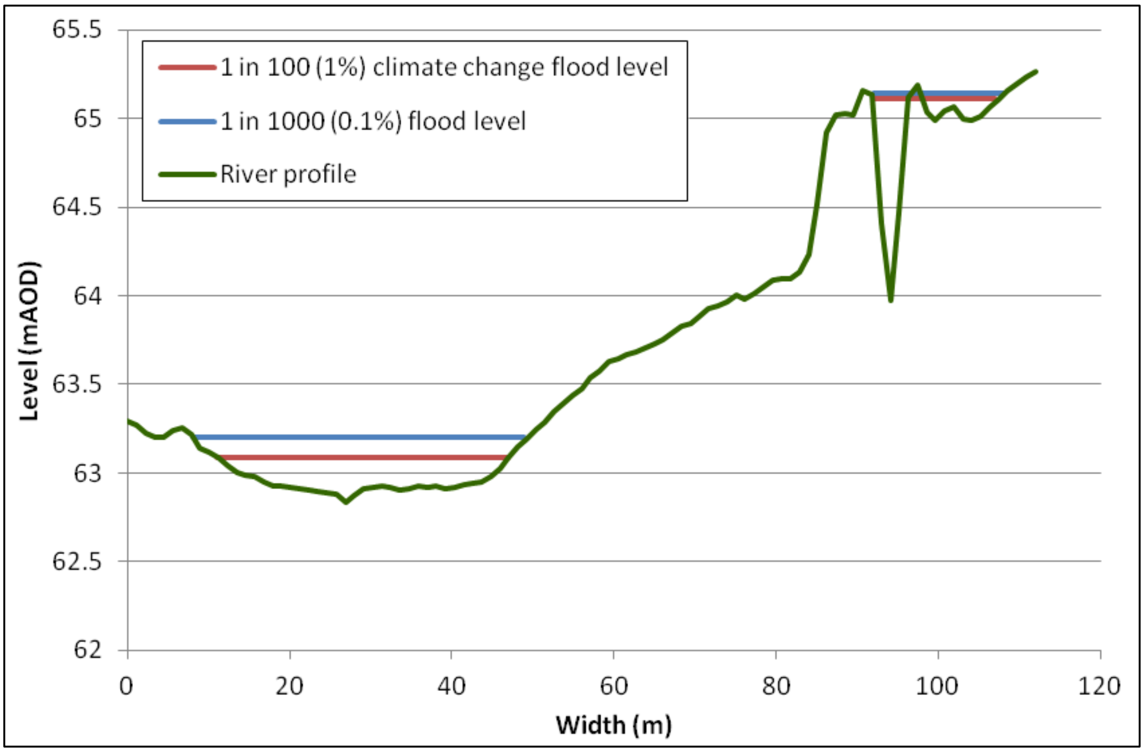
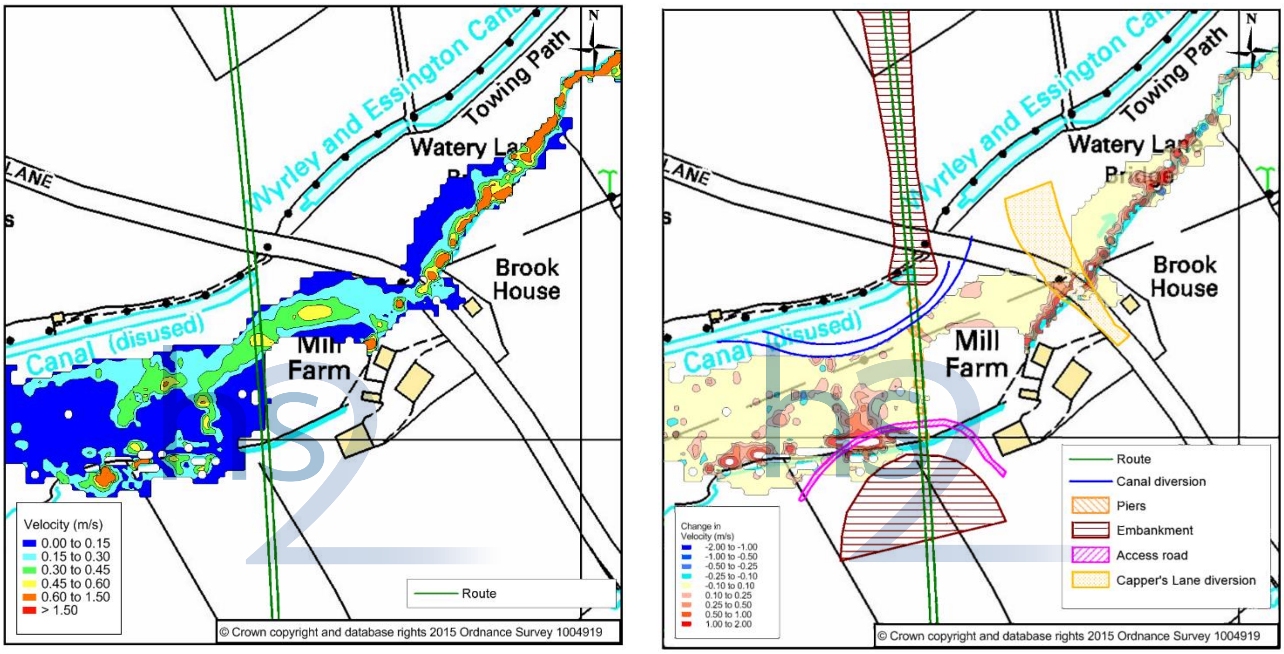


Table 4 - Modelled peak levels for Capper's Lane viaduct

Flood event	Peak flood level (mAOD)		Change in flood level (mm)
	Baseline	Scheme	
1 in 20 (5%)	63.067	63.070	2
1 in 100 (1%) climate change	63.090	63.097	7
1 in 1000 (0.1%)	63.204	63.231	27

Figure 4 - Baseline peak velocity contours and scheme impact on velocities for 1 in 100 (1%) climate change event at Capper's Lane viaduct



Sensitivity assessment

2.3.11 Sensitivity assessment was carried out by adding 20% to the 1 in 100 (1%) annual probability with an allowance for climate change and 1 in 1000 (0.1%) annual probability events. Models were run for both the baseline and scheme scenarios. The peak levels for the 1 in 100 (1%) annual probability with an allowance for climate change event increased by up to 17mm with an increase in flood extent of 6%. No additional receptors have been affected as a result.

2.3.12 These changes were considered minimal and hence the impact of the scheme on flood risk will still be valid with these sensitivity changes.

Conclusions

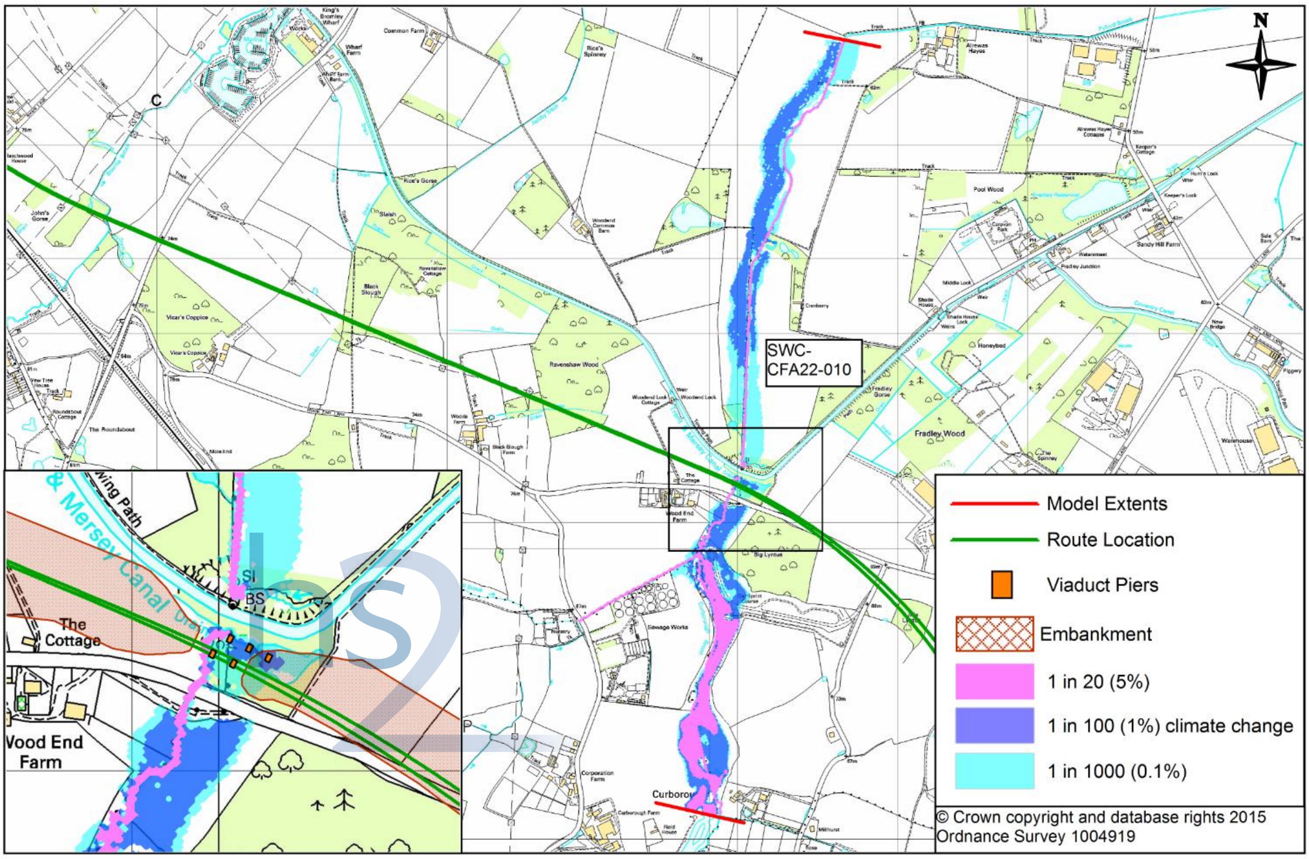
2.3.13 The scheme showed increase in peak levels of <10mm for the 1 in 100 (1%) annual probability with an allowance for climate change event. The increases in peak level are limited within 60m upstream of the crossing with no receptors being affected. Therefore, the viaduct structure will not have any impact on flood risk.

2.3.14 There are localised increases of velocities by up to 1.6m/s near the watercourse near the location of the proposed access road. There are localised increases of velocities by up to 1.7m/s at the crossing with diverted Capper's Lane. These velocity increases will be investigated further in the detailed design stage to assess any scour protection requirements. Apart from these locations, there is increase in velocity of up to 0.11m/s near the piers which was considered minimal.

2.4 Pyford Brook viaduct

2.4.1 The crossing will consist of a viaduct structure of 66m width on the Curborough Brook, SWC-CFA22-010 (Volume 5: CFA22 Map Book, Map WR-05-063, C7). The proposed viaduct will be situated between the existing Wood End Lane and the Trent and Mersey Canal. Wood End Lane will be re-aligned with a new road crossing immediately north and parallel of the rail crossing. The watercourse flows from south of the crossing and continues as shown in Figure 5.

Figure 5 - Crossing location plan and flood extents for Pyford Brook viaduct



Hydrology

2.4.2 The hydrological inflow was calculated using the ReFH method. The catchment area was determined from the FEH CD-ROM. Catchment descriptors were extracted from the FEH CD-ROM and updated for urban expansion. The critical storm duration was calculated at the location of the crossing. Flows were then calculated based on these catchment descriptors as no suitable local donor station was identified. The FEH proforma for this watercourse is provided in Section 0 of this report.

Table 5 - Hydrology results: model inflows to Pyford Brook

Watercourse identifier	Environment Agency Flood Zone	1 in 20 (5%) flow (m3/s)	1 in 100 (1%) climate change flow (m3/s)	1 in 1000 (0.1%) flow (m3/s)	Modelled structure
SWC-CFA22-010	3	4.71	8.46	15.51	Viaduct

Hydraulics

2.4.3 A TUFLOW model has been constructed and built with a 5m cell resolution. The topography of the model is based upon 5m resolution LiDAR data. Around the location of the route, more detailed 0.2m resolution LiDAR data has been utilised. A Manning's n value of 0.05 has been used to define the floodplain and a value of 0.03 has been used to define the watercourse. These values have been selected based on a desk-based study.

2.4.4 Watercourses within the modelled extent have been defined using the TUFLOW flow constriction and storage reduction factor functions. These allow for the capacity of the channel to be reduced and not limited to the cell resolution of the model. Bed levels and the width of watercourses have been estimated from the LiDAR DTM.

2.4.5 An HQ boundary has been applied to the downstream extent of the model and has been automatically generated by TUFLOW based on an assumed floodplain gradient of 0.003. The gradient has been measured from the LiDAR DTM along the channel bed at this location.

2.4.6 The AP2 revised scheme was modelled by representing the embankment as a Z-shape layer with a 66m gap representing the viaduct width. The viaduct piers for both the proposed HS2 and re-aligned road crossing were modelled as flow constriction with a 100% blockage factor.

2.4.7 The results showed that the there was no out of bank flow during the 1 in 20 (5%) annual probability event. Minor out of bank flow occurs at the crossing location during the 1 in 100 (1%) annual probability event with an allowance for climate change.

2.4.8 Flood levels during the 1 in 100 (1%) annual probability event with an allowance for climate change show a 14mm increase in levels due to the proposed scheme. The increased levels effect a reach 40m upstream of the crossing to the existing alignment of Wood End Lane. Upstream of this location there are negligible increases in flood levels.

2.4.9 During the 1 in 1000 (0.1%) annual probability event the model shows an increase of 9mm, raising flood levels to 65.336mAOD.

2.4.10 For the 1 in 1000 (0.1%) annual probability event, the peak levels will approximately 8m below the soffit level of the proposed viaduct. Therefore, the model outputs reported here are suitable to confirm the impacts of the Proposed Scheme on flood risk.

2.4.11 There are three key hydraulic constraints to this model. Firstly, the Curborough Brook flows under Wood End Lane approximately 30m upstream of the proposed HS2 crossing. This structure is currently not modelled and is represented only by the watercourse flow constriction and storage reduction functions. This structure has currently been modelled with no soffit or deck level. The road is also slightly raised and acts as an embankment retaining flood water.

2.4.12 Secondly, the watercourse then flows under the Trent and Mersey Canal immediately downstream of the crossing. This structure has been modelled in one dimensional with the width of the structure assumed to be equal to the width of the watercourse. The soffit level was estimated by calculating the depth between the crest of the road embankment and the bed level of the drain, minus the clearance above the culvert. The canal embankment is raised and retains river floodplain flow.

2.4.13 Thirdly, due to the desk-based nature of this study the dimensions of these structures are not known and therefore the width of the structures has been assumed to be the same size as the channel. The structures have been represented in one dimension and approximate channel widths and invert levels have been taken from LiDAR data.

2.4.14 The baseline floodplain width at the crossing is 14m for a 1 in 100 (1%) annual probability with an allowance for climate change event. The cross section with peak flood levels is shown in Figure 6. The modelled peak levels along with scheme impacts is summarised in Table 6. The baseline peak velocities and scheme impacts for the 1 in 100 (1%) annual probability with an allowance for climate change event is also provided in Figure 7.

Figure 6 - Cross section with baseline flood levels at Pyford Brook viaduct

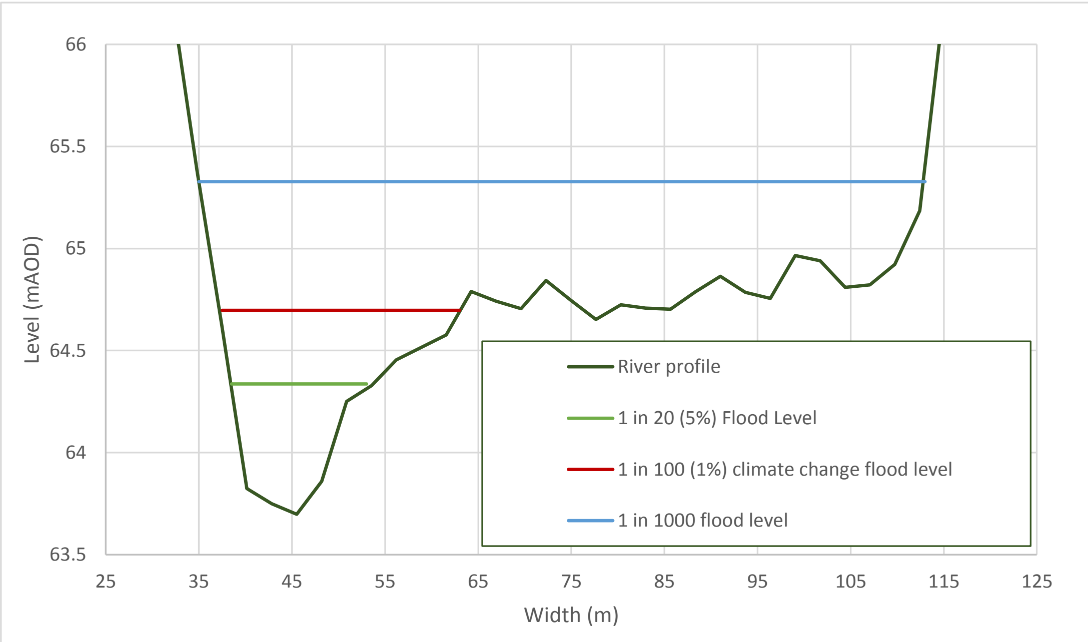
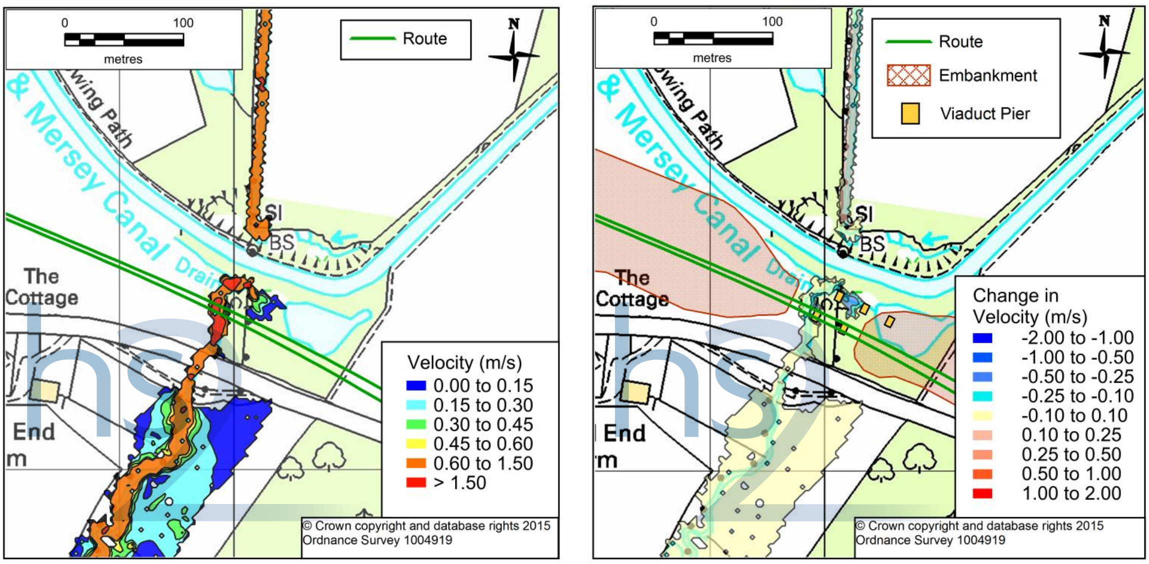


Table 6 - Modelled peak levels for Pyford Brook viaduct

Flood event	Peak flood level (mAOD)		Change in flood level (mm)
	Baseline	Scheme	
1 in 20 (5%)	64.336	64.336	0
1 in 100(1%) climate change	64.697	64.711	14
1 in 1000 (0.1%)	65.327	65.336	9

Figure 7 - Baseline peak velocity contours and scheme impacts on velocities for the 1 in 100 (1%) climate change event at Pyford viaduct



Sensitivity assessment

2.4.15 Sensitivity assessment was undertaken on the inflows by increasing and decreasing flows by 20% on the 1 in 100 (1%) annual probability with an allowance for climate change event. A 20% increase in flows causes up to a 170mm increase in channel peak levels and showed inundation of the floodplain at the crossing which did not show flooding before. The peak levels with the sensitivity allowance are still well below the soffit level, providing the necessary clearance of 600mm. A 20% decrease in flows causes up to a 190mm decrease in channel peak levels.

2.4.16 The increase in inflows showed an increase in the flood extents of up to 41% with greatest increases seen 200m downstream of the proposed crossing. The increased flooding effects no additional receptors apart from agricultural land. Therefore, the impact of the scheme on flood risk will still be valid with these sensitivity changes.

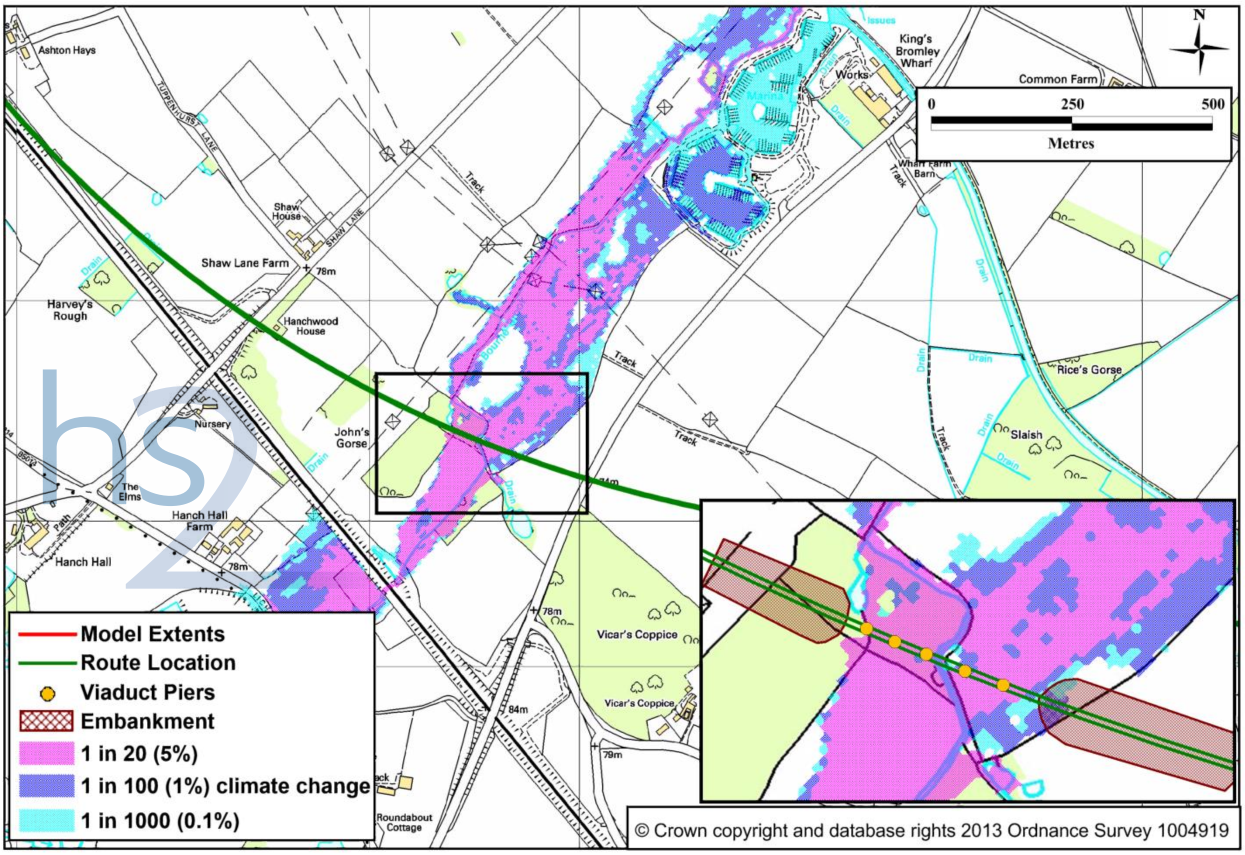
Conclusions

2.4.17 The scheme showed minor increases in peak levels for the 1 in 100 (1%) annual probability with an allowance for climate change event extending for a short distance upstream of the crossing and not affecting any additional receptors. Therefore, the viaduct structure will have negligible impact on flood risk. There are minor, localised reductions in velocities due to the structure.

2.5 Bourne Brook Viaduct

2.5.1 The crossing will consist of a viaduct structure of 124m width on Bourne Brook SWC-CFA22-012 (Volume 5: CFA22 Map Book, Map WR-05-064, D7). The watercourse flows from south-west of the crossing and continues north-east as shown in Figure 8.

Figure 8 - Crossing location plan and flood extents for Bourne Brook viaduct



Hydrology

2.5.2 The hydrological inflow was calculated using the ReFH method. The catchment area was inferred from the LiDAR DTM. Catchment descriptors were extracted from the FEH CD-ROM and updated for urban expansion. The catchment area is less than 1km^2 hence, the catchment area and drainage path length was calculated and other catchment descriptors were used from an adjacent small catchment following a sensibility check. The critical storm duration was calculated for the catchment at the location of the crossing. Flows were then calculated based on the above described catchment descriptors as no suitable local donor station was identified. The FEH proforma for this watercourse is provided in Section 0 of this report. The flows used in the model are summarised in Table 7.

Table 7 - Hydrology results: model inflows for Bourne Brook viaduct

Watercourse identifier	Environment Agency Flood Zone	1 in 20 (5%) flow (m^3/s)	1 in 100 (1%) climate change flow (m^3/s)	1 in 1000 (0.1%) flow (m^3/s)	Modelled structure
SWC-CFA22-012	3	7.33	12.73	19.82	Viaduct

Hydraulics

2.5.3 A TUFLOW model has been constructed and built with a 5m cell resolution. The topography of the model is based upon 5m resolution LiDAR data. Around the location of the crossing, more detailed 0.2m resolution LiDAR data has been utilised. A Manning's n value of 0.05 has been used to define the floodplain and a value of 0.03 has been used to define the watercourse. These values have been selected based on a desk-based study.

2.5.4 Watercourses within the modelled extent have been defined using the TUFLOW flow constriction and storage reduction factor functions. These allow for the capacity of the channel to be reduced and not limited to the cell resolution of the model. Bed levels and the width of watercourses have been estimated from the LiDAR DTM.

2.5.5 An HQ boundary has been applied to the downstream extent of the model and has been automatically generated by TUFLOW based on an assumed floodplain gradient of 0.004. The gradient has been measured from the LiDAR DTM along the channel bed at this location.

2.5.6 There are two key hydraulic constraints to this model. Firstly, the Bourne Brook flows under Lichfield Road approximately 500m upstream of the crossing and under the existing railway embankment approximately 300m upstream. The structures are currently only represented by the watercourse flow constriction and storage reduction factor functions. The railway embankment, represented in the LiDAR, retains a large amount of floodwater.

2.5.7 Secondly, Hanch Reservoir which is located approximately 700m upstream of the crossing; the reservoir is modelled as full at 79mAOD in the model. This is a conservative assumption and assumes the reservoir provides no additional storage in a flood event.

2.5.8 The baseline floodplain width at the crossing is 162m for a 1 in 100 (1%) annual probability with an allowance for climate change event. The cross section with peak flood levels is shown in Figure 9. The modelled peak levels along with scheme impacts is summarised in Table 8. The baseline peak velocities and scheme impacts for the 1 in 100 (1%) annual probability with an allowance for climate change event is also provided in Figure 10.

Figure 9 - Cross section with flood levels for Bourne Brook viaduct

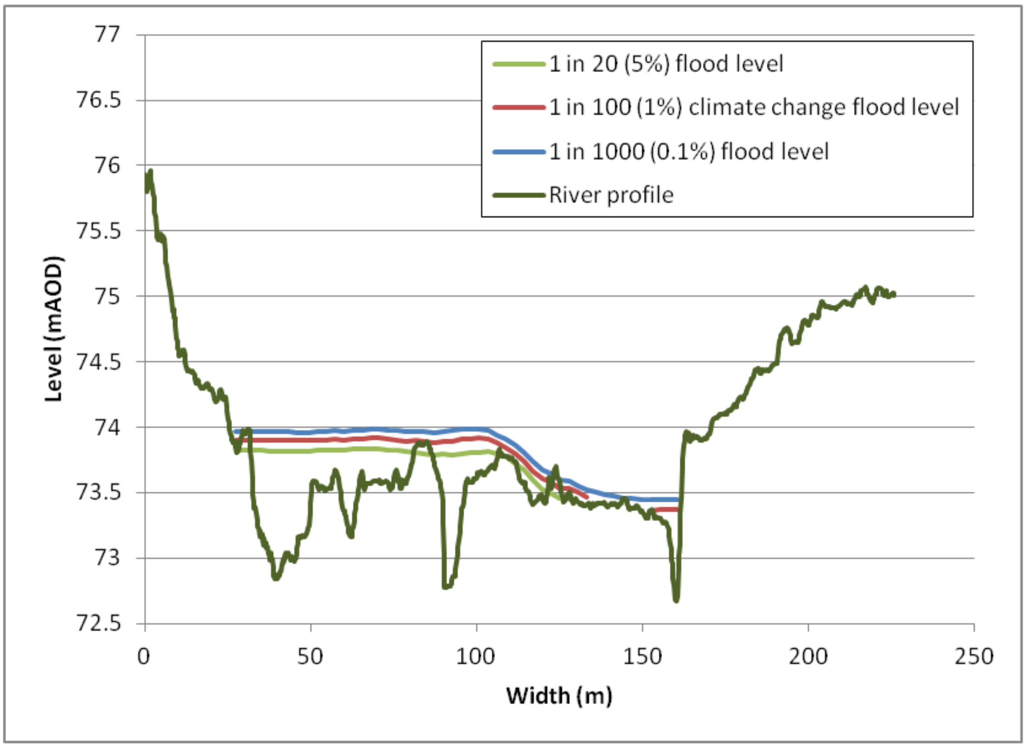
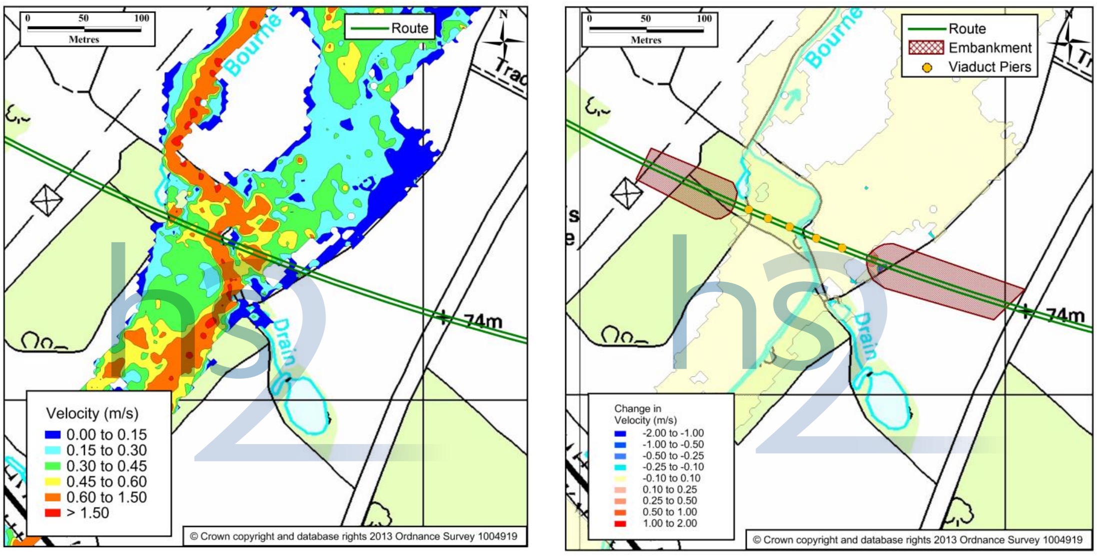


Table 8 - Modelled peak levels for Bourne Brook viaduct

Flood event	Peak flood level (mAOD)		Change in flood level (mm)
	Baseline	Scheme	
1 in 20 (5%)	73.790	73.790	0
1 in 100 (1%) climate change	73.802	73.793	-9
1 in 1000 (0.1%)	73.826	73.833	7

Figure 10 - Baseline peak velocity contours and scheme impacts on velocities for 1 in 100 (1%) climate change at Bourne Brook viaduct



Sensitivity assessment

2.5.9 Sensitivity assessment was undertaken on the inflows by increasing and decreasing flows by 20% on the 1 in 100 (1%) annual probability with an allowance for climate change event. A 20% increase in flows causes up to a 30mm increase in channel peak levels and a 20mm increase in floodplain peak levels. The peak levels with the sensitivity allowance are still well below the soffit level, providing the necessary clearance of 600mm. A 20% decrease in flows causes up to a 20mm decrease in channel peak levels and a 30mm decrease in floodplain peak levels.

2.5.10 The increase in inflows resulted in an increase in flood extents of 15% mostly downstream of the crossing. However, no additional receptors apart from agricultural land were affected. Therefore, the impact of the scheme on flood risk will still be valid with these sensitivity changes.

Conclusions

2.5.11 The scheme showed no increase in peak levels for the 1 in 100 (1%) annual probability with an allowance for climate change event and hence no increase in flood risk. There were minimal changes in velocities due to the viaduct structure.

3 FEH proformas

3.1 Overview

3.1.1 This section provides the FEH proformas for the hydrological calculations of the various watercourses for which there was no existing hydrology available.

3.1.2 The FEH proformas are based on the Environment Agency supporting document to the flood estimation guidelines4.

3.1.3 The FEH proformas provided here are for the watercourses at the Capper's Lane viaduct (SWC-CFA22-001), Mare Brook south culvert (SWC-CFA22-004), Mare Brook north culvert (SWC-CFA22-006), Pyford Brook viaduct (SWC-CFA22-010), Bourne Brook viaduct (SWC-CFA22-012), Handsacre east culvert (SWC-CFA22-017) and Handsacre west culvert extension (SWC-CFA22-018).

3.1.4 In Section 3.2 of this report, derivation of flows using the ReFH method for crossing Mare Brook north culvert are presented, with the derivation of scaling factors for the 1 in 1000 (0.1%) annual probability flows for crossings Capper's Lane viaduct and Mare Brook south culvert.

3.1.5 Section 3.3 of this report presents the derivation of flows using the FEH Statistical method for the two highly permeable catchments which drain to crossings Capper's Lane viaduct and Mare Brook south culvert.

3.1.6 Section 3.4 of this report details the derivation of flows for Pyford Brook viaduct, Bourne Brook viaduct, Handsacre east culvert and Handsacre west culvert extension.

3.2 Capper's Lane viaduct, Mare Brook south culvert and Mare Brook north culvert

Method statement

Overview of requirements for flood estimates

Item	Comments
Give an overview which includes: Purpose of study Approx. no. of flood estimates required Peak flows or hydrographs? Range of return periods and locations Approx. time available	This proforma outlines the hydrological calculations carried out for the assessment of flood risk for the Proposed Scheme. As part of the Proposed Scheme, two of the watercourses will require culvert structures under the rail line and hence it must be ensured that the culvert would be of sufficient capacity. The other watercourse at Capper's Lane viaduct has a viaduct structure due to additional floodplain flow. It is vital at this stage that the proposed structures are not under designed and hence conservative flows are necessary in line with current requirements of the Proposed Scheme. At a later stage, if a more in-depth assessment determines lower flow, and hence smaller structures would have sufficient capacity, this is acceptable. This particular assessment outlines the derivation of flows at Capper's Lane viaduct (SWC-CFA22-001), Mare Brook south culvert (SWC-CFA22-004) and Mare Brook north culvert (SWC-CFA22-006) for the 1 in 20 (5%) annual probability, 1 in 100 (1%) annual probability, 1 in 100 (1%) annual probability with an allowance for climate change and the 1 in 1000 (0.1%) annual probability.

Overview of catchment

Item	Comments
Brief description of catchment, or reference to section in accompanying report	The three crossings have separate catchments which are rural and ranging from low permeability to permeable catchments. The catchments range in size of 0.58km² to 14.83km².

Source of flood peak data

Was the HiFlows UK dataset used? If so, which version? If not, why not? Record any changes made	No. Only method implemented at this stage is ReFH and hence HiFlows data is not utilised.

Gauging stations (flow or level)

3.2.2 Gauging stations at the sites of flood estimates or nearby at potential donor sites.

3.2.3 Local donor sites have been sought however in most cases the catchment area of the subject catchment was found to be significantly smaller than that of any potential local donor.

Watercourse	Station name	Gauging authority number	National River Flow Archive number (used in FEH)	Grid reference	Catchment area (km²)	Type (rated / ultrasonic / level	Start and end of flow record
N/A							

Data available at each flow gauging station

Station name	Start and end of data in HiFlows UK	Update for this study?	Suitable for QMED	Suitable for pooling?	Data quality check needed?	Other comments on station and flow data quality - e.g. information from HiFlows-UK, trends in flood peaks, outliers
N/A						
Give link/reference to any further data quality checks carried out						

Rating equations

Station name	Type of rating e.g. theoretical, empirical; degree of extrapolation	Rating review needed	Reasons - e.g. availability of recent flow gaugings, amount of scatter in the rating.
N/A			
Give link/reference to any rating reviews carried out			

Other data available and how it has been obtained

Type of data	Data relevant to this study	Data available?	Source of data and licence reference if from Environment Agency	Date obtained	Details
Check flow gaugings (if planned to review ratings)	No				
Historic flood data – give link to historic review if carried out.	No				
Flow data for events	No				
Rainfall data for events	No				
Potential evaporation data	No				
Results from previous studies	No				
Other data or information (e.g. groundwater, tides)	No				

Initial choice of approach

Is FEH appropriate? (it may not be for very small, heavily urbanised or complex catchments) If not, describe other methods to be used.	ReFH has been utilised for this assessment, as a quick method for determining flows, given the high number of locations requiring flood estimates within the northern area of the Proposed Scheme. At the beginning of the modelling study this method was specifically aimed at determining at which locations the proposed culvert or bridge would have sufficient capacity for flood flows, and hence whether the proposed routes design requires mitigation.
Outline the conceptual model, addressing questions such as: Where are the main sites of interest? What is likely to cause flooding at those locations? (peak flows, flood volumes, combinations of peaks, groundwater, snowmelt, tides) Might those locations flood from runoff generated on part of the catchment only, e.g. downstream of a reservoir? Is there a need to consider temporary debris dams that could collapse?	The main sites of interest are at the crossing locations and hence are the points at which flow has been derived. Each point at which flow has been derived has been named in accordance with the associated watercourse identifier. At this stage it is considered that peak flows are likely to be the main cause of flooding, following development, due to the potentially constricting culvert or bridge. As part of this assessment it is not deemed necessary to consider the risk of a temporary dam collapse.

Any unusual catchment features to take into account? e.g. highly permeable – avoid ReFH if BFIHOST>0.65, consider permeable catchment adjustment for statistical method if SPRHOST<20% highly urbanised – avoid standard ReFH if URBEXT1990>0.125; consider FEH Statistical or other alternatives; consider method that can account for differing sewer and topographic catchments pumped watercourse – consider lowland catchment version of rainfall-runoff method major reservoir influence (FARL<0.90) – consider flood routing extensive floodplain storage – consider choice of method carefully	The catchments for Capper's Lane viaduct (SWC-CFA22-001) and Mare Brook south culvert (SWC-CFA22-004) are classed as highly permeable, with BFIHOSTs of 0.688 and 0.751 and hence ReFH would not normally be the initial method of choice. However, for the purposes of deriving scaling factors for 1 in 1000 (0.1%) annual probability flows, the ReFH assessment has been included with this proforma. All catchments have FARL>0.9 and is not highly urbanised.
Initial choice of method(s) and reasons Will the catchment be split into subcatchments? If so, how?	ReFH has been used as the only method for determining flows at Mare Brook north culvert (SWC-CFA22-006). As noted above for the purposes of deriving scaling factors for 1 in 1000 (0.1%) annual probability flows, the ReFH assessment has been included with this proforma for the permeable catchments that drain to crossings Capper's Lane viaduct (SWC-CFA22-001) and Mare Brook south culvert (SWC-CFA22-004). For the purposes of this assessment it was assumed that the catchment descriptors and boundaries as output from the FEH CD-ROM are accurate and hence no manual adjustment was carried out.
Software to be used (with version numbers)	FEH CD-ROM v3.0[8] ISIS Free 3.3

Summary of subject sites

Site code (taken from watercourse identifier)	Watercourse	Site	Easting	Northing	Catchment area on FEH CD-ROM (km2)	Catchment area if altered
SWC-CFA22-001	Ordinary Watercourse (tributary of Fisherwick Brook)	Capper's Lane viaduct	414770	308990	14.83	Not altered
SWC-CFA22-004	Ordinary Watercourse (tributary of Mare Brook)	Mare Brook south culvert	414360	311260	1.77	Not altered

[8] FEH CD-ROM v3.0 © NERC (CEH). © Crown copyright. © AA. 2009. All rights reserved.

Site code (taken from watercourse identifier)	Watercourse	Site	Easting	Northing	Catchment area on FEH CD-ROM (km2)	Catchment area if altered
SWC-CFA22-006	Ordinary Watercourse (tributary of Mare Brook)	Mare Brook north culvert	414180	311840	0.58	Not altered
Reasons for choosing above locations	Locations the route is proposed to cross the respective watercourses.					

Important catchment descriptors at each subject site (incorporating any changes made)

Site code	FARL	PROPWET	BFIHOST	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	SPRHOST	URBEXT 2000	FPEXT
SWC-CFA22-001	0.908	0.31	0.862	3.96	31.3	670	16.55	0.040	0.064
SWC-CFA22-004	1.000	0.31	0.688	1.26	22.9	664	25.73	0.108	0.095
SWC-CFA22-006	1.000	0.31	0.605	0.56	8.8	658	29.68	0.000	0.095

Checking catchment descriptors

Record how catchment boundary was checked and describe any changes (refer to maps if needed)	Catchment boundaries were not checked, it was assumed that catchment boundaries as shown on the FEH CD-ROM were accurate. Where detailed assessment is required at a later stage, it is recommended that catchment boundaries are fully checked. This may result in different flows than those outlined within this proforma.
Record how other catchment descriptors (especially soils) were checked and describe any changes. Include before/after table if necessary.	No further checking of catchment descriptors was carried out.
Source of URBEXT	URBEXT1990
Method for updating of URBEXT	CPRE formula from FEH Volume 4

Revitalised flood hydrograph (ReFH) method

Parameters for ReFH model

3.2.4 Note: If parameters are estimated from catchment descriptors, they are easily reproducible so it is not essential to enter them in the table.

Site code	Method OPT: Optimisation BR: Baseflow recession fitting CD: Catchment descriptors DT: Data transfer (give details)	Tp (hours) Time to peak	Cmax (mm) Maximum storage capacity	BL (hours) Baseflow lag	BR Baseflow recharge
SWC-CFA22-001	CD	4.28	687	52	2.095

Site code	Method OPT: Optimisation BR: Baseflow recession fitting CD: Catchment descriptors DT: Data transfer (give details)	Tp (hours) Time to peak	Cmax (mm) Maximum storage capacity	BL (hours) Baseflow lag	BR Baseflow recharge
SWC-CFA22-004	CD	1.90	554	31	1.643
SWC-CFA22-006	CD	2.15	491	33	1.430
Brief description of any flood event analysis carried out (further details should be given below or in a project report)			None at this stage of the assessment.		

Note: only the catchments which are represented on the FEH CD-ROM have been included in the table above.

Design events for ReFH method

Site Code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours)	Storm area for ARF (if not catchment area)
SWC-CFA22-001	Rural	Winter	7.1	0.952
SWC-CFA22-004	Rural	Winter	3.1	0.968
SWC-CFA22-006	Rural	Winter	3.5	0.979
Are the storm durations likely to be changed in the next stage of the study, e.g. by optimisation within a hydraulic model?			Storm durations will not be altered during the next stage of the hydraulic modelling.	

Flood estimates from the ReFH method

Site Code	Flood peak (m3/s) for the following flood events				Scaling factor ratio of 1 in 1000 (0.1%) flow to the 1 in 100 (1%) flow
	1 in 20 (5%)	1 in 100 (1%)	1 in 100 (1%) climate change[9]	1 in 1000 (0.1%)	
SWC-CFA22-001[10]	0.43	1.00	1.20	3.28	3.28
SWC-CFA22-004[10]	0.55	0.84	1.01	1.73	2.05
SWC-CFA22-006	0.25	0.37	0.44	0.72	1.94

[9] The 1 in 100 (1%) annual probability flow with an allowance for climate change is the 1 in 100 (1%) annual probability flow factored by 1.2.
[10] The ReFH flow estimates for these crossings are used to derive scaling factors for the 1 in 1000 (0.1%) annual probability flow in Section 3.3 of this report.

Discussion and summary of results

Comparison of results from different methods

3.2.6 This table compares peak flows from various methods with those from the FEH Statistical method at example sites for two key return periods. Blank cells indicate that results for a particular site were not calculated using that method.

Site code	Ratio of peak flow to FEH Statistical peak					
	1 in 2 (50%)			1 in 100 (1%)		
	ReFH	Other method	Other method	ReFH	Other method	Other method
	N/A			N/A		

Final choice method

Choice of method and reasons – include reference to type of study, nature of catchment and type of data available.	ReFH has been used as the only method for determining flows at Mare Brook north culvert (SWC-CFA22-006). For the purposes of deriving scaling factors for 1 in 1000 (0.1%) annual probability flows, the ReFH assessment has been included with this proforma for the permeable catchments that drain to crossings Capper's Lane viaduct (SWC-CFA22-001) and Mare Brook south culvert (SWC-CFA22-004).

Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	The FEH CD-ROM accurately represented the catchment boundaries and catchment descriptors. ReFH conservatively estimates flow in permeable catchments.
Discuss any particular limitations, e.g. applying methods outside the range of catchment types or return periods for which they were developed	ReFH is not normally the preferred option for the permeable catchments at Capper's Lane viaduct (SWC-CFA22-001) and Mare Brook south culvert (SWC-CFA22-004). This method was applied to determine the scaling factors for the 1 in 1000 (0.1%) annual probability flow estimation as described in Section 3.3 of this report.
Give what information you can on uncertainty in the results – e.g. confidence limits for the QMED estimates using FEH 3 12.5 or the factorial standard error from Science Report SC050050 (2008).	There is some uncertainty with the results based on the assumptions listed above, however it is considered that the results are conservative and hence would be overestimating, rather than underestimating flows.
Comment on the suitability of the results for future studies, e.g. at nearby locations or for different purposes.	The results have been completed for the purposes of the assessment of flood risk as the proposed crossings. The results should not be used for other studies with the exception for comparative purposes.
Give any other comments on the study, for example suggestions for additional work.	When the assessment moves to the detailed design phase it may be useful that the catchment boundaries are checked against LiDAR, OS mapping and other such sources. If possible the FEH Statistical method should be carried out for Mare Brook north culvert for comparative purposes and to provide a greater level of confidence with the results.

Checks

Are the results consistent, for example at confluences?	N/A
What do the results imply regarding the return periods of floods during the period of record?	N/A
What is the 100-year growth factor? Is this realistic? (The guidance suggests a typical range of 2.1 to 4.0)	Not determined.

If 1000-year flows have been derived, what is the range of ratios for 1000-year flow over 100-year flow?	1.94
What range of specific runoffs (l/s/ha) do the results equate to? Are there any inconsistencies?	None.
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.	None.
Are the results compatible with the longer-term flood history?	None.
Describe any other checks on the results	None.

Final results

Site code	Flood peak (m^3/s) for the following flood events			
	1 in 20 (5%)	**1 in 100 (1%)**	**1 in 100 (1%) climate change**	**1 in 1000 (0.1%)**
SWC-CFA22-001[11]	0.43	1.00	1.20	3.28
SWC-CFA22-004[11]	0.55	0.84	1.01	1.73
SWC-CFA22-006	0.25	0.37	0.44	0.72
If flood hydrographs are needed for the next stage of the study, where are they provided? (e.g. give filename of spreadsheet, name of ISIS model, or reference to table below)			Hydrographs not required for these crossings.	

3.3 Permeable catchment assessment - Capper's Lane viaduct and Mare Brook south culvert

Method statement

Overview of requirements for flood estimates

Item	Comments
Give an overview which includes: Purpose of study Approx. no. of flood estimates required Peak flows or hydrographs? Range of return periods and locations Approx. time available	This assessment has been completed for the purposes of the Proposed Scheme. The initial assessment phase of river flood risk included an estimation of flow within watercourses to be crossed by the route. The initial assessment produced quick flow estimates through the use of the ReFH model. However, as part of the assessment it was determined that the two catchments that drain to the Capper's Lane viaduct (SWC-CFA22-001) and the Mare Brook south culvert (SWC-CFA22-004) were highly permeable in nature and hence the flood estimation guidelines4 state that ReFH is not appropriate for these catchments. This calculation record outlines the estimation of flow for these two highly permeable catchments using the recommended approach. The flows are required to provide an indication of size requirements for the route crossings to prevent increases in flood risk as a result of the scheme. The flow will also be used to determine the 1 in 1000 (0.1%) annual probability flood level to ensure that the track is not at an unacceptable level of risk. At this stage it is necessary to follow a conservative approach, because it is vital that the culverts/bridges are not under-designed. It is acceptable at this stage that structures are over-designed and reduced (if necessary) during the detailed design phase. Flows are required for the 1 in 20 (5%) annual probability, 1 in 100 (1%) annual probability, 1 in 100 (1%) annual probability with an allowance for climate change and 1 in 1000 (0.1%) annual probability events. These flows are required at two locations.

[11] The ReFH flow estimates for these crossings are used to derive scaling factors for the 1 in 1000 (0.1%) annual probability flow in Section 3.3.

Item	Comments
	At this stage only peak flows (no hydrographs) are required. Approximately two days are available for the assessment.

Overview of catchment

Item	Comments
Brief description of catchment, or reference to section in accompanying report	The two catchments are shown on location plans included in Section 3.5 of this calculation record. These catchments are defined by FEH catchment descriptors as being highly permeable in nature. The catchments are named in accordance with the associated watercourse identifier and are located at Capper's Lane viaduct (SWC-CFA22-001) and the Mare Brook south culvert (SWC-CFA22-004). These two catchments which are located on the outskirts of Lichfield, are defined as moderately urbanised. Capper's Lane viaduct (SWC-CFA22-001) is primarily underlain with sandstones. Mare Brook south culvert (SWC-CFA22-004) is primarily underlain by sandstones in the upstream reaches and mudstones in the downstream reaches of the catchment.

Source of flood peak data

Was the HiFlows UK dataset used? If so, which version? If not, why not? Record any changes made	Yes – Version 3.1.2, December 2011

Gauging stations (flow or level)

3.3.1 Gauging stations at the sites of flood estimates or nearby at potential donor sites.

3.3.2 Local donor sites have been sought however in most cases the catchment area of the subject catchment was found to be significantly smaller than that of any potential local donor.

Watercourse	**Station name**	**Gauging authority number**	**National River Flow Archive number (used in FEH)**	**Grid reference**	**Catchment area (km²)**	**Type (rated / ultrasonic / level**	**Start and end of flow record**
N/A							

Data available at each flow gauging station

Station name	**Start and end of data in HiFlows UK**	**Update for this study?**	**Suitable for QMED**	**Suitable for pooling?**	**Data quality check needed?**	**Other comments on station and flow data quality - e.g. information from HiFlows-UK, trends in flood peaks, outliers**
N/A						

Give link/reference to any further data quality checks carried out	

Rating equations

Station name	**Type of rating e.g. theoretical, empirical; degree of extrapolation**	**Rating review needed**	**Reasons - e.g. availability of recent flow gaugings, amount of scatter in the rating.**
N/A			
Give link/reference to any rating reviews carried out			

Other data available and how it has been obtained

Type of data	**Data relevant to this study**	**Data available?**	**Source of data and licence reference if from Environment Agency**	**Date obtained**	**Details**
Check flow gaugings (if planned to review ratings)	No				
Historic flood data – give link to historic review if carried out.	No				
Flow data for events	No				
Rainfall data for events	No				
Potential evaporation data	No				
Results from previous studies	No				Quick estimates taken from the initial assessment phase for the proposed scheme. ReFH was utilised and was not considered ideal
					For permeable catchments (Section 3.2 of this report).
Other data or information (e.g. groundwater, tides)	No				

Initial choice of approach

Is FEH appropriate? (it may not be for very small, heavily urbanised or complex catchments) If not, describe other methods to be used.	FEH is appropriate for these two catchments. The catchments areas are 1.77 and 14.83 km^2 and hence are within the appropriate range for the application of FEH methods. These catchments are considered to be moderately urbanised and have $URBEXT_{2000}$ values of 0.067 and 0.119. The catchments are not considered complex.
Outline the conceptual model, addressing questions such as: Where are the main sites of interest? What is likely to cause flooding at those locations? (peak flows, flood volumes, combinations of peaks, groundwater, snowmelt, tides) Might those locations flood from runoff generated on part of the catchment only, e.g. downstream of a reservoir? Is there a need to consider temporary debris dams that could collapse?	There are two sites of interest, these are located at proposed watercourse crossings which are required as part of the route. The crossings are located on different watercourses and hence have separate catchments. As a result of the scheme, flooding at the sites of interest is likely to be caused by peak flow rather than flood volumes. There are no reservoirs or temporary dam collapses that need to be considered at the sites of interest.
Any unusual catchment features to take into account? e.g. highly permeable – avoid ReFH if BFIHOST>0.65, consider permeable catchment adjustment for statistical method if SPRHOST<20% highly urbanised – avoid standard ReFH if URBEXT1990>0.125; consider FEH Statistical or other alternatives; consider method that can account for differing sewer and topographic catchments pumped watercourse – consider lowland catchment version of rainfall-runoff method major reservoir influence (FARL<0.90) – consider flood routing extensive floodplain storage – consider choice of method carefully	The catchments are considered highly permeable, all with BFIHOST>0.65. As a result ReFH is not considered an appropriate method. The catchments are moderately urbanised with $URBEXT_{2000}<0.125$. The catchments are not located on pumped watercourses. There is no major reservoir influence at any of the two sites of interest, the catchments have FARL values of 0.908 and 1. It is not considered that the catchments have extensive floodplain storage.
Initial choice of method(s) and reasons Will the catchment be split into subcatchments? If so, how?	The FEH Statistical method has been applied to the two catchments. As part of this assessment the permeability adjustment method has also been carried out due to the permeable nature of these two catchments. A scaling method has been carried out to determine the 1 in 1000 (0.1%) annual probability flow, as discussed the section 'Estimation of 1 in 1000 (0.1%) annual probability flow'.
Software to be used (with version numbers)	FEH CD-ROM v3.0[12]

[12] FEH CD-ROM v3.0 © NERC (CEH). © Crown copyright. © AA. 2009. All rights reserved.

	WINFAP-FEH v3[13]

Summary of subject sites

Site code	Watercourse	Site	Easting	Northing	Catchment area on FEH CD-ROM (km²)	Revised catchment area if altered
SWC-CFA22-001	Ordinary Watercourse (tributary of Fisherwick Brook)	Capper's Lane viaduct	414750	309000	14.83	N/A
SWC-CFA22-004	Ordinary Watercourse (tributary of Mare Brook)	Mare Brook south culvert	414350	311250	1.77	N/A
Reasons for choosing above locations		Locations the route is proposed to cross the respective watercourses.				

Important catchment descriptors at each subject site (incorporating any changes made)

Site code	FARL	PROPWET	BFIHOST	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	SPRHOST	$URBEXT_{2000}$	FPEXT
SWC-CFA22-001	0.908	0.31	0.862	3.96	31.3	670	16.55	0.0671	0.06
SWC-CFA22-004	1.000	0.31	0.688	1.26	22.9	664	25.73	0.1194	0.09

Checking catchment descriptors

Record how catchment boundary was checked and describe any changes (refer to maps if needed)	The catchment boundaries were checked against OS mapping and appeared to be reasonable. It has been deemed appropriate to retain the FEH CD-ROM catchments for this assessment. This approach is consistent with flow estimations for all other route crossings as part of the overall assessment for the Proposed Scheme.
Record how other catchment descriptors (especially soils) were checked and describe any changes. Include before/after table if necessary.	The catchments were checked against geology mapping, and no changes were considered necessary.
Source of URBEXT	$URBEXT_{2000}$
Method for updating of URBEXT	$URBEXT_{2000}$ – A new FEH catchment descriptor. R&D Technical Report FD1919/TR. Environment Agency 2006.

[13] WINFAP-FEH v3 © Wallingford HydroSolutions Limited and NERC (CEH) 2009.

Statistical method

Search for donor sites for QMED (if applicable)

Comment on potential donor sites Mention: Number of potential donor sites available Distances from subject site Similarity in terms of catchment area, BFIHOST, FARL and other catchment descriptors Quality of flood peak data Include a map if necessary. Note that donor catchments should usually be rural.	Donor sites were sought through three approaches. Firstly the identification of donors in close proximity to the subject sites using the FEH CD-ROM and the Hydrometric Register (CEH, 2008)[14]. This approach identified seven potential donors, although on inspection of the HiFlows data set, three were classed as unsuitable for pooling or QMED. Secondly four donors for each catchment were identified as the top four in a pooling group using the 'OK for pooling' HiFlows data set. Thirdly, a further four for each catchment were identified as the top four in a pooling group using the 'OK for QMED' HiFlows data set. These approaches identified a total of 12 possible donors for each catchment. It was not possible to identify any donors within 10km of the subject sites (between centroids). For Capper's Lane viaduct (SWC-CFA22-001), there are four donors within 50km and additional two donors within 100km. For Mare Brook south culvert (SWC-CFA22-004), there are four donors within 50km and additional three donors within 100km. The identified potential donors vary in similarity to the subject sites. Where possible the donor most similar to the subject site has been selected. Further detail is included in the next section ('Donor sites chosen and QMED adjustment factors'). The majority of the potential donors have fairly long records of gauged data, in excess of 30 years.

Donor sites chosen and QMED adjustment factors

Potential Donors for Capper's Lane viaduct (SWC-CFA22-001)

National River Flow Archive no.	Reasons for choosing or rejecting	Method (AM or POT)	Adjustment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)[15]
28095	Rejected – The catchment is too urban and too large in size in comparison to the subject catchment.	AM	Not required	157.5	102.98	1.1563
28026	Chosen – The catchment is one of the closest in distance to the subject site (the others closer are not suitable). The data record covers 42 years and the adjustment factor is >1 and hence follows a conservative approach. The catchment geology is the same as the subject site.	AM	Not required	52.1	36.94	1.1004
28053	Rejected – Even though the catchment descriptors are as similar to the subject site as 28026, the adjustment factor is <1 and hence would not follow a conservative approach.	AM	Not required	27.7	28.81	0.9893

[14] Centre for Ecology and Hydrology, (2008), *UK Hydrometric Register*.
[15] Adjustment factor has been updated and include an allowance for distance from the subject site. The updated adjustment calculation is provided within the flood estimation guidelines (Environment Agency, 2012).

National River Flow Archive no.	Reasons for choosing or rejecting	Method (AM or POT)	Adjustment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)[15]
28002	Rejected – The FARL is too low.	AM	Not required	17.5	18.56	0.9849
26802	Rejected – The catchment is too far from the subject site and the catchment descriptors are less similar in comparison to 28026. In addition the record length is short.	AM	Would be required – 10 years of data.	0.1	0.43	0.9835
25019	Rejected – The SAAR is too high and the catchment is too far from the subject site.	AM	Not required	6.1	3.74	1.0035
32029	Rejected – The catchment descriptors are less similar to the subject site in comparison to 28026 and the record length is short.	AM	Would be required – 5 years of data.	2.5	1.42	1.0694
44006	Rejected – The SAAR is too high and the catchment is too far from the subject site.	AM	Not required	0.9	0.85	1.0000
41016	Rejected – The catchment is too far from the subject site and the catchment descriptors are less similar in comparison to 28026.	AM	Not required	13.7	5.12	1.0038
39036	Rejected – This donor is very similar in relation to suitability as 28026 (the chosen donor) however the adjustment factor is <1 and hence would not follow a conservative approach. As a result 28026 is preferred for this study.	AM	Not required	0.5	0.69	0.9957
52015	Rejected – SAAR is too high and catchment is too far from the subject site.	AM	Not required	3.4	3.04	1.0024
30014	Rejected – Catchment is not permeable enough and the SAAR is too low.	AM	Not required	2.7	1.87	1.0235
Which version of the urban adjustment was used for QMED at donor sites, and why? Note: The guidelines recommend great caution in urban adjustment of QMED on catchments that are also highly permeable (BFIHOST>0.8).				Urban adjustment was carried out on the QMED using the recommended approach[16].		

[16] Urban adjustment was required in line with the Environment Agency guidelines, page 45, because the subject site has an URBEXT2000>0.03. These guidelines also stated that the use of an urban adjustment factor based on SPRHOST (as in Winfap-FEH V3) is known to underestimate QMED in permeable catchments, particularly those with BFIHOST >0.8, such as this subject site. As a result the equation for estimating urban adjustment, using BFIHOST, has been used for this site.

Potential Donors for Mare Brook south culvert (SWC-CFA22-004)

NRFA no.	Reasons for choosing or rejecting	Method (AM or POT)	Adjustment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)[15]
28095	Rejected – The catchment is too urban and too large in size in comparison to the subject catchment.	AM	Not required	157.46	102.98	1.1440
28026	Rejected - The catchment is significantly greater in size than the subject site and the catchment descriptors are less similar in comparison to 31026.	AM	Not required	52.05	36.94	1.0973
28053	Rejected – Even though the catchment descriptors are as similar to the subject site as 31026, the adjustment factor is <1 and hence would not follow a conservative approach.	AM	Not required	27.74	28.81	0.9892
28002	Rejected – The FARL is too low.	AM	Not required	17.52	18.56	0.9838
76011	Rejected – SAAR is too high, the catchment is not permeable enough and the catchment is too far from the subject site.	AM	Not required	1.82	2.02	0.9998
45817	Rejected – SAAR is too high and the catchment is too far from the subject site.	AM	Not required	1.34	0.92	1.0024
32029	Rejected – The catchment descriptors are less similar to the subject site in comparison to 31026 and the record length is short.	AM	Would be required – 5 years of data.	2.54	1.42	1.0657
44009	Rejected – The SAAR is too high, catchment is too permeable and the catchment is too far from the subject site.	AM	Not required	1.69	0.90	1.0029
31026	Chosen – The catchment descriptors are most similar to the subject site in comparison to the other potential donors. In addition the adjustment factor is >1 and hence follows the conservative approach.	AM	Not required	1.08	0.31	1.1436
31023	Rejected – The catchment is not permeable enough.	AM	Not required	1.91	1.13	1.0466
205999	Rejected – The SAAR is too high, the FARL is slightly too low, the catchment is too far from the subject site. In addition the adjustment factor	AM	Would be required – 11 years of data.	0.12	3.13	0.8500

NRFA no.	Reasons for choosing or rejecting	Method (AM or POT)	Adjustment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)[15]
	would significantly reduce the QMED and the record period is short.					
27038	Rejected – The catchment is too far and the catchment descriptors are not as similar to the subject site in comparison to 31026.	AM	Not required	1.33	0.55	1.0096
Which version of the urban adjustment was used for QMED at donor sites, and why? Note: The guidelines recommend great caution in urban adjustment of QMED on catchments that are also highly permeable (BFIHOST>0.8).				Urban adjustment was carried out on the QMED using the recommended approach[16].		

Overview of estimation of QMED at each subject site

Site code	Method	Initial estimate of QMED (m^3/s)	Data transfer				Final estimate of QMED (m^3/s)
			National River Flow Archive numbers for donor sites used (see section 'Donor sites chosen and QMED adjustment factors' o)	Distance between centroids dij (km)	asg	Moderated QMED adjustment factor, (A/B)a	
SWC-CFA22-001	DT	0.37	28026	24.97	0.279	1.1004	0.61
SWC-CFA22-004	DT	0.19	31026	73.23	0.106	1.1436	0.27
Are the values of QMED consistent, for example at successive points along the watercourse and at confluences?					N/A		
Which version of the urban adjustment was used for QMED, and why?					In line with guidance, PRUAF using SPRHOST[17] for Mare Brook south culvert (SWC-CFA22-004) and PRUAF using BFIHOST for Capper's Lane viaduct (SWC-CFA22-001).		

Notes

Methods: AM – Annual maxima; POT – Peaks over threshold; DT – Data transfer; CD – Catchment descriptors alone.

When QMED is estimated from POT data, it should also be adjusted for climatic variation. Details should be added.

When QMED is estimated from catchment descriptors, the revised 2008 equation from Science Report SC050050should be used. If the original FEH equation has been used, say so and give the reason why.

The guidelines recommend great caution in urban adjustment of QMED on catchments that are also highly permeable

[17] PRUAF estimated using SPRHOST, Bayliss et al (2007) and PRUAF estimated using BFIHOST, Kjeldsen (2010) as outlined in the Environment Agency guidelines.

Site	Method	Initial	Data transfer	Final

(BFIHOST>0.8). The adjustment method used in WINFAP-FEH v3.0.003 is likely to overestimate adjustment factors for such catchments. In this case the only reliable flood estimates are likely to be derived from local flow data.

The data transfer procedure is from Science Report SC050050. The QMED adjustment factor A/B for each donor site is given in Table 3.3. This is moderated using the power term, a, which is a function of the distance between the centroids of the subject catchment and the donor catchment. The final estimate of QMED is (A/B) at times the initial estimate from catchment descriptors.

If more than one donor has been used, use multiple rows for the site and give the weights used in the averaging. Record the weighted average adjustment factor in the penultimate column.

Derivation of pooling groups

3.3.5 The composition of the pooling groups is given in the Section 3.5. Several subject sites may use the same pooling group.

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged? (enhanced single site analysis)	Changes made to default pooling group, with reasons Note also any sites that were investigated but retained in the group.	Weighted average L-moments, L-CV and L-skew, (before urban adjustment)
SWC-CFA22-001	Capper's Lane viaduct	No	One station (32029) was removed because it has a record length of only five years. 22003 was also removed because it was highly discordant. Two stations were added to ensure there were enough years of data following the permeability adjustment (removal of non-flood years).	L-CV = 0.258 L-skew = 0.143
SWC-CFA22-004	Mare Brook south culvert	No	One station (32029) was removed because it has a record length of only five years. One station (27010) was added to ensure there were enough years of data following the permeability adjustment (removal of non-flood years).	L-CV = 0.227 L-skew = 0.233

Notes

Pooling groups were derived using in WINFAP-FEH v3. The permeability adjustment procedure was carried out on the pooling group to remove the non-flood years.

The weighted average L-moments, before urban adjustment, can be found at the bottom of the Pooling-group details window in WINFAP-FEH.

Derivation of flood growth curves at subject sites

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution (location, scale and shape) after adjustments	Growth factor for 100-year return period
SWC-CFA22-001	P	Capper's Lane viaduct	Generalised logistic as recommended in FEH	Permeable and urban adjustment.	Growth curve has a shallower gradient in comparison to the non adjusted curve.	Non adjusted = 2.92 Adjusted = 1.67
SWC-CFA22-004	P	Mare Brook south culvert	Generalised logistic as recommended in FEH	Permeable and urban adjustment.	Growth curve has a shallower gradient in comparison to the non adjusted curve.	Non adjusted = 2.80 Adjusted = 1.43

Notes

Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis

A pooling group (or ESS analysis) derived at one gauge can be applied to estimate growth curves at a number of ungauged sites. Each site may have a different urban adjustment, and therefore different growth curve parameters.

Urban adjustments to growth curves should use the version 3 option in WINFAP-FEH: Kjeldsen (2010).

Flood estimates from the Statistical method

Site code	Flood peak (m^3/s) for the following flood events			
	1 in 20 (5%)	1 in 100 (1%)	1 in 100 (1%) climate change	1 in 1000 (0.1%)
Non-adjusted				
SWC-CFA22-001	1.25	0.98	1.17	1.06
SWC-CFA22-004	0.52	0.76	0.92	1.32
Permeability and urban adjustment				
SWC-CFA22-001	0.92	1.01	1.22	1.10
SWC-CFA22-004	0.37	0.39	0.47	0.41

Estimation of 1 in 1000 (0.1%) annual probability flow

Scaling for in 1000 (0.1%) annual probability flow

3.3.7 The FEH Statistical method is not normally the most appropriate for use in determining the 1 in 1000 (0.1%) annual probability flow. The FEH flood estimation guidelines[4] states that the ReFH method can be used to determine a ratio between the 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability flow, which can then be used to factor the 1 in 100 (1%) annual probability flow estimated using the FEH Statistical method. However, it has already been noted that the ReFH method is not ideal for these two catchments due to the BFIHOST values being greater than 0.65.

3.3.8 This assessment is to be used in the early stages of the design process, with the focus being not to under-design the crossing structures. When the detailed design is being completed at a later stage, it is probable that the hydrology will have to be revisited. It is therefore considered appropriate to carry out a scaling approach using flows determined through the FEH Statistical and ReFH methods at this stage.

3.3.9 It is also worthy to note that the 1 in 1000 (0.1%) annual probability flow is not to be used to size the structure. Where culverts are necessary it is only required that the structure has sufficient capacity for the 1 in 100 (1%) annual probability with an allowance for climate change (and associated freeboards). The 1 in 1000 (0.1%) annual probability flow is to be utilised to determine flood level to ensure the track is sufficiently above this level.

ReFH flows

3.3.10 These flows have been taken from the ReFH assessment of flows (Section 3.2 of this report) for the Proposed Scheme.

Site code	Flood peak (m^3/s) for the following flood events				
	1 in 20 (5%)	1 in 100 (1%)	1 in 100 (1%) climate change	1 in 1000 (0.1%)	Scaling factor ratio of 1 in 1000 (0.1%) flow to the 1 in 100 (1%) flow
SWC-CFA22-001	0.43	1.00	1.20	3.28	3.28
SWC-CFA22-004	0.55	0.84	1.01	1.73	2.05

Final estimates of 1 in 1000 (0.1%) annual probability flows

Site code	Flood peak (m^3/s)				
	FEH Stat 1 in 1000 (0.1%) perm non-adjusted[18]	FEH Stat 1 in 1000 (0.1%) perm adjusted[19]	Scaling factor ratio of 1 in 1000 (0.1%) flow to the 1 in 100 (1%) flow	Updated FEH Stat 1 in 1000 (0.1%) perm non-adjusted[18]	Updated FEH Stat 1 in 1000 (0.1%) perm adjusted[19]
SWC-CFA22-001	1.06	1.10	3.28	3.20	3.32
SWC-CFA22-004	1.32	0.41	2.05	1.57	0.80

Discussion and summary of results

Comparison of results from different methods

3.3.11 This table compares peak flows from various methods with those from the FEH Statistical method at example sites for two key return periods. Blank cells indicate that results for a particular site were not calculated using that method.

Site code	Ratio of peak flow to FEH Statistical peak					
	1 in 2 (50%) annual probability			1 in 100 (1%) annual probability		
	ReFH	Other method	Other method	ReFH	Other method	Other method
SWC-CFA22-001				0.99		
SWC-CFA22-004				2.15		

[18] Includes urban adjustment on QMED but not urban adjustment on growth curve.
[19] Includes urban adjustment on QMED and growth curve.

Final choice method

Choice of method and reasons – include reference to type of study, nature of catchment and type of data available.	The FEH Statistical method is the preferred choice due to the permeability nature of the catchments. The permeability adjustment procedure has been applied to the pooling group to remove non-flood years; however the result of the permeability adjustment on the growth curve is a reduction in flood flows in comparison to a non-adjusted growth curve. Urban adjustment has also been applied to both the QMED and the growth curve. The guidance states that ReFH is not appropriate for these catchments and hence the flows estimated using FEH Statistical with urban and permeability adjustment have been used (as recommended within the guidelines). In line with the FEH flood estimation guidelines4 the scaling factor, taken from the ReFH flows, has been used to determine the flow for the 1 in 1000 (0.1%) annual probability event.

Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	It has been assumed that the catchments as delimited in the FEH CD-ROM are correct. The catchments appear reasonable through brief catchment boundary checking, but there is potentially some uncertainty with the urban areas contributing to flow within the catchments. This is not considered a concern at this stage, but it may be something worth assessing for the detailed design phase. Assumptions have been made in the estimation of the 1 in 1000 (0.1%) annual probability flow. It is recognised that the method undertaken does not wholly comply with the guidelines; however given the use of the 1 in 1000 (0.1%) annual probability flow within the study and that the most conservative value has been taken forward, this approach is considered acceptable. The calculation QMED has been altered based on donor catchments; it is assumed that the donor catchment are suitable.
Discuss any particular limitations, e.g. applying methods outside the range of catchment types or return periods for which they were developed	The scaling factor for the 1 in 1000 (0.1%) annual probability flow was determined from the ReFH methods. It is not normally recommended that the ReFH method is used for flow estimation in permeable catchments such as these. It should also be noted that urban, highly permeable catchments are outside the range of the vast majority of catchments from which FEH methods have been developed. The guidance4 states that there is very little data on the effects of urbanisation on highly permeable catchments, hence there is inherent uncertainty within the flood flows estimated as there is no measured flow data.
Give what information you can on uncertainty in the results – e.g. confidence limits for the QMED estimates using FEH 3 12.5 or the factorial standard error from Science Report SC050050 (2008).	There is potential that the flows provided within this calculation record overestimated flows, however this is considered acceptable for the purposes of this study. Even though there is potential that the flows have been over estimated, there is also a chance that flows may have been under estimated. However given a conservative approach that has been taken in some aspects of this assessment and for the overall modelling it is considered that the overall results are unlikely to be an underestimation.
Comment on the suitability of the results for future studies, e.g. at nearby locations or for different purposes.	The flow estimates up to and including the 1 in 100 (1%) annual probability flow values would be considered acceptable for information in future studies. However new estimates would be necessary if flows were required at locations either upstream or downstream from the point of interest. It is not recommended that the results for the 1 in 1000 (0.1%) annual probability event are utilised in future studies.

Give any other comments on the study, for example suggestions for additional work.	Although not anticipated necessary, a detailed assessment of the catchment boundaries could be carried out, particularly for the urban contributions to the catchments. The FEH Rainfall-runoff method could also be applied to provide a better estimate of the 1 in 1000 (0.1%) annual probability flow if deemed necessary at a later stage.

Checks

Are the results consistent, for example at confluences?	N/A
What do the results imply regarding the return periods of floods during the period of record?	No flood events to compare to.
What is the 100-year growth factor? Is this realistic? (The guidance suggests a typical range of 2.1 to 4.0)	Growth factor not taking into account permeable adjustment is 2.80 and 2.92. Taking into account permeable adjustment the growth factor is 1.43 and 1.67.
If 1000-year flows have been derived, what is the range of ratios for 1000-year flow over 100-year flow?	A scaling factor between 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability flows was applied. The factors were 2.05 and 3.27 in this assessment.
What range of specific runoffs (l/s/ha) do the results equate to? Are there any inconsistencies?	N/A
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.	No other studies used for comparison. ReFH flows estimated from an earlier study were utilised for this assessment, see section 4.
Are the results compatible with the longer-term flood history?	No history to compare to.
Describe any other checks on the results	No other checks.

Final results

Site code	**Flood peak (m^3/s) for the following flood events**			
	1 in 20 (5%)	**1 in 1000 (1%)**	**1 in 100 (1%) climate change**	**1 in 1000 (0.1%)**
SWC-CFA22-001	0.92	1.01	1.22	3.32
SWC-CFA22-004	0.37	0.39	0.47	0.80

If flood hydrographs are needed for the next stage of the study, where are they provided? (e.g. give filename of spreadsheet, name of ISIS model, or reference to table below)	Hydrographs not required at this stage.

3.4 Pyford Brook viaduct, Bourne Brook viaduct, Handsacre east culvert and Handsacre west culvert extension

Method statement

Overview of requirements for flood estimates

Item	Comments
Give an overview which includes: Purpose of study Approx. no. of flood estimates required Peak flows or hydrographs? Range of return periods and locations Approx. time available	This proforma outlines the hydrological calculations carried out for four crossings Pyford Brook viaduct (SWC-CFA22-010), Bourne Brook viaduct (SWC-CFA22-012), Handsacre east culvert (SWC-CFA22-017) and Handsacre west culvert extension SWC-CFA22-018. As part of the Proposed Scheme, structures may need to be incorporated into the design where a number of watercourses pass beneath the proposed route of the Proposed Scheme. The capacity of these structures needs to be determined to ensure there is no increase to flood risk. It is vital at this stage that the proposed structures are not under designed and hence conservative flows are necessary in line with current requirements of the Proposed Scheme. At a later stage, if a more in-depth assessment determines lower flows, and hence smaller structures would have sufficient capacity, this is acceptable. Flows estimated for the route watercourse crossings along the 75km northern section of the Proposed Scheme (from north of Lichfield to Banbury) have been used to inform this assessment. Flows are required where the route will cross all watercourses. This assessment outlines the derivation of flows and hydrographs at four locations for the 1 in 20 (5%) annual probability, 1 in 100 (1%) annual probability, 1 in 100 (1%) annual probability with an allowance for climate change and the 1 in 1000 (0.1%) annual probability.

Overview of catchment

Item	Comments
Brief description of catchment, or reference to section in accompanying report	The four crossings have separate catchments which have sizes from <1km² to 28.47km². The level of urbanisation in the catchments ranges from entirely rural to heavily urbanised.

Source of flood peak data

Was the HiFlows UK dataset used? If so, which version? If not, why not? Record any changes made	Yes – Version 3.1.2, December 2011

Gauging stations (flow or level)

3.4.1 Gauging stations at the sites of flood estimates or nearby at potential donor sites.

3.4.2 Local donor sites have been sought however in most cases the catchment area of the subject catchment was found to be significantly smaller than that of any potential local donor.

Watercourse	Station name	Gauging authority number	National River Flow Archive number (used in FEH)	Grid reference	Catchment area (km²)	Type (rated / ultrasonic / level	Start and end of flow record
N/A							

Data available at each flow gauging station

Station name	Start and end of data in HiFlows UK	Update for this study?	Suitable for QMED	Suitable for pooling?	Data quality check needed?	Other comments on station and flow data quality - e.g. information from HiFlows-UK, trends in flood peaks, outliers
N/A						
Give link/reference to any further data quality checks carried out						

Rating equations

Station name	Type of rating e.g. theoretical, empirical; degree of extrapolation	Rating review needed	Reasons - e.g. availability of recent flow gaugings, amount of scatter in the rating.
N/A			
Give link/reference to any rating reviews carried out			

Other data available and how it has been obtained

Type of data	Data relevant to this study	Data available?	Source of data and licence reference if from Environment Agency	Date obtained	Details
Check flow gaugings (if planned to review ratings)	No				
Historic flood data – give link to historic review if carried out.	No				
Flow data for events	No				
Rainfall data for events	No				

Type of data	Data relevant to this study	Data available?	Source of data and licence reference if from Environment Agency	Date obtained	Details
Potential evaporation data	No				
Results from previous studies	No				
Other data or information (e.g. groundwater, tides)	No				

Initial choice of approach

Is FEH appropriate? (it may not be for very small, heavily urbanised or complex catchments) If not, describe other methods to be used.	Yes. There are two crossings Handsacre east culvert (SWC-CFA22-017) and Handsacre west culvert extension (SWC-CFA22-018) which have small catchments <0.5km². Current guidance recommends that for catchments smaller than 0.5km², runoff estimates should be derived from FEH methods applied to the nearest suitable catchment above 0.5km² for which descriptors can be derived from the FEH CD-ROM and scaled down. The catchment of one crossing, Pyford Brook viaduct (SWC-CFA22-010), may be defined as very heavily urbanised. For this catchment the FEH Statistical method with an urban adjustment will be considered as well as the ReFH method. The bullet points below summarise the general approach to flow estimation for minor watercourses and the larger watercourses and main rivers. Minor watercourses at Handsacre west culvert extension (SWC-CFA22-018) and Handsacre east culvert (SWC-CFA22-017) : - Define catchment area either on the FEH CD-ROM or using the DTM if catchment area is <0.5km² - Check catchment descriptors and adjust where necessary. - Calculate critical duration for the catchment of each crossing using the equation D (hrs) = Tp*(1+SAAR/1000). - Calculate flows using the ReFH method from catchment descriptors. Main rivers and larger watercourses at Pyford Brook viaduct (SWC-CFA22-010) and Bourne Brook viaduct (SWC-CFA22-012): - Extract catchment descriptors from the FEH CD-ROM and check. - Search for a local donor station (using the FEH CD-ROM and in pooling group). - Derive flow estimates using both ReFH and FEH Statistical methods. - Calculate critical duration for the catchment of each crossing using the equation, D (hrs) = T_p*(1+SAAR/1000). - Review existing hydrology studies for the catchments of major crossings where available. - Compare flow estimates and make recommendations for flows to be used in modelling.

Outline the conceptual model, addressing questions such as: Where are the main sites of interest? What is likely to cause flooding at those locations? (peak flows, flood volumes, combinations of peaks, groundwater, snowmelt, tides…) Might those locations flood from runoff generated on part of the catchment only, e.g. downstream of a reservoir? Is there a need to consider temporary debris dams that could collapse?	The main sites of interest are at the crossing locations and hence are the points at which flow has been derived. Each point at which flow has been derived has been named in accordance with the associated watercourse identifier. However, it should be noted that the catchments at crossings Handsacre east culvert (SWC-CFA22-017) and Handsacre west culvert extension (SWC-CFA22-018) are two of four catchments which drain to a single watercourse. Therefore, the site code for this watercourse will be referred as a unique identifier in this proforma section. It was considered that peak flows are likely to be the main cause of flooding, following development, due to the potentially constricting culvert or bridge. There is a reservoir present upstream of Bourne Brook. The operation of the reservoir is unknown at this stage. As part of this assessment it is not currently deemed necessary to consider the risk of a temporary dam collapse; however this may be considered in future.
Any unusual catchment features to take into account? e.g. highly permeable – avoid ReFH if BFIHOST>0.65, consider permeable catchment adjustment for statistical method if SPRHOST<20% highly urbanised – avoid standard ReFH if URBEXT1990>0.125; consider FEH Statistical or other alternatives; consider method that can account for differing sewer and topographic catchments pumped watercourse – consider lowland catchment version of rainfall-runoff method major reservoir influence (FARL<0.90) – consider flood routing extensive floodplain storage – consider choice of method carefully	The catchment at Pyford Brook viaduct (SWC-CFA22-010) has BFIHOST greater than 0.65, however SPRHOST for the catchment is greater than 20%. Given the SPRHOST is greater than 20% the ReFH method is considered suitable. Pyford Brook viaduct (SWC-CFA22-010) is a larger crossing of the Curborough Brook and also has an $URBEXT_{1990}$ value <0.125. As this is a major crossing both the ReFH and the FEH Statistical method will be undertaken and compared. All other catchments are within a suitable range of urbanisation for the ReFH method. All catchments have a FARL >0.9.
Initial choice of method(s) and reasons Will the catchment be split into sub-catchments? If so, how?	For the purposes of this assessment two levels of assessment have been undertaken for crossings of minor watercourses and for crossings of major watercourses. The choice of method for each assessment is summarized below. Crossings of minor watercourses [Handsacre east culvert (SWC-CFA22-017) and Handsacre west culvert extension (SWC-CFA22-018)]: -Calculate flows using the ReFH method from catchment descriptors. Crossings of main rivers/ larger watercourses [Pyford Brook viaduct (SWC-CFA22-010) and Bourne Brook viaduct (SWC-CFA22-012)]: -Derive flow estimates using both ReFH and FEH Statistical pooling group methods. -Review existing hydrology studies for the catchments of major crossings where available. It should be noted that there are four small catchments draining into the same watercourse including those at crossings Handsacre east culvert (SWC-CFA22-017) and Handsacre west culvert extension (SWC-CFA22-018). These are all small catchments <1km².Flow will be estimated to a point downstream of crossings

	(national grid reference 409700, 315350) and distributed based on the catchment area for each crossing.
Software to be used (with version numbers)	FEH CD-ROM v3.0[20] WINFAP-FEH v3.0[21] ReFH calculations - ReFH spreadsheet / ISIS

Summary of subject sites

Site code (taken from watercourse identifier/unique identifier)	**Watercourse**	**Site**	**Easting**	**Northing**	**Catchment area on FEH CD-ROM (km^2)**	**Revised catchment area if altered**
191-192	Ordinary watercourse (no unique watercourse ID)	A point downstream of the crossings (national grid reference 409700, 315350).	There are four small catchments draining into the same watercourse including those at crossings Handsacre east culvert (SWC-CFA22-017) and Handsacre west culvert extension (SWC-CFA22-018). These are all small catchments <1km^2.Flow will be estimated to a point downstream of crossings (national grid reference 409700, 315350) and distributed based on the catchment area for each crossing. The catchment area of the flow estimation location is incorrect on the FEH CD-ROM, the catchment boundary has been checked using the DTM and increased by 0.60km^2. The DTM has been used to define the small catchment areas for the crossings.			Total area to a point downstream of the crossings used in flow estimation is 1.69km^2. Individual catchment areas used in area weighting: Handsacre east culvert (SWC-CFA22-017)= 0.18 km^2 Handsacre west culvert extension (SWC-CFA22-018)= 0.41 km^2
SWC-CFA22-012	Bourne Brook (ordinary watercourse)	Bourne Brook viaduct	410850	314150	28.47	Not altered
SWC-CFA22-010	Main river (Curborough Brook)	Pyford Brook viaducts	413050	313400	17.19	Not altered
Reasons for choosing above locations		Locations the Proposed Scheme crosses the respective watercourses.				

[20] FEH CD-ROM v3.0 © NERC (CEH). © Crown copyright. © AA. 2009. All rights reserved.
[21] WINFAP-FEH v3 © Wallingford HydroSolutions Limited and NERC (CEH) 2009.

Important catchment descriptors at each subject site (incorporating any changes made)

Site code	FARL	PROPWET	BFIHOST	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	SPRHOST	URBEXT 2000	FPEXT
191-192	1.000	0.31	0.624	1.33	28.5	692	29.96	0.0110	0.0106
SWC-CFA22-012	0.962	0.31	0.635	6.66	47.5	722	30.22	0.0565	0.0557
SWC-CFA22-010	0.946	0.31	0.669	4.82	27.9	682	26.75	0.1550	0.1906

Checking catchment descriptors

Record how catchment boundary was checked and describe any changes (refer to maps if needed)	The boundary of each catchment has been checked against contours from OS 50K mapping and DTM where available. Adjustment to the catchment boundaries and area was made where necessary. The boundary of catchments not represented on the FEH CD-ROM was determined using the DTM. Changes to the catchment boundary and resulting area are provided in table of 'Summary of subject sites'.
Record how other catchment descriptors (especially soils) were checked and describe any changes. Include before/after table if necessary.	This proforma outlines the hydrological assessment for the initial stage of assessment. Broad scale checks of catchment descriptors have been carried out. The catchment descriptors for catchments not represented on the FEH CD-ROM were extracted for downstream or any adjacent catchment. The FEH CD-ROM catchment area was adjusted and the DPLBAR was recalculated based on the new area (catchment area^0.548). The average slope has been calculated using the Weighted Height-Distance Method. Other catchment descriptors were sensibility checked for suitability. For all catchments, where the catchment area has changed the new catchment area has been used to calculate the DPLBAR (catchment area^0.548). The underlying geology and soils have been reviewed on a broad scale for the larger area of interest and the catchment values for BFIHOST and SPRHOST values appear reasonable, no changes were considered necessary at this stage.
Source of URBEXT	URBEXT1990 (ReFH method) / URBEXT2000 (FEH Statistical Method)
Method for updating of URBEXT	CPRE formula from FEH Volume 4 on URBEXT1990 / CPRE formula from 2006 CEH report on URBEXT2000.

Statistical method

3.4.4 Peak flows from the FEH Statistical method have been calculated at the Bourne Brook viaduct (SWC-CFA22-012) and Pyford Brook viaduct (SWC-CFA22-010). These flow estimates were used for comparison with flow estimates derived from the ReFH method.

Search for donor sites for QMED (if applicable)

Comment on potential donor sites Mention: Number of potential donor sites available Distances from subject site Similarity in terms of catchment area, BFIHOST, FARL and other	Potential donor sites were sought for the catchments of the major crossings using the FEH CD-ROM, HiFlows-UK database and from within the pooling groups. Stations within a reasonable distance of the catchments of the crossings were either significantly larger, heavily urbanised or had very different catchment descriptors and were considered unsuitable donor stations. The asg factor applied to more distant potential donor stations negated the adjustment of QMED.

catchment descriptors Quality of flood peak data Include a map if necessary. Note that donor catchments should usually be rural.	

Donor sites chosen and QMED adjustment factors

National River Flow Archive no.	Reasons for choosing or rejecting	Method (annual maxima or POT)	Adjustment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)
No suitable donor stations have been identified. QMED has been calculated from catchment descriptors. Please refer to comments in the section 'Search for donor sites for QMED (if applicable)'.						

Which version of the urban adjustment was used for QMED at donor sites, and why? Note: The guidelines recommend great caution in urban adjustment of QMED on catchments that are also highly permeable (BFIHOST>0.8).	

Overview of estimation of QMED at each subject site

Site code	Method	Initial estimate of QMED (m3/s)	Data transfer	Final estimate of QMED (m3/s)
SWC-CFA22-012	CD	2.906	N/A	2.906
SWC-CFA22-010	CD	1.603	N/A	1.603

Are the values of QMED consistent, for example at successive points along the watercourse and at confluences?	N/A – Estimates for different catchments
Which version of the urban adjustment was used for QMED, and why?	Bayliss (2007) – appropriate method at the time of the assessment.

Derivation of pooling groups

3.4.5 The composition of the pooling groups is given in the Annex. Several subject sites may use the same pooling group.

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged? (enhanced single site analysis)	Changes made to default pooling group, with reasons Note also any sites that were investigated but retained in the group.	Weighted average L-moments, L-CV and L-skew, (before urban adjustment)
Bourne Brook @	SWC-CFA22-	No	Details provided in	

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged? (enhanced single site analysis)	Changes made to default pooling group, with reasons Note also any sites that were investigated but retained in the group.	Weighted average L-moments, L-CV and L-skew, (before urban adjustment)
Cro6	012		Section 3.5.	
Curborough Brook @ Cro9	SWC-CFA22-010	No	Details provided in Section 3.5.	

Notes

Pooling groups were derived using the revised procedures from Science Report SC050050 (2008). The weighted average L-moments, before urban adjustment, can be found at the bottom of the Pooling-group details window in WINFAP-FEH.

Derivation of flood growth curves at subject sites

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution (location, scale and shape) after adjustments	Growth factor for 1 in 100 (1%)
SWC-CFA22-012	P	Bourne Brook @ Cro6	Generalised logistic as recommended in FEH	Urban adjustment Kjeldsen (2010)	Location 1 Scale 0.26 Shape -0.13 Bound -1.02	2.672
SWC-CFA22-010	P	Curborough Brook @ Cro9	Generalised logistic as recommended in FEH	Urban adjustment Kjeldsen (2010)	Location 1 Scale 0.278 Shape -0.168 Bound -0.653	3.012

Notes

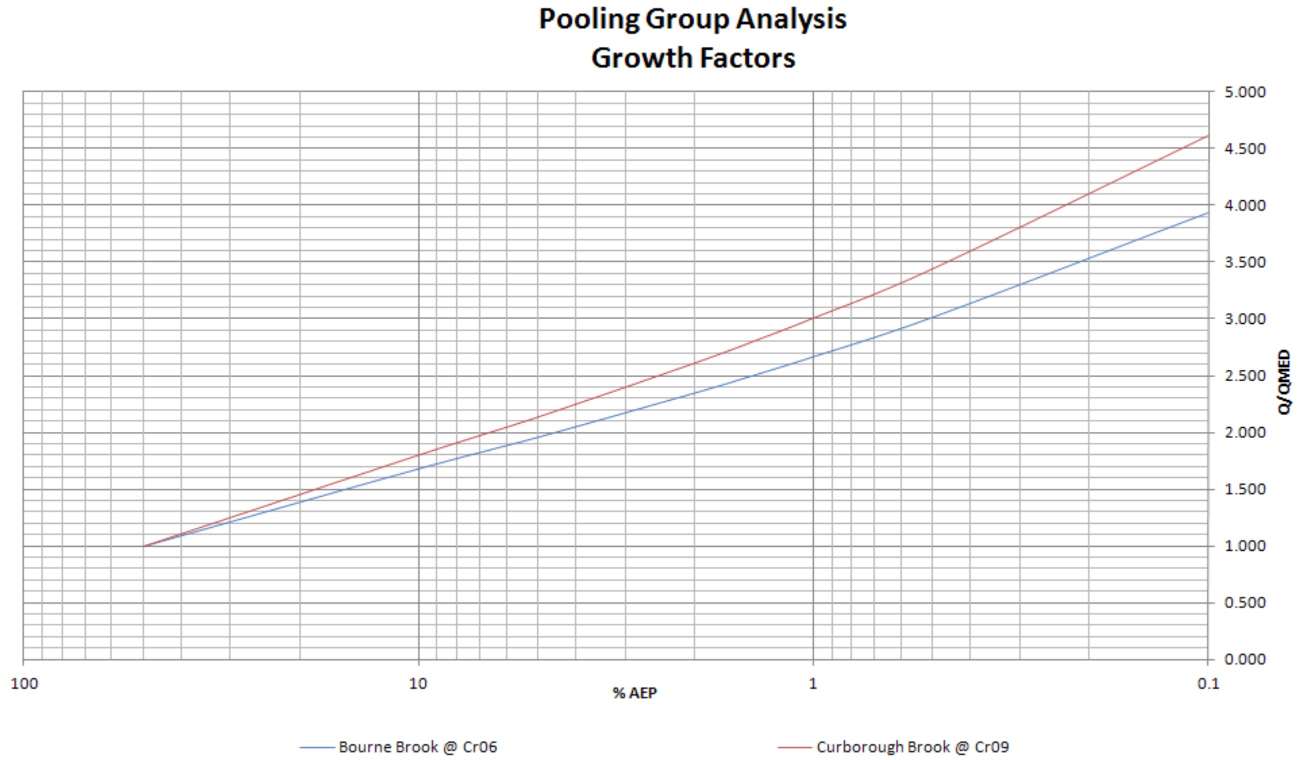
Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis

A pooling group (or ESS analysis) derived at one gauge can be applied to estimate growth curves at a number of ungauged sites. Each site may have a different urban adjustment, and therefore different growth curve parameters.

Urban adjustments to growth curves should use the version 3 option in WINFAP-FEH: Kjeldsen (2010).

Flood estimates from the Statistical method

Site code	Flood peak (m^3/s) for the following flood events							
	1 in 2 (50%)	1 in 10 (10%)	1 in 20 (5%)	1 in 50 (2%)	1 in 100 (1%)	1 in 100 (1%) climate change	1 in 200 (0.5%)	1 in 1000 (0.1%)
SWC-CFA22-012	2.91	4.85	5.65	6.78	7.31	7.71	8.72	11.46
SWC-CFA22-010	1.60	2.79	3.30	4.06	4.42	4.70	5.42	7.43



Revitalised flood hydrograph (ReFH) method

Parameters for ReFH model

3.4.7 Note: If parameters are estimated from catchment descriptors, they are easily reproducible so it is not essential to enter them in the table.

Site code	Method OPT: Optimisation BR: Baseflow recession fitting CD: Catchment descriptors DT: Data transfer (give details)	T_p (hours) Time to peak	C_{max} (mm) Maximum storage capacity	BL (hours) Baseflow lag	BR Baseflow recharge
191-192	CD	2.51	504.96	39.06	1.48
SWC-CFA22-012	CD	4.93	513.41	48.36	1.51
SWC-CFA22-010	CD	3.50	539.49	35.41	1.59
Brief description of any flood event analysis carried out (further details should be given below or in a project report)			Potential donor sites were sought for the catchments of major crossings using the FEH CD-ROM, HiFlows-UK database and from within the pooling groups. In general stations local to the catchments were either significantly larger, heavily urbanised or had very different catchment descriptors and were unsuitable donor stations.		

Design events for ReFH method

Site Code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours)	Storm area for ARF (if not catchment area)
191-192	Rural	Winter	4.2	ReFH Design Standard
SWC-CFA22-012	Urban	Summer	8.5	ReFH Design Standard
SWC-CFA22-010	Urban	Summer	5.9	ReFH Design Standard
Are the storm durations likely to be changed in the next stage of the study, e.g. by optimisation within a hydraulic model?			Storm durations will not be altered during the next stage of the hydraulic modelling.	

Flood estimates from the ReFH method

Site Code	Flood peak (m^3/s) for the following flood events			
	1 in 20 (5%)	1 in 100 (1%)	1 in 100 (1%) climate change[22]	1 in 1000 (0.1%)
191-192	0.63	0.93	1.12	1.79
SWC-CFA22-012	7.33	10.61	12.73	19.82
SWC-CFA22-010	4.71	7.05	8.46	15.51

[22] The 1 in 100 (1%) annual probability flow with an allowance for climate change is the 1 in 100 (1%) annual probability flow factored by 1.2.

Discussion and summary of results

Comparison of results from different methods

3.4.8 This table compares peak flows from various methods with those from the FEH Statistical method at example sites for two key return periods. Blank cells indicate that results for a particular site were not calculated using that method.

Site code	Ratio of peak flow to FEH Statistical peak			
	1 in 2 (50%) annual probability		1 in 100 (1%) annual probability	
	ReFH	FEH Statistical pooling group	ReFH	FEH Statistical pooling group
191-192	0.63		0.93	
SWC-CFA22-012	7.33	5.65	10.61	7.71
SWC-CFA22-010	4.71	3.30	7.05	4.70

Final choice method

Choice of method and reasons – include reference to type of study, nature of catchment and type of data available.	There are four small catchments draining into the same watercourse including those at crossings Handsacre west culvert extension and Handsacre east culvert. These are all small catchments <1km². Flows were estimated using the ReFH method from catchment descriptors extracted from the FEH CD-ROM to a point downstream of crossings (national grid reference 409700, 315350) and then distributed based on the catchment area for each crossing using the catchment areas detailed in "Summary of subject sites". A comparison of the peak flows from the FEH Statistical method have been provided for two major crossings of the Bourne Brook and the Curborough Brook (Bourne Brook viaduct and Pyford Brook viaduct). The catchment of the Curborough Brook crossing is heavily urbanised and the FEH Statistical method is arguably the most appropriate method. However for both crossings (Bourne Brook viaduct and Pyford Brook viaduct) the peak flow estimates from the ReFH method are larger. It is vital at this stage that the proposed structures are not under designed and hence conservative flows are necessary in line with current requirements of the Proposed Scheme. Therefore peak flows from the ReFH method have been used in modelling for all crossings.

Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	Crossings Handsacre west culvert extension and Handsacre east culvert drain to the same watercourse. Flows have been estimated to a point downstream of the crossings (national grid reference 409700, 315350) and distributed based on the catchment area for each crossing. The resulting peak flows at this point downstream, Handsacre west culvert extension and Handsacre east culvert are provided in the table of 'Final results' section.
Discuss any particular limitations, e.g. applying methods outside the range of catchment types or return periods for which they were developed	ReFH would not normally be the preferred option for crossing Pyford Brook viaduct due to the urban nature of the catchment. However this stage of the study requires conservative flow estimates for design purposes and therefore the ReFH method peak flow estimate has been used for this catchment.

Give what information you can on uncertainty in the results – e.g. confidence limits for the QMED estimates using FEH 3 12.5 or the factorial standard error from Science Report SC050050 (2008).	There is some uncertainty with the results, however it is considered that the results are conservative and hence would be over estimating, rather than under estimating.
Comment on the suitability of the results for future studies, e.g. at nearby locations or for different purposes.	Peak flow estimates have been produced for the purposes of this assessment and should not be used outside of this study except for comparative purposes.
Give any other comments on the study, for example suggestions for additional work.	When the assessment moves to the detailed design phase the FEH Statistical method should be carried out for all suitable catchments for comparative purposes and to provide a greater level of confidence with the results. If there is the opportunity to install temporary flow gauges at the un-gauged crossings, this may also improve confidence in design flows at the detailed design phase.

Checks

Are the results consistent, for example at confluences?	N/A Separate catchments assessed.
What do the results imply regarding the return periods of floods during the period of record?	N/A
What is the 100-year growth factor? Is this realistic? (The guidance suggests a typical range of 2.1 to 4.0)	Not determined for ReFH method.
If 1000-year flows have been derived, what is the range of ratios for 1000-year flow over 100-year flow?	Range between 1.87 and 2.2.
What range of specific runoffs (l/s/ha) do the results equate to? Are there any inconsistencies?	Different catchments so not comparable.
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.	None.
Are the results compatible with the longer-term flood history?	Not investigated as part of the initial assessment.
Describe any other checks on the results	None.

Final results

Site code	**Flood peak (m^3/s) for the following flood events**			
	1 in 20 (5%)	**1 in 100 (1%)**	**1 in 100 (1%) climate change**	**1 in 1000 (0.1%)**
191-192	0.63	0.93	1.12	1.79
SWC-CFA22-018	0.15	0.23	0.27	0.44
SWC-CFA22-017	0.07	0.10	0.12	0.19
SWC-CFA22-012	7.33	10.61	12.73	19.82
SWC-CFA22-010	4.71	7.05	8.46	15.51

3.5 Supporting information

Default pooling groups

Capper's Lane viaduct (SWC-CFA22-001)

Name	nYears	L-CV	L-skew	Discordancy	Distance
26802 (Gypsey Race @ Kirby Grindalythe)	10	0.233	0.25	0.387	0.738
25019 (Leven @ Easby)	31	0.355	0.396	1.086	0.871
44006 (Sydling Water @ Sydling st Nicholas)	35	0.227	0.087	0.038	1.049
36010 (Bumpstead Brook @ Broad Green)	42	0.428	0.223	1.173	1.092
36009 (Brett @ Cockfield)	39	0.26	-0.113	1.493	1.125
27010 (Hodge Beck @ Bransdale Weir)	41	0.224	0.293	0.668	1.173
203046 (Rathmore Burn @ Rathmore Bridge)	27	0.126	0.125	0.81	1.184
44008 (Sth Winterbourne @ W'bourne Steepleton)	30	0.382	0.325	0.871	1.204
20002 (West Peffer Burn @ Luffness)	41	0.292	0.015	0.664	1.218
27051 (Crimple @ Burn Bridge)	37	0.22	0.133	1.238	1.257
44009 (Wey @ Broadwey)	32	0.34	0.241	0.246	1.305
50009 (Lew @ Norley Bridge)	20	0.13	-0.243	2.472	1.399
41020 (Bevern Stream @ Clappers Bridge)	40	0.229	0.22	0.207	1.439
203049 (Clady @ Clady Bridge)	27	0.197	0.123	0.216	1.443
206004 (Bessbrook @ Carnbane)	25	0.23	0.37	1.314	1.491
73015 (Keer @ High Keer Weir)	19	0.076	-0.225	1.786	1.506
72014 (Conder @ Galgate)	42	0.192	0.058	1.755	1.509
44809 (Piddle @ Little Puddle)	16	0.456	0.266	1.574	1.525
Total	554				
Weighted means		0.258	0.143		

Mare Brook south culvert (SWC-CFA22-004)

Name	nYears	L-CV	L-skew	Discordancy	Distance
76011 (Coal Burn @ Coalburn)	32	0.178	0.347	0.837	0.993
45817 (Rhb Trib to Haddeo @ Upton (trib))	16	0.292	0.304	0.396	1.433
44009 (Wey @ Broadwey)	32	0.34	0.241	1.395	2.349
27051 (Crimple @ Burn Bridge)	37	0.22	0.133	0.527	2.369
45816 (Haddeo @ Upton)	16	0.331	0.427	0.971	2.393

Name	nYears	L-CV	L-skew	Discordancy	Distance
27073 (Brompton Beck @ Snainton Ings)	29	0.205	0.011	1.047	2.657
28033 (Dove @ Hollinsclough)	30	0.257	0.403	0.479	2.677
54091 (Severn @ Hafren Flume)	34	0.184	0.27	2.629	2.861
54092 (Severn @ Hore Flume)	34	0.116	-0.052	2.496	2.881
44006 (Sydling Water @ Sydling st Nicholas)	35	0.227	0.087	0.614	2.965
25019 (Leven @ Easby)	31	0.355	0.396	1.318	3.138
26802 (Gypsey Race @ Kirby Grindalythe)	10	0.233	0.25	0.084	3.156
25011 (Langdon Beck @ Langdon)	23	0.247	0.399	1.268	3.28
91802 (Allt Leachdach @ Intake)	34	0.153	0.257	1.096	3.317
25003 (Trout Beck @ Moor House)	36	0.173	0.328	0.769	3.35
206006 (Annalong @ Recorder 1895)	48	0.189	0.052	1.298	3.48
54022 (Severn @ Plynlimon Flume)	38	0.156	0.171	0.676	3.492
27010 (Hodge Beck @ Bransdale Weir)	41	0.224	0.293	0.1	3.522
Total	556				
Weighted means		0.227	0.233		

Amendments to default pooling groups for Pyford Brook viaduct (SWC-CFA22-010) and Bourne Brook viaduct (SWC-CFA22-012)

Pyford Brook viaduct (Curborough Brook)

Subject catchment information	
Crossing	Curborough Brook @ Pyford Brook Viaduct (Cr09)
National grid reference	413050, 313400
Area	17.19km2
Permeability	Not permeable (BFIHOST < 0.75 and SPRHOST > 20%)
Urbanisation	Heavily urbanised (URBEXT2000 > 0.15)
Target return period	100
Required years of data	500

Pyford Brook viaduct default pooling group

Name	nYears	L-CV	L-Skew	Discordancy	Distance
54060 (Potford Brook @ Sandyford Bridge)	31	0.46	0.36	1.46	0.68
41016 (Cuckmere @ Cowbeech)	41	0.33	0.10	0.53	0.71
41028 (Chess Stream @ Chess Bridge)	44	0.22	0.18	1.02	0.71

Name	nYears	L-CV	L-Skew	Discordancy	Distance
36009 (Brett @ Cockfield)	38	0.26	-0.10	1.57	0.74
30014 (Pointon Lode @ Pointon)	36	0.41	0.33	1.37	0.78
52015 (Land Yeo @ Wraxall Bridge)	29	0.30	0.11	0.15	0.79
26802 (Gypsey Race @ Kirby Grindalythe)	8	0.20	0.19	2.59	0.79
20002 (West Peffer Burn @ Luffness)	41	0.29	0.02	1.16	0.82
39017 (Ray @ Grendon Underwood)	42	0.35	0.10	0.52	0.86
39036 (Law Brook @ Albury)	41	0.26	0.09	0.84	0.90
31025 (Gwash South Arm @ Manton)	30	0.28	0.08	0.27	0.91
7006 (Lossie @ Torwinny)	19	0.28	0.11	0.15	0.92
52016 (Currypool Stream @ Currypool Farm)	38	0.28	0.27	1.10	0.92
36010 (Bumpstead Brook @ Broad Green)	41	0.43	0.24	0.97	0.95
25019 (Leven @ Easby)	30	0.36	0.41	1.30	0.96
Total	509				
Weighted means		0.32	0.16		

Pyford Brook viaduct pooling group review

Comment	Information	Decision	Station years
Discordant sites	None		
Period of record (<8 years?)	26802 (Gypsey Race @ Kirby Grindalythe) has 8 years of data (not flagged as 'short in WinFap)	As < 8 years recommended in FEH guidelines - not enough reason to remove.	509
Assessment of sites flagged on the HiFlows-UK database as 'No Pooling' and No Pooling / No QMED' and sites with permeable catchments or major catchment differences.	54060 (Potford Brook @ Sandyford Bridge) the top 11 annual maxima events are out-of-bank and the rating has not been developed beyond bank full - flows have been extrapolated.	Retain - not enough information to remove	509
	41016 (Cuckmere @ Cowbeech) No gaugings at highest flows, high flows often out of bank.	Retain - not enough information to remove	509
	41028 (Chess Stream @ Chess Bridge) No gaugings for verification of rating, possible bypassing and drowning.	Retain - not enough information to remove	509
	30014 (Pointon Lode @ Pointon) Theoretical rating for Crump weir with broad crested weir on either	Retain - not enough information to remove	509

Comment	Information	Decision	Station years
	side. Correction to rating to remove 1m stage. Flow is non-modular and out of bank at the third highest annual maximum.		
	26802 (Gypsey Race @ Kirby Grindalythe)	Remove - very permeable site (SPRHOST = 5.7) also has a short record.	501
	52015 (Land Yeo @ Wraxall Bridge) Doubt in rating at higher flows, unconfirmed by gaugings.	Retain - not enough information on data record to remove. SAAR and DPSBAR are high compared to the subject catchment however other CDs are good.	501
	39017 (Ray @ Grendon Underwood) At extreme flows above bank full, rating does not seem to measure flows accurately. Rating appears to be accurate whilst weir modular, but more gaugings are required and does not apply above bankfull.	Retain - not enough information to remove	501
	39036 (Law Brook @ Albury) Rating underestimates flows by around 25% at QMED value, though more gaugings are required to determine extent of problem. Flow is within bank full.	Retain - No reason to remove.	492
	31025 (Gwash South Arm @ Manton) Modular limit is approx 15 m3/s and highest flows may exceed this, with bypassing.	Retain - not enough information to remove	492
	7006 (Lossie @ Torwinny) Geographically distant (located in the north of Scotland) affected by ice. Not suitable for estimation of QMED or pooling; control is sensitive to floods.	Remove - Geographically distant, differences in catchment and poor data.	473
	52016 (Currypool Stream @ Currypool Farm) High flows out of bank, no confirmation of high flow rating. The present rating is acceptable for levels to 0.4m but needs to be confirmed by gaugings between 0.4-0.8m.	Retain - not enough information to remove.	473
	25019 (Leven @ Easby) Catchment is significantly stepper than the subject catchment.	Remove	443

Pyford Brook viaduct added stations

Name	nYears	L-CV	L-Skew	Discordancy	Distance
43019 (Shreen Water @ Colesbrook)	35	0.20	0.00	0.55	1.03
45013 (Tale @ Fairmile)	24	0.21	0.20	1.20	1.17

Pyford Brook viaduct reviewed pooling group

Station	Years of data
54060 (Potford Brook @ Sandyford Bridge)	31
41016 (Cuckmere @ Cowbeech)	41
41028 (Chess Stream @ Chess Bridge)	44
36009 (Brett @ Cockfield)	38
30014 (Pointon Lode @ Pointon)	36
52015 (Land Yeo @ Wraxall Bridge)	29
20002 (West Peffer Burn @ Luffness)	41
39017 (Ray @ Grendon Underwood)	42
39036 (Law Brook @ Albury)	32
31025 (Gwash South Arm @ Manton)	30
52016 (Currypool Stream @ Currypool Farm)	38
36010 (Bumpstead Brook @ Broad Green)	41
43019 (Shreen Water @ Colesbrook)	35
45013 (Tale @ Fairmile)	24
Total	502

Pyford Brook viaduct heterogeneity - following review

3.5.2 The pooling group was found to be strongly heterogeneous. Review of alternative sites indicate it is unlikely the quality of the pooling group will be improved by using stations further down the list generated in WinFap.

Pyford Brook viaduct goodness of fit details

Fitting	Z values
Generalised Logistic	5.32
Generalised Extreme Value	2.37
Pearson Type III	2.35
Generalised Pareto	-3.79

The permeable adjustment method assumes that the flood growth curve follows a Generalised Logistic distribution. On average the Generalised Logistic distribution is considered to perform better than the GEV for pooled growth curve derivation. In this instance the Generalised Logistic distribution has been selected.

Pyford Brook viaduct growth curves

Flood event	Rural (GL)	Urban (GL)
1 in 2 (50%)	1.00	1.000
1 in 10 (10%)	1.81	1.740
1 in 20 (5%)	2.14	2.062
1 in 50 (2%)	2.62	2.531
1 in 75 (1.33%)	2.84	2.760
1 in 100 (1%)	3.01	2.932
1 in 200 (0.5%)	3.44	3.379
1 in 1000 (0.1%)	4.62	4.638

Pyford Brook viaduct growth curve parameters

Growth curve	Location	Scale	Shape	Bound
Rural GL	1.00	0.31	-0.14	-1.30
Urban GL	1.00	0.28	-0.17	-0.65

Bourne Brook viaduct (Bourne Brook)

Subject catchment information	
Crossing	Bourne Brook @ 188_L1 (Cr06)
National grid reference	410850, 314150
Area	28.47km^2
Permeability	Not permeable (BFIHOST < 0.75 and SPRHOST > 20%)
Urbanisation	Urban (URBEXT2000 > 0.03)
Target return period	100
Required years of data	500

Bourne Brook viaduct default pooling group

Name	nYears	L-CV	L-Skew	Discordancy	Distance
43019 (Shreen Water @ Colesbrook)	35	0.20	0.00	0.45	0.45
41028 (Chess Stream @ Chess Bridge)	44	0.22	0.18	0.78	0.51
36010 (Bumpstead Brook @ Broad Green)	41	0.43	0.24	2.59	0.53
41020 (Bevern Stream @ Clappers Bridge)	39	0.23	0.22	1.03	0.54
52015 (Land Yeo @ Wraxall Bridge)	29	0.30	0.11	0.26	0.56
45013 (Tale @ Fairmile)	24	0.21	0.20	1.55	0.58
31025 (Gwash South Arm @ Manton)	30	0.28	0.08	0.22	0.58

Name	nYears	L-CV	L-Skew	Discordancy	Distance
30015 (Cringle Brook @ Stoke Rochford)	32	0.25	0.17	0.40	0.62
40017 (Dudwell @ Burwash)	39	0.21	-0.12	1.97	0.63
26803 (Water Forlornes @ Driffield)	9	0.22	-0.07	0.55	0.65
36009 (Brett @ Cockfield)	38	0.26	-0.10	0.90	0.68
41016 (Cuckmere @ Cowbeech)	41	0.33	0.10	0.84	0.70
28058 (Henmore Brook @ Ashbourne)	12	0.23	0.01	0.91	0.73
20002 (West Peffer Burn @ Luffness)	41	0.29	0.02	0.73	0.78
7006 (Lossie @ Torwinny)	19	0.28	0.11	0.13	0.78
39033 (Winterbourne st @ Bagnor)	46	0.34	0.40	2.69	0.80
Total	519				
Weighted means		0.27	0.11		

Bourne Brook viaduct pooling group review

Comment	Information	Decision	Station years
Discordant sites	None		
Period of record (<8 years?)	26803 (Water Forlornes @ Driffield) has 9 years of data	Although record is short, it is > 8 years. Not enough evidence to remove based on the short record alone.	519
Assessment of sites flagged on the HiFlows-UK database as 'No Pooling' and No Pooling / No QMED' and sites with permeable catchments or major catchment differences.	43019 (Shreen Water @ Colesbrook) Scatter in high flow gaugings. Drowns early. Uncertainty in the rating at high flows.	Retain - not enough information to remove	519
	41028 (Chess Stream @ Chess Bridge) No gaugings for verification of rating, possible bypassing and drowning.	Retain - not enough information to remove	519
	52015 (Land Yeo @ Wraxall Bridge) Doubt in rating at higher flows, unconfirmed by gaugings.	Retain - not enough information to remove	519
	45013 (Tale @ Fairmile) Doubts about data quality, significant scatter in gaugings pre 1999. Post 1999 EM gauge installed - may not measure flows <7 cumecs accurately.	Retain - not enough information to remove.	519
	31025 (Gwash South Arm @ Manton) Modular limit is approx 15 m3/s and highest flows may exceed this, with bypassing.	Retain - not enough information to remove	516

Comment	Information	Decision	Station years
	30015 (Cringle Brook @ Stoke Rochford) Qmed is above the wing wall level and the modular limit of the weir. The rating includes an allowance for drowning using assumed positions of d/s weirs and sluices.	Retain - some uncertainty in the rating but not enough information to remove.	516
	40017 (Dudwell @ Burwash) High flow rating based on gaugings, but does not take account of bypassing or drowning.	Retain - some uncertainty in the rating but not enough information to remove.	516
	26803 (Water Forlornes @ Driffield) Station data poor quality. High flow rating is very poor and needs to be reviewed.	Remove - Remove due to poor data quality and short record.	507
	41016 (Cuckmere @ Cowbeech) No gaugings at highest flows, high flows often out of bank.	Retain - not enough information to remove	507
	28058 (Henmore Brook @ Ashbourne) Unsure of modular limit and gaugings not to a high enough level.	Retain - not enough information to remove	507
	7006 (Lossie @ Torwinny) Geographically distant (located in the north of Scotland) affected by ice. Not suitable for estimation of QMED or pooling; control is sensitive to floods.	Remove - Geographically distant, differences in catchment and poor data.	488
	39033 (Winterbourne st @ Bagnor)	Retain	484

Bourne Brook viaduct added stations

Name	nYears	L-CV	L-Skew	Discordancy	Distance
53017 (Boyd @ Bitton)	35	0.25	0.13	0.08	0.81

Bourne Brook viaduct reviewed pooling group

Station	Years of data
43019 (Shreen Water @ Colesbrook)	35
41028 (Chess Stream @ Chess Bridge)	44
36010 (Bumpstead Brook @ Broad Green)	41
41020 (Bevern Stream @ Clappers Bridge)	39
52015 (Land Yeo @ Wraxall Bridge)	29
45013 (Tale @ Fairmile)	24
31025 (Gwash South Arm @ Manton)	30
30015 (Cringle Brook @ Stoke Rochford)	29
40017 (Dudwell @ Burwash)	39

Station	Years of data
36009 (Brett @ Cockfield)	38
41016 (Cuckmere @ Cowbeech)	41
28058 (Henmore Brook @ Ashbourne)	12
20002 (West Peffer Burn @ Luffness)	41
39033 (Winterbourne st @ Bagnor)	42
53017 (Boyd @ Bitton)	35
Total	519

Bourne Brook viaduct heterogeneity - following review

3.5.3 The pooling group was found to be strongly heterogeneous. Review of alternative sites indicate it is unlikely the quality of the pooling group will be improved by using stations further down the list generated in WinFap.

Bourne Brook viaduct goodness of fit details

Fitting	Z values
Generalised Logistic	3.33
Generalised Extreme Value	0.41
Pearson Type III	0.48
Generalised Pareto	-5.60

The permeable adjustment method assumes that the flood growth curve follows a Generalised Logistic distribution. On average the Generalised Logistic distribution is considered to perform better than the GEV for pooled growth curve derivation. In this instance the Generalised Logistic distribution has been selected.

Bourne Brook viaduct growth curves

Flood event	Rural (GL)	Urban (GL)
1 in 2 (50%)	1.000	1.000
1 in 10 (10%)	1.685	1.668
1 in 20 (5%)	1.962	1.943
1 in 50 (2%)	2.352	2.332
1 in 75 (1.33%)	2.537	2.516
1 in 100 (1%)	2.672	2.653
1 in 200 (0.5%)	3.018	3.002
1 in 1000 (0.1%)	3.939	3.942

Bourne Brook viaduct growth curve parameters

Growth curve	Location	Scale	Shape	Bound
Rural GL	1.00	0.27	-0.12	-1.24
Urban GL	1.00	0.26	-0.13	-1.02

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X66