HIGH SPEED RAIL (LONDON - WEST MIDLANDS)

Supplementary Environmental Statement 3 and Additional Provision 4 Environmental Statement

Volume 5 | Technical appendices

Off-route

(HEX-CH-002, HEX-CH-003, HEX-WR-001,
HEX-WR-002, HEX-EC-001, EC-001-005)

October 2015

SES3 and AP4 ES 3.5.1.14

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Department for Transport

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1 Introduction

1.1.1 This appendix provides descriptive information for the Heathrow Express Depot Langley scheme relating to identified designated and non-designated heritage assets that lie within the following study areas:

- designated assets: within the additional land required for the construction of the scheme and the 500m study area; and
- non-designated assets (identified by the Heritage Gateway and Buckinghamhsire Historic Environment Record): within the additional land required for the construction of the scheme, the 500m study area.

2 Gazetteer

Table 1 : Gazetteer of heritage assets for HEx

Unique ID	Map reference	Asset type	Name	Description	Period	Designation	Grade	Significance/value	NHL reference	HER/Heritage Gateway Ref.
LAN041	CH-01-HEx	Historic Landscape / Archaeology	1603 Extent of Langley Park	Langley Park was first mapped in 1603. The parkland was recorded as containing various woodland enclosures with extensive areas of lawn and fallow deer. Parts of the 1603 parkland may predate the post medieval period. Below ground archaeological remains associated with the parkland include park pales (boundaries) and hunting features, may survive. The area has been designated as an Archaeological Priority Area by Buckinghamshire County Council.	Post medieval	Archaeology priority area	N/a	Moderate	N/A	0162504000
LAN042	CH-01-HEx	Historic Landscape	Langley Park	A deer park is first mentioned at Langley Marish in 1202, continuing in	Post medieval	Registered park and garden	II	Moderate	1000603	N/A

				use throughout the Middle Ages. In 1603 Sir John Kederminster was appointed Chief Steward of the Manor of Langley Park, and shortly after replaced the hunting lodge with a house, red-brick stables and outbuildings. In 1626 the park and manor were granted to Sir John, ceasing to be Crown property. The park was sold in 1738 to Charles Spencer, third Duke of Marlborough who used it as a hunting lodge until, in 1756, he commissioned Stiff Leadbetter to build the present house, finished in 1760. His son George, the fourth Duke, succeeded in 1758 and commissioned Lancelot Brown (1716-83) to landscape Langley Park.						

LAN043	CH-01-HEx	Building	Manor House, Middle Green	18th century three storey, red brick house.	Post medieval	Listed building	II	Moderate	1125032	N/A
LAN044	CH-01-HEx	Building	The Priory, Middle Green	18th century two storey, red brick house.	Post medieval	Listed building	II	Moderate	1166279	N/A
LAN045	CH-01-HEx	Building	Lodge to Manor House, Middle Green	Early 19th century Gothic style lodge.	Post Medieval	Listed building	II	Moderate	1166307	N/A
LAN046	CH-01-HEx	Building	Entrance Lodge and Gate to Langley Park	18th century octagonal lodge, with attached iron railings and gate.	Post medieval	Listed building	II	Moderate	1308997	N/A
LAN047	CH-01-HEx	Building	Home Cottage, Middle Green	17th century timber framed house.	Post medieval	Listed building	II	Moderate	1332430	N/A
LAN048	CH-01-HEx	Building	The Marish, Middle Green	18th century two storey, red brick house.	Post medieval	Listed building	II	Moderate	1125030	N/A

Environmental topic:	Cultural heritage	CH
Appendix name:	Impact assessment table	003
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1 Introduction

1.1.1 This appendix provides new cultural heritage impact assessment tables for the SES3 and AP4 ES Volume 4 Off-route effects that were not included in the SES and AP2 ES Volume 4 Off-route effects. Details on the assignment of values and the assessment of the scale of impacts are set out in the Scope and Methodology Report (Volume 5: Appendix CT-001-000/1) and the Scope and Methodology Report Addendum (Volume 5: Appendix CT-001-000/2).

2 Impact assessment

Table 1 : Impact assessment for HEx

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different likely significant environmental effect from that reported in the main ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
LAN041	1603 Extent of Langley Park	Archaeology Priority Area	Moderate	The asset is within the area required for the construction of the ecology mitigation. The earthworks associated with the construction of the water features and other ecological mitigation features may potentially remove archaeological features associated with the former user of the park and will alter the appreciation of the setting and historic context of wider parkland remains	Medium	Moderate adverse	No impact on value of assets	No change	Neutral	New environmental effect.
LAN042	Langley Park	Registered Park and Garden	Moderate	No impact on value of asset.	No change	Neutral	No impact on value of assets	No change	Neutral	No new or different significant environment effects have been identified.
LAN043	Manor House, Middle Green	Listed Building	Moderate	No impact on value of asset.	No change	Neutral	No impact on value of assets	No change	Neutral	No new or different significant environment effects have been identified.
LAN044	The Priory, Middle Green	Listed Building	Moderate	No impact on value of asset.	No change	Neutral	No impact on value of assets	No change	Neutral	No new or different significant environment effects have been identified.

Unique identification	Name	Designation(s)	Value	Construction impact			Operation impact			New or different likely significant environmental effect from that reported in the main ES
				Nature of impact including mitigation	Scale of impact	Effect	Nature of impact including mitigation	Scale of impact	Effect	
LAN045	Lodge to Manor House, Middle Green	Listed Building	Moderate	No impact on value of asset.	No change	Neutral	No impact on value of assets	No change	Neutral	No new or different significant environment effects have been identified.
LAN046	Entrance Lodge and Gate to Langley Park	Listed Building	Moderate	No impact on value of asset.	No change	Neutral	No impact on value of assets	No change	Neutral	No new or different significant environment effects have been identified.
LAN047	Home Cottage, Middle Green	Listed Building	Moderate	No impact on value of asset.	No change	Neutral	No impact on value of assets	No change	Neutral	No new or different significant environment effects have been identified.
LAN048	The Marish, Middle Green	Listed Building	Moderate	No impact on value of asset.	No change	Neutral	No impact on value of assets	No change	Neutral	No new or different significant environment effects have been identified.

Environmental topic:	Water resources and flood risk assessment	WR
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1 Introduction

1.1 Scope of this assessment

1.1.1 This Flood Risk Assessment (FRA) report describes the assessment of flood risk to and from the proposed Heathrow Express (HEx) Rail Depot Relocation in Langley, Slough and provides the results and findings of the assessment. The scheme comprises a rail depot, railway line and associated rail embankments.

1.1.2 The FRA includes an assessment of the baseline flood risk to the study area and assesses the potential impacts on flood risk elsewhere due to the proposed scheme. The assessment indicates that the proposed scheme has the potential to impact flood risk to third parties and local receptors due to development within the floodplain. In order to prevent an increase of flood risk to third parties and local receptors due to the proposed scheme, mitigation measures in the form of replacement floodplain storage and a flood defence are proposed.

1.1.3 It is noted that the design of the proposed scheme and mitigation measures to date provide the level of detail necessary for the purposes of the Bill and the requirements of the Environmental Impact Assessment Regulations. The level of detailed design necessary to enable the scheme to be constructed has yet to be carried out, and will not be completed until after the Bill has secured Royal Assent.

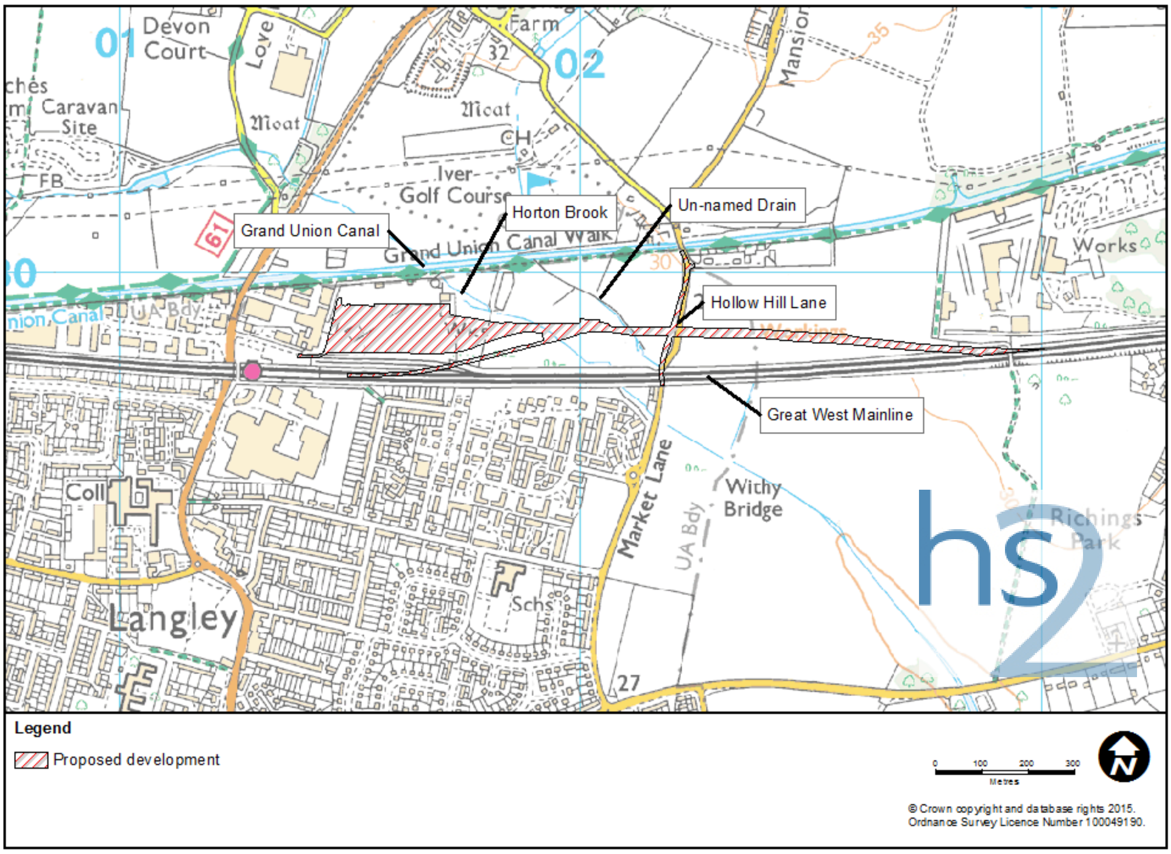
1.1.4 The assessment has been carried out in accordance with the requirements of the National Planning Policy Framework (NPPF, 2012) and associated Planning Practice Guidance (PPG, published 2014 and updated March 2015) which aims to prevent inappropriate development in areas at risk of flooding and to ensure that, where development is necessary in areas at risk of flooding, it is safe without increasing flood risk elsewhere.

1.2 Location

1.2.1 The scheme is located in Langley, Slough near Grid Reference TQ 01880 79885 (nearest post code SL3 8YG). The site is bounded by the Grand Union Canal to the north, Hollow Hill Lane to the east, the Great Western Main Line to the south, and the Canal Wharf Industrial Estate and Langley railway station to the west (see Figure 1). The site area lies within Slough Borough Council administrative area, but is bounded to the north and east by South Buckinghamshire District Council.

1.2.2 The proposed route and depot will cross two water features within the study area including the Horton Brook and an un-named drain.

Figure 1 : Study area



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, including surface water, groundwater, rivers, sewers, artificial sources such as impounded reservoirs and canals, or tidal flooding.

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 and outputs from site specific hydraulic modelling that show the spatial distribution of flood risk. The associated risk magnitude is then categorised.

2.1.3 Receptors considered in this assessment include the scheme and any potential receptors that may be impacted due to the construction of the scheme. This correlates to the area upstream of the scheme to Station Road (B470) and downstream to Market Lane. The scheme includes all associated 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 proposed in line with recommendations in the NPPF.

2.1.4 Existing receptors within the study area are identified using Ordnance Survey (OS) mapping information. A high-level screening assessment is then undertaken to identify receptors that are within or in close proximity to an area of flood risk via pathways indicated using the flood risk data sources listed below. The vulnerability of each receptor is classified using Table 2: Flood Risk Vulnerability Classification of the NPPF PPG[1].

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: Flood Risk Vulnerability and Flood Zone 'Compatibility' of the NPPF PPG and assesses whether the scheme has any potential to influence or alter the risk of flooding to each receptor. Where such potential has been identified, mitigation is proposed based on further analysis.

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.

[1] Department for Communities and Local Government (DCLG) *Planning Practice Guidance web-based resource for the National Planning Policy Framework*, published online 06 March 2014 and updated in March 2015.

Table 1 : Flood risk category matrix for all flooding sources

Source of flooding	**Flood risk category**				
	No risk	**Low**	**Medium**	**High**	**Very high**
Rivers	-	Flood Zone 1	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
Surface water	No surface water flooding.	Surface water flooding <0.3m for 1 in 200 years event.	Surface water flooding >0.3m for 1 in 200 years event; and Surface water flooding <0.3m for 1 in 30 years event.	Surface water flooding <0.3m for 1 in 30 years event.	-
Groundwater	-	Very low to low	Moderate	High to very high	-
Drainage and sewer systems	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	Outside of inundation mapping/no pathway exists.	Within inundation mapping/pathway exists	-	-	-

3 Data sources

3.1 Primary datasets

3.1.1 Consistent with the requirements of the NPPF, the assessment considers the risk of flooding from rivers, surface water, groundwater, drainage, tidal sources, sewer systems and artificial sources such as reservoirs, lakes and canals.

3.1.2 The scheme is not at risk of flooding from the sea, as the site is located over 70km from the south coast of England, and over 20km upstream (west) of the normal tidal boundary of the River Thames at Teddington Lock.

3.1.3 The primary data sets for each source of flooding used to assess the design elements are presented in Table 2. A high-level review of the risk of flooding and potential impacts is undertaken on the basis of these datasets across all flooding sources. Where this review indicates potentially significant impacts on the risk of flooding, or a risk of flooding to the route, further investigation in the form of hydraulic modelling is undertaken.

Table 2 : Flood risk assessment data sources

Source of flooding	Datasets reviewed	Data owner
Rivers	Flood zone mapping. Detailed River Network (DRN). Catchment hydraulic models. Site specific detailed hydraulic model.	Environment Agency Model produced for this FRA
Surface water	Updated Map for Risk of Flooding from Surface Water	Environment Agency
Groundwater	1:50,000 geological mapping (superficial and bedrock) Areas susceptible to Groundwater flooding	British Geological Society (BGS) EA Slough Borough Council
Drainage and sewer systems	Sewer network plans. Lost river location plans.	Water companies (various) Local planning authority
Artificial sources	Risk of flooding from reservoirs Canal infrastructure locations. Trunk water main asset plans.	Environment Agency Canal & River Trust Water companies (various)

3.2 Site familiarisation visits

3.2.1 A site visit was undertaken on 31 March 2015 at the Horton Brook and surrounding catchment. This site visit covered the area of the scheme, extended upstream to where the Horton Brook crosses the B470 (Langley Park Road) and downstream to Withy Bridge on the Horton Brook. The site visit also included the Slough Arm of the Grand Union Canal between the B470 (Langley Park Road) and Hollow Hill Lane. Data collected from the site visit was used to improve the understanding of flow paths and critical hydraulic structures in the catchment, and to inform the hydraulic model build.

3.3 Hydraulic modelling

3.3.1 As part of this FRA, updated hydrological analysis and bespoke site specific hydraulic modelling have been undertaken to gain a detailed understanding of flood risk at the study area. Further details of the hydrology and hydraulic modelling are provided in the Model Report (reference SES3 and AP4 Appendix HEX-WR-002).

4 Design criteria

4.1.1 It is a requirement of the design that the scheme shall be protected against flooding from any source during the 1 in 1000 year return period (0.1% Annual Exceedence Probability) event, with water levels not rising closer than 1m to the top of proposed rail level.

4.1.2 All culverts within the scheme will be designed to convey the 1 in 100 year (1%AEP) 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).

4.1.3 In accordance with HS2 guidelines, an allowance of climate change for Ordinary Watercourses (non-EA Main Rivers) is included in the assessment by assuming that peak river flows will increase by 30% due to the effects of climate change.

4.1.4 For the purposes of this FRA and the associated hydrology and hydraulic modelling as described in the Model Report, the proposed mitigation measures, watercourse diversion and culvert were tested as a "proof of concept" to understand the baseline, post-scheme and with-mitigation flood risk to the scheme and local receptors. During detailed design, the exact dimensions and configuration of these measures should be revisited.

5 Study area description and proposed development

5.1 Existing study area topography

5.1.1 The topography within the proposed area is generally flat, with typical ground levels ranging from 25.0mAOD at the south of the site (just north of the railway line) to 27.8mAOD at the north of the site (just south of the canal). Various areas of the site rise to higher ground levels, for instance a steep rise in the north east corner of the site, where ground levels rise to over 30mAOD, and to nearly 29mAOD at the western site extent.

5.1.2 Various raised land features affect the flow paths of floodwater overtopping the Horton Brook in the vicinity of the site, most notably:

- the Slough Arm of the Grand Union Canal at the northern site extent, with ground levels of the embankments of roughly 29.8mAOD in the site vicinity;
- the Great Western Main Line at the southern site extent, with ground levels of the railway embankments of roughly 30.8mAOD in the site vicinity;
- a raised crossing running north-south through the proposed site, with typical crest levels of 27.5mAOD where the Horton Brook is culverted beneath this raised area.

5.1.3 Various structures and culverts also restrict the flow of water in Horton Brook, including the culverts beneath the Grand Union Canal, the Great Western Main Line and various other smaller culverts. More detail about the existing culverts and their representation in the hydraulic model are provided in the Model Report.

5.2 Existing study area land use

5.2.1 The Horton Brook catchment, which rises in the vicinity of Iver Heath and flows in a south, south easterly direction towards the eastern part of Slough, is predominantly rural in the upper reaches of the catchment. Downstream of Slough, Horton Brook flows through the complex system of watercourses and wetlands in the area of the Colne Valley and eventually discharges into the River Thames.

5.2.2 The catchment of Horton Brook within the study area contains very few urban areas which include parts of Iver, Iver Heath, Shedding Green and the north of Langley. Most of the catchment is a mixture of grassland, arable, woodland (country parks) with some small water bodies.

5.2.3 The land use at the scheme is mostly rural, with open grassy fields and arable farmland. The Iver Heath Golf Course lies directly north of the site. Just south of the site is the Langley Business Centre and residential areas. Just west of the site is industrial land and to the east of the site lie farmland and a caravan park.

5.3 The scheme

5.3.1 The scheme comprises a rail depot, railway line and associated rail embankments within the Horton Brook floodplain between the Grand Union Canal and the existing Great Western Main Line. The Horton Brook will be diverted with a new culvert to be installed through the scheme embankment to allow flood flows to pass. The Hollow Hill Lane will be re-aligned and lowered beneath the proposed embankment of the HEx Langley proposed works.

5.4 Local flood risk receptors

5.4.1 The vulnerability of each local receptor with an identified pathway within the study area is presented in Table 3. The vulnerability is classified in accordance with the recommendations of Table 2 in the NPPF PPG.

Table 3 : Vulnerability of local receptors in study area

Local Receptor	**Description**	**Vulnerability Classification**	**Source/pathway**
Iver Heath Golf Course	Green open space with associated buildings	Less vulnerable	River flooding - Flood Zone 3 Surface water – high
Sawyers Green Farm	Agricultural land with residential property and farm buildings	Less vulnerable	River flooding Flood Zone 3 Surface water - low
Rosewood Kennels	Residential dwellings and associated buildings	Less vulnerable	River flooding - Flood Zone 2 Surface water - low
Grand Union Canal	Canal	Water-compatible development	River flooding – Flood Zone 1 Surface water – very low
Disused open fields/land between Grand Union Canal and Great Western Main Line	Green open space (no buildings)	Less vulnerable	River flooding - Flood Zone 3 Surface water – medium Black Park Lake
Agricultural land south of Grand Union Canal and west of Hollow Hill Lane	Agricultural land (no buildings)	Less vulnerable	River flooding - Flood Zone 3 Surface water – low Black Park Lake
Langley Connect	Industrial land	Less vulnerable	River flooding - Flood Zone 3 Surface water - medium
Great Western Main Line and Langley Station	Railway line	Essential infrastructure	River flooding - Flood Zone 3 Surface water – very low
Chequers Bridge Cottages	Residential dwellings and associated buildings	More vulnerable	River flooding - Flood Zone 2 Surface water – low Black Park Lake
Agricultural land east of Market Lane and south of Great Western Main Line	Agricultural land (no buildings)	Less vulnerable	River flooding - Flood Zone 3 Surface water – high Black Park Lake

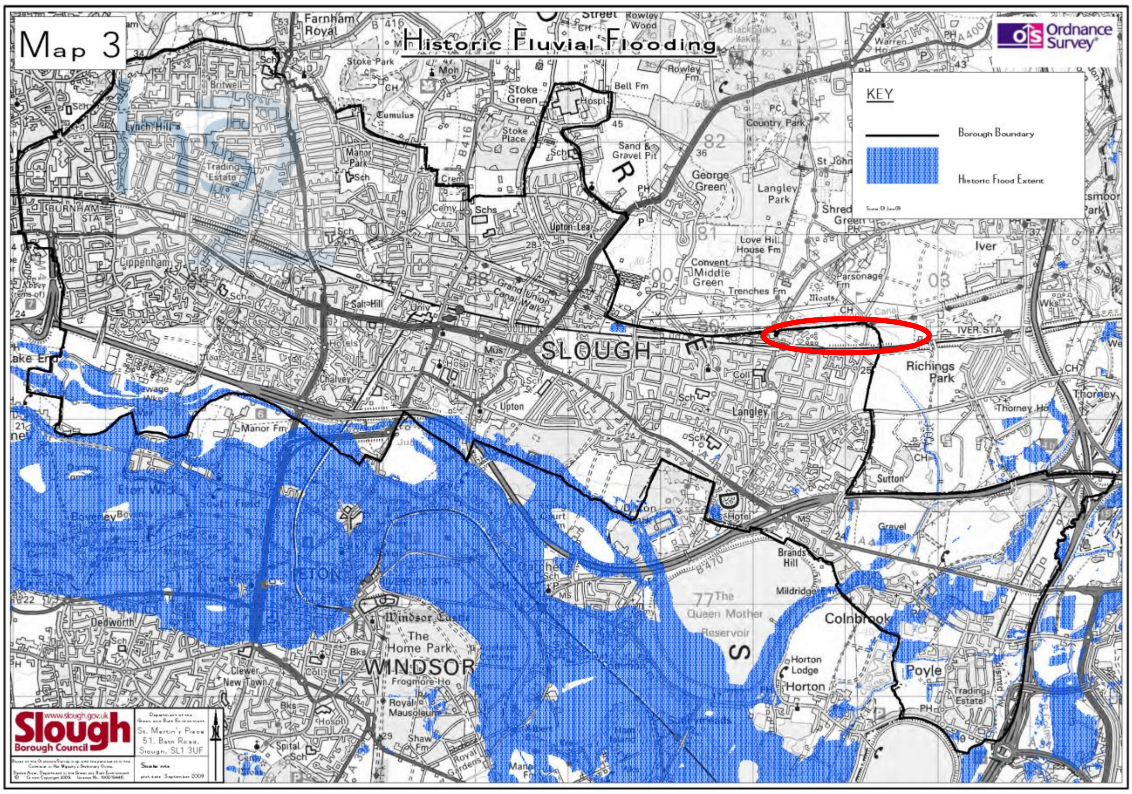
Source: Mott MacDonald, 2015.

6 Baseline flood risk to the development

6.1 Historical flooding incidents

6.1.1 The Slough Borough Council (SBC) Strategic Flood Risk Assessment (SFRA) identifies historical flooding events within SBC. The map in Figure 2 shows no recorded flooding events in the site vicinity.

Figure 2 : Historic flooding extents



Source: Slough Borough Council SFRA, 2012

6.2 Risk of flooding from rivers

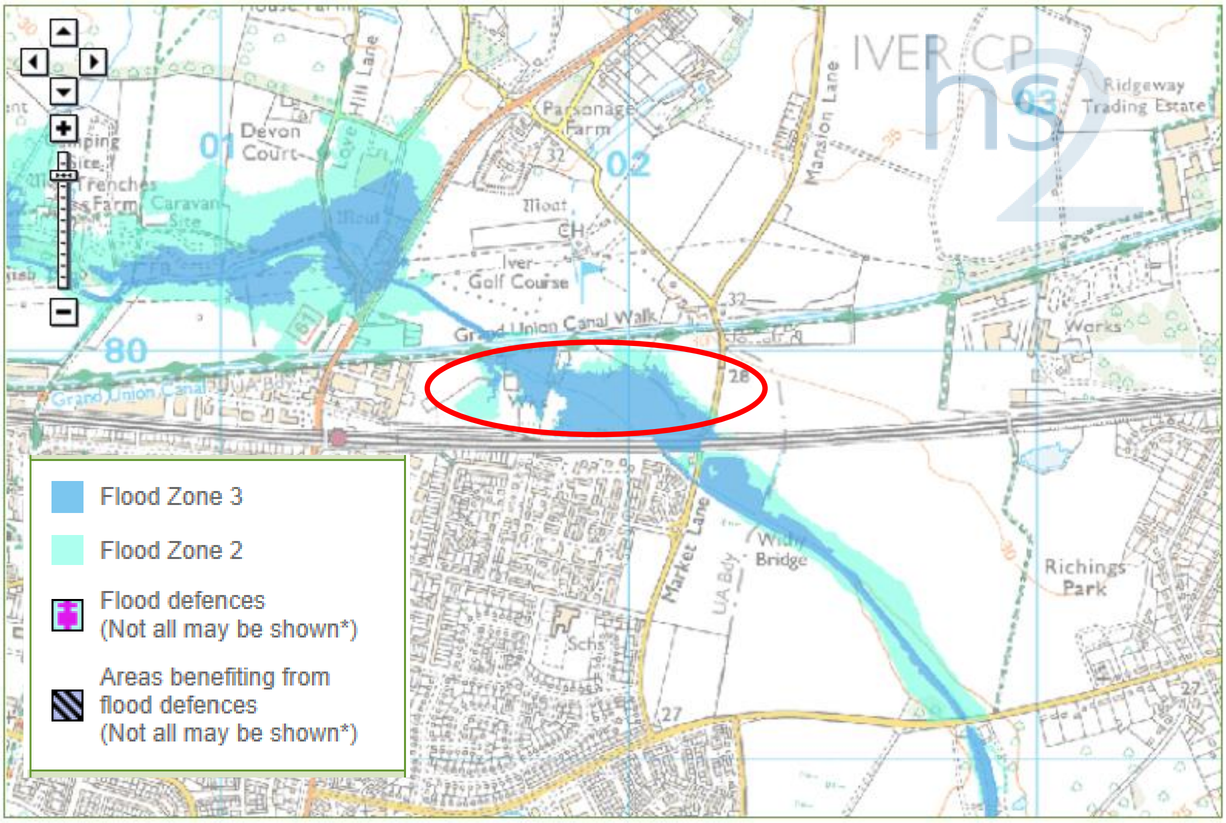
6.2.1 The Horton Brook runs through the scheme flowing from north west to south east. The Horton Brook is not a designated Environment Agency main river and is therefore considered an "ordinary watercourse" and is under the responsibility of Slough Borough Council as the Lead Local Flood Authority (LLFA).

6.2.2 A small, un-named drain is visible on OS Mapping data. The drain is shown to flow from north to south west of the scheme area. During the site visit, no water was noted within this watercourse. There is also no clear inflow or discharge point of this drain and therefore it is assumed to be a local drain with no clear conveyance. The risk of flooding from this source is considered to be small in comparison with the risk from Horton Brook.

6.2.3 The scheme crosses both the Horton Brook and the un-named drain, therefore crossing the associated flood zones related to these watercourses.

6.2.4 The Environment Agency Flood Zone map indicates that the scheme lies within an area designated as Flood Zone 3 (High Probability) and is therefore classified by Table 1: Flood Zones on the PPG web portal as 'land assessed as having greater than a 1 in 100 annual probability of fluvial flooding.' This indicates that the proposed site lies within an area defined as high risk of fluvial flooding.

Figure 3 : Environment Agency Flood Zone Map



Source: Environment Agency, 2015

Horton Brook

6.2.5 Upstream of the scheme, the Horton Brook has a catchment area of approximately 10.6km^2.

6.2.6 There are existing restrictions to the flow of water in the Horton Brook in the vicinity of the site, in the form of culverts beneath the Grand Union Canal and the Great Western Main Line. The dimensions of these structures were confirmed with topographical survey collected along the watercourse and other key structures on 31 March 2015.

6.2.7 These structures are critical for understanding flood risk to the site and the impact of the scheme. The site specific hydraulic modelling, described below, takes into account the impact of these structures on the flow and water levels on the Horton Brook.

Hydrology and hydraulic modelling

6.2.8 While the EA Flood Zone map provides an indication of the flood risk to the proposed site area, it does not provide adequate detail of flood levels at the proposed site. The EA have confirmed in writing that no detailed modelling exists for the area of Horton Brook between the canal and railway line. The Chalvey Ditches Modelling Study (JBA, 2009) includes a detailed assessment of the Horton Brook, but extends only from the upstream extent of Horton Brook to the canal.

6.2.9 In order to produce accurate flood levels suitable for a site specific assessment, detailed hydrology analysis and hydraulic modelling was undertaken for the Horton Brook. This included the commission of topographical channel survey of the Horton Brook and key structures to inform the hydraulic model build. Further details of the site specific modelling are provided in the Model Report.

6.2.10 According to the site specific modelling, the scheme will occupy approximately 18,070m^2 of Flood Zone 3 on Horton Brook.

6.2.11 The resulting flood levels at the scheme for a range of return periods is provided in Table 4 below.

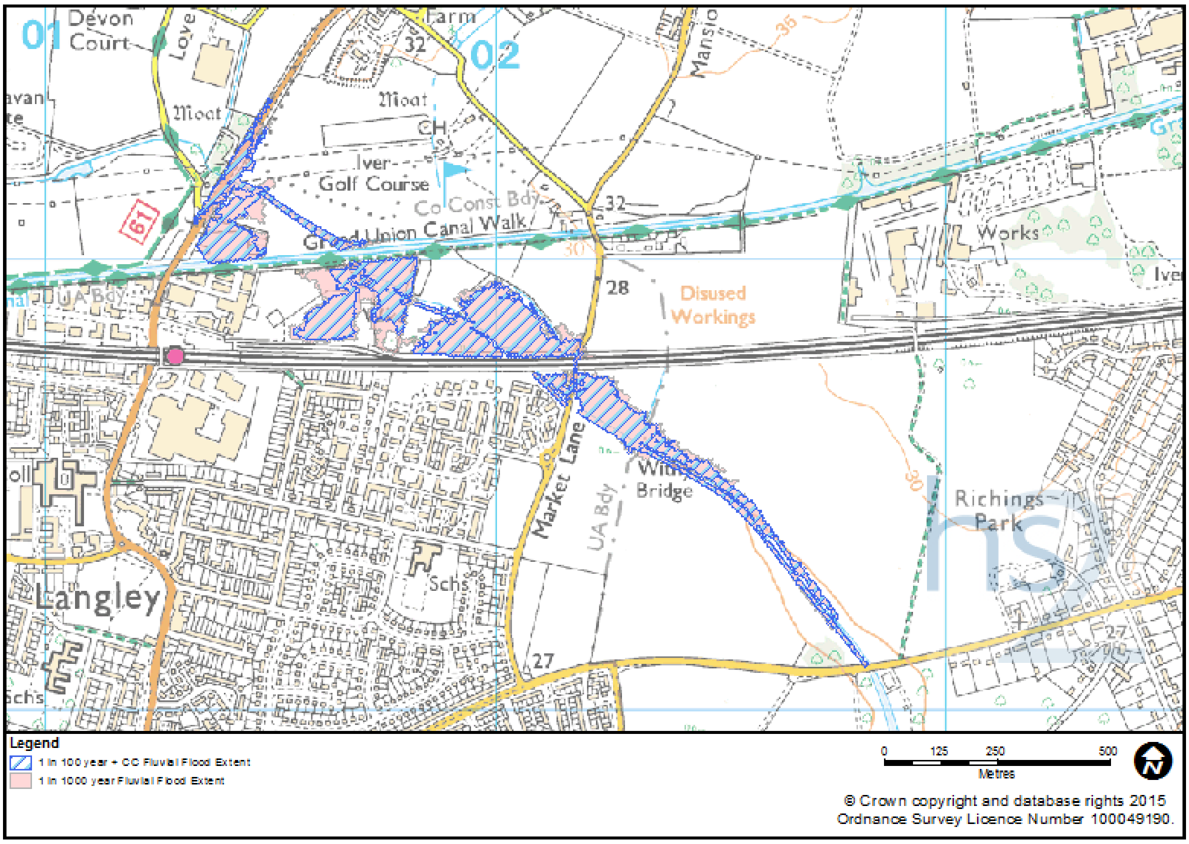
Table 4 : Baseline flood levels (pre-scheme) at scheme

Return period	Maximum flood level at scheme - just south of canal (mAOD)	Maximum flood level at scheme - just north of Great Western Main Line (mAOD)
2 year	26.17	25.32
20 year	26.58	25.63
100 year	26.93	25.83
1000 year	27.53	26.06
100 year including climate change (+30% flows)	27.23	25.95
1000 year including climate change (+30% flows)	27.60	26.11

Source: Mott MacDonald, 2015.

6.2.12 Figure 4 below shows the resulting baseline fluvial flood extents in the area of the scheme for the 100 year + CC and 1000 year events.

Figure 4 : Results from baseline hydraulic modelling - flood extents



Flood risk to the scheme

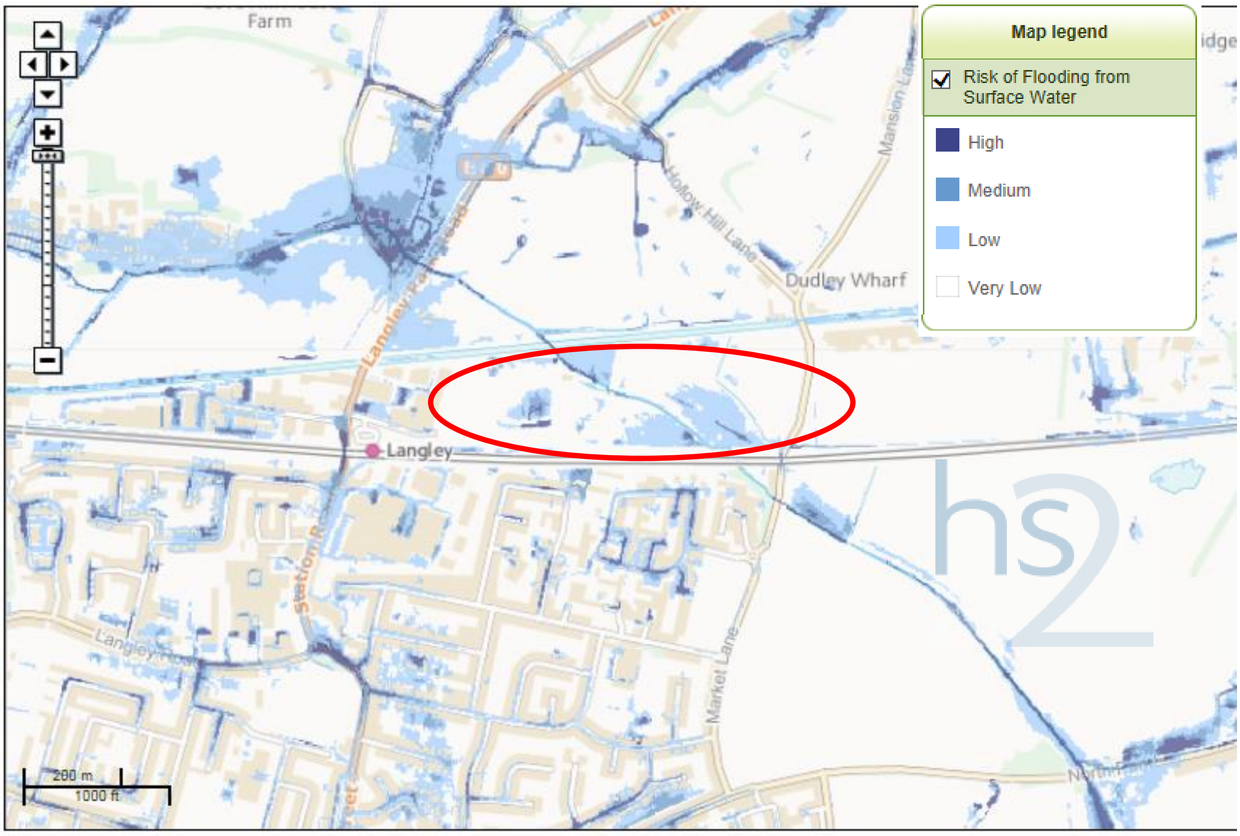
6.2.13 The whole of the scheme (shown on Figure 1) will be on a raised embankment that crosses the Horton Brook and associated floodplain, with a proposed culvert to convey the watercourse beneath the embankment. The top of rail level across the embankment is approximately 29mAOD. The embankment and associated works form an obstruction to flows.

6.2.14 The maximum water level upstream of the scheme for the 1 in 1,000 year return period (0.1% AEP) is approximately 27.5mAOD. Therefore, there will be a 1.5m freeboard of the top of rail level for this return period event. The scheme is therefore not at risk of flooding from the Horton Brook for events up to this magnitude and meets the design requirements (see Section 4.1).

6.3 Risk of flooding from surface water / overland flow

6.3.1 The Environment Agency Risk of Flooding from Surface Water map provides a broad scale indication of flood risk from surface water / overland flow. This mapping indicates that the scheme is at risk from surface water, with the risk ranging from high to very low.

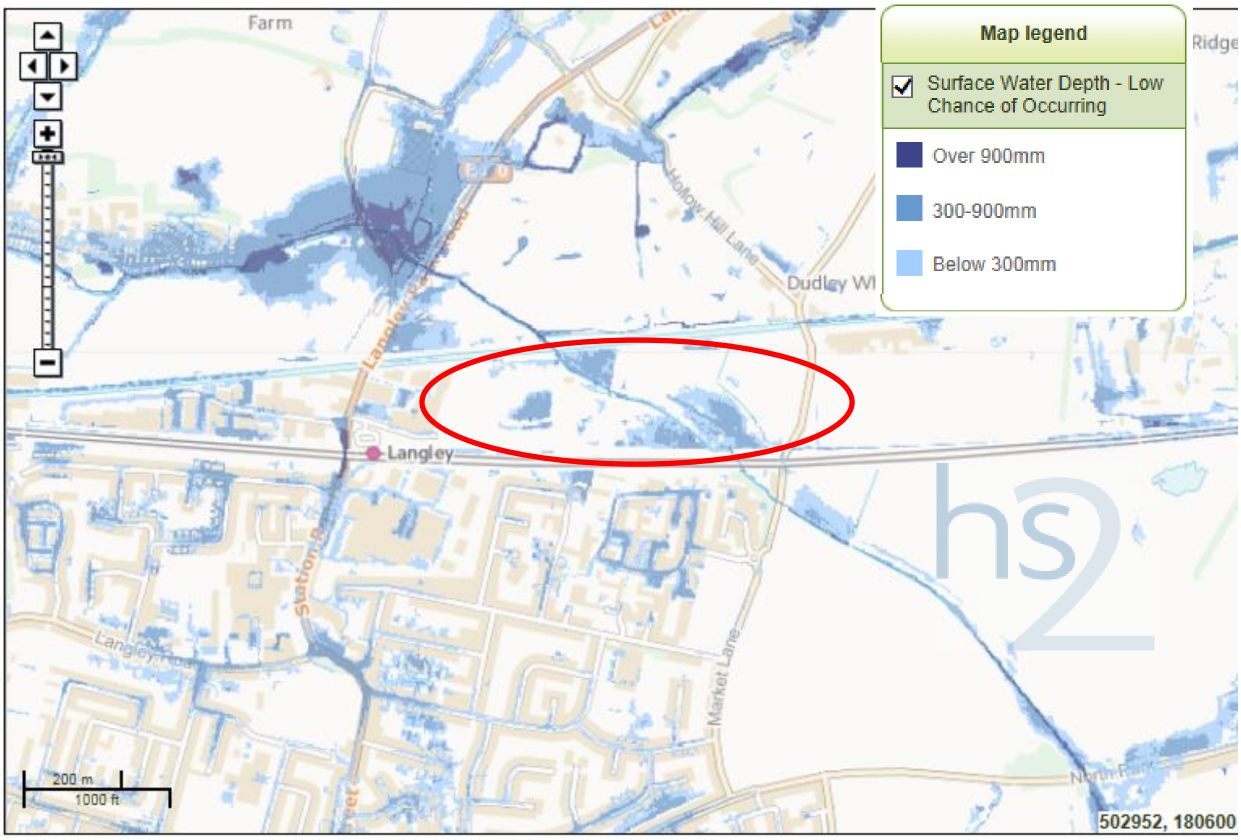
Figure 5 : Environment Agency risk of flooding from surface water map



Source: Environment Agency, 2015

6.3.2 The Environment Agency Surface Water Depth Mapping Indicates that during a low risk event (with a probability of flooding between 1 in 1000 (0.1%) and 1 in 100 (1%) each year), the depth of flooding may range from below 300mm to over 900mm deep.

Figure 6 : Environment Agency Surface Water Flooding Depth Map



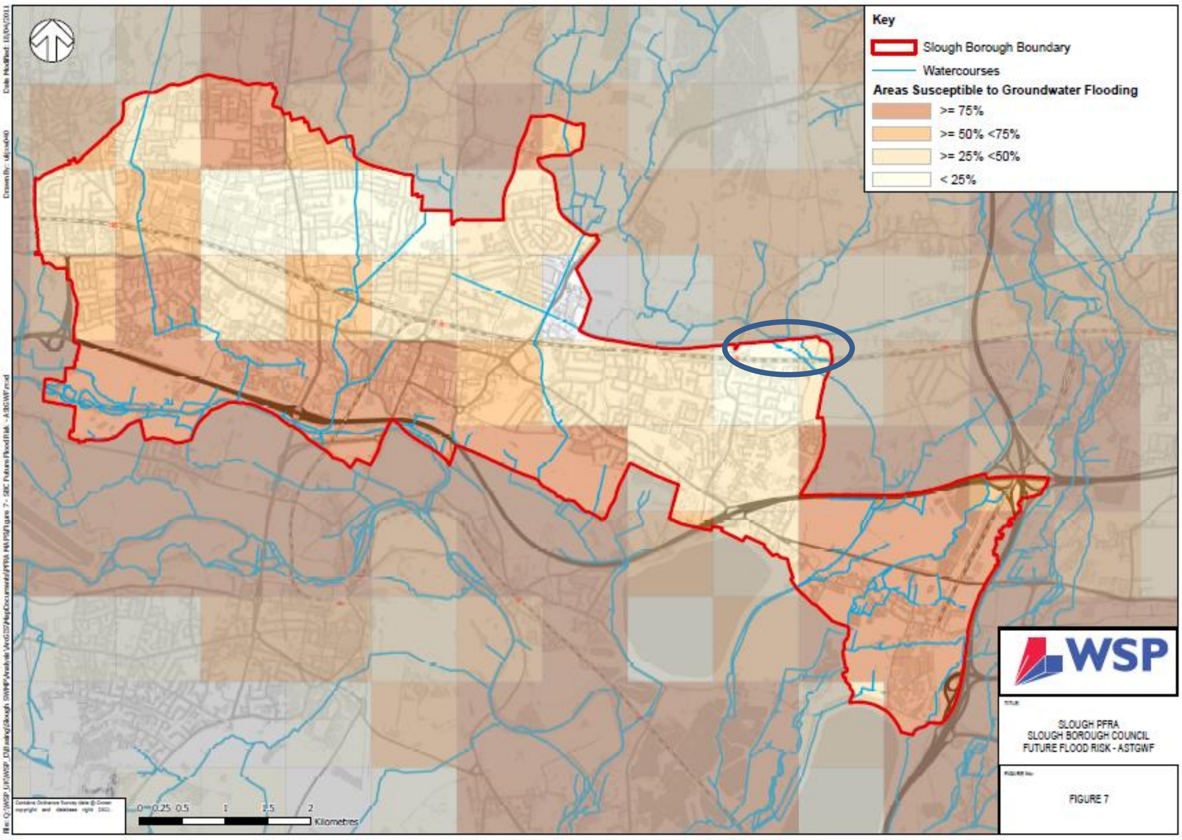
Source: Environment Agency, 2015

6.3.3 Due to the raised nature of the proposed development, the risk of flooding from surface water flooding to the proposed development is low, and therefore mitigation for this risk is not required.

6.4 Risk of flooding from groundwater

6.4.1 According to the SBC Preliminary Flood Risk Assessment (PFRA) prepared in 2011, the Environment Agency's areas susceptible to groundwater flooding mapping indicates the scheme to be located in an area with low to moderate susceptibility to groundwater flooding (<25% up to 50% of the 1km tile where the scheme lies is within an area potentially at risk of groundwater flooding).

Figure 7 : Areas susceptible to groundwater flooding



Source: Slough Borough Council PFRA, 2011

6.4.2 The Slough BC PFRA does not have any recorded historical incidents of groundwater flooding within the area of the scheme.

6.4.3 As the proposed works are on a raised embankment, the risk of flooding from this source is low, and therefore no further mitigation is required.

6.5 Risk of flooding from drainage systems

6.5.1 The scheme does not pass through any urban areas, and therefore the risk of flooding from urban drainage is expected to be low.

6.5.2 Due to the raised nature of the proposed development, the risk of flooding from drainage systems is low and therefore no mitigation is required.

6.6 Risk of flooding from artificial sources

6.6.1 Flooding from artificial sources can occur in the event of a failure of impounding or associated infrastructure, typically from reservoirs, canals or lakes. It should be noted that flooding from these sources should be considered as a residual risk. Although the flood risk consequence from these sources is potentially severe, the likelihood of failure occurring is extremely low. Flood Emergency

Plans for the scheme should be produced to identify how emergency evacuation would be undertaken in the event of reservoir failure or breach or overtopping of the canal.

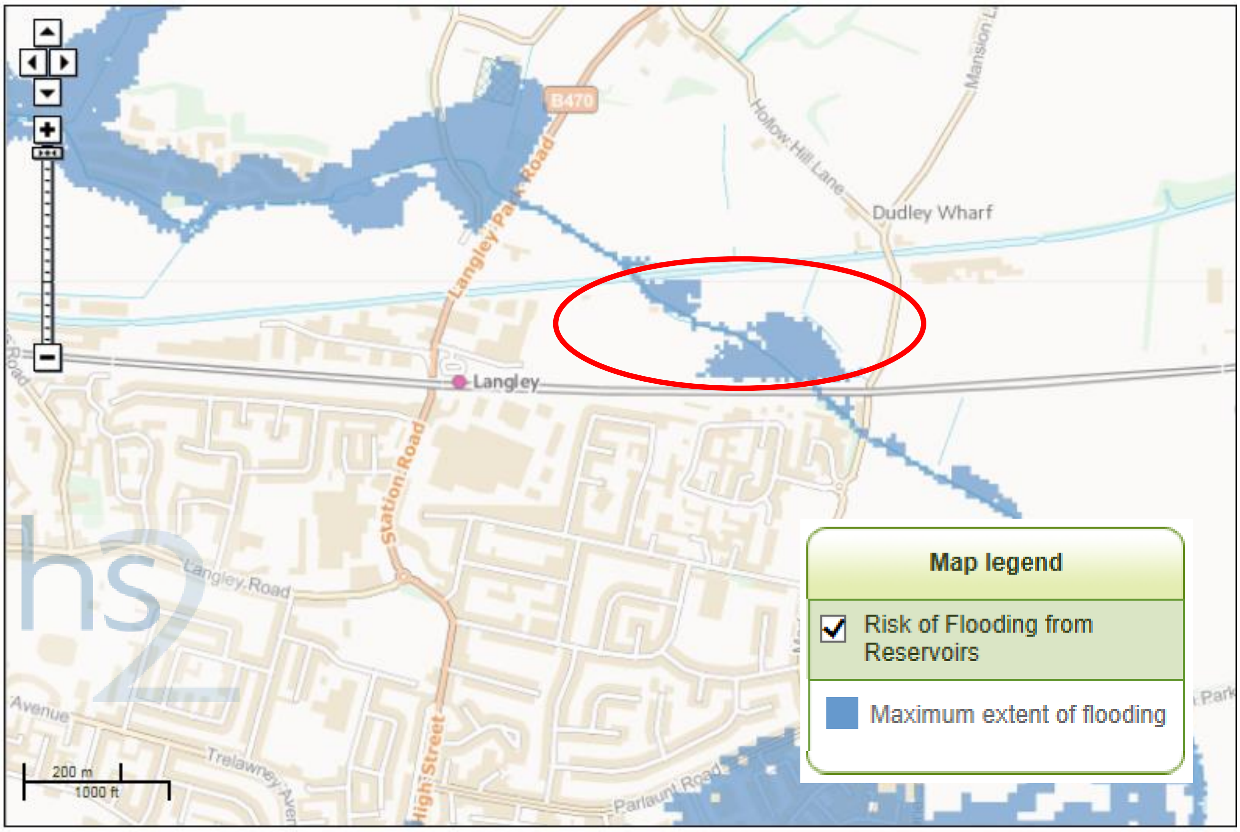
Reservoir failure

6.6.2 The scheme is within the maximum extent of flooding from reservoirs. The risk at the scheme is from Black Park Lake, owned by Buckinghamshire County Council, which is located over 4km upstream of the scheme. It is noted that these maps do not show the complete residual risk of failure as they do not show inundation for all possible failure types and locations.

6.6.3 Given the unlikely nature of risk of reservoir breach, the risk of flooding from reservoirs is considered to be low.

6.6.4 The potential risk of flooding from reservoir failure, based on the EA reservoir inundation mapping, indicates that the resulting flood levels are unlikely to exceed the levels of the raised embankment at the scheme. Therefore, no further mitigation is required to protect against the risk of reservoir failure.

Figure 8 : Risk of flooding from reservoirs



Source: Environment Agency, 2015

Canal breach

6.6.5 The Slough Arm of the Grand Union Canal is located on the northern boundary of the study area. The Canal is managed by the Canal and River Trust (CRT). The Slough Arm is a short canal branch connecting the Grand Union Main Line to Slough originally engineered to serve the brick-making industry. The stretch was re-opened in 1975.

6.6.6 Due to the raised nature of the water levels in the canal, there is a risk of flood risk to the scheme if the canal embankments were to breach or be overtopped during an extreme event. The LIDAR data indicates that at the time the LIDAR data was collected, water level in the canal was approximately 29.4-29.6mAOD. Therefore the water levels in the canal are raised approximately 0.4-0.6m above the proposed level of the track (29.0mAOD).

6.6.7 According to a response provided by the CRT in July 2015, a general inspection of the embankment is conducted monthly with an annual engineering inspection. The CRT state that based on the most recent inspections, they do not note any areas of concern on these embankments.

6.6.8 The south bank canal is considered by CRT to be a non-principal embankment with a consequence of failure score of 4 on a scale of 1 (single minor injury) to 5 (multiple deaths). The secondary flooding impacts are therefore identified to have the potential to flood a small community (groups of >4 houses or >1 commercial operation) and flow across A class roads.

6.6.9 This information would suggest that the potential consequence of failure of the canal embankment is severe; however, the likelihood of such an event is very low.

6.6.10 A breach of the Grand Union Canal could potentially cause flooding above the proposed level of the railway embankment. In the event of a breach, water velocities are potentially high and the volume of water from the canal pound could be extensive. However, the likelihood of occurrence of a breach of the canal embankment is low given the regular maintenance regime of the southern embankment. Given the low likelihood of canal breach or failure, further mitigation measures are not proposed against this risk. However, an emergency plan should be prepared to address this potential risk.

6.7 Summary of baseline flood risk

Table 5 : Summary of baseline flood risk

Source of Flooding	Location of Flooding Source	Flood Risk Category
Tidal	Not applicable	Low
River	Horton Brook	High
River	Un-named Drain	Unknown, but smaller risk that from Horton Brook
Surface Water	Rainfall/overland flow	High
Groundwater	Groundwater emergence	Low to moderate
Flooding from sewers and drains	Local sewer or drainage networks	Low
Artificial - reservoirs	Black Park Lake	Low
Artificial - canals	Grand Union Canal - Slough Arm	Low

Source: Mott MacDonald, 2015

7 Future flood risk and mitigation (post-development)

7.1 Local receptors

7.1.1 In addition to the risk of flooding that exists to the scheme, there is potential for the scheme to affect the risk of flooding to third party receptors by altering flow volumes and mechanisms across the range of flood sources. All local receptors with a potential flood risk are identified in Section 5. For the scheme to have an impact on a given receptor, the identified pathway for that receptor must be shared by both the subject receptor and the scheme. Table 6 summarises the shared pathways between the scheme and each receptor and identifies cases where no shared pathway exists.

Table 6 : Shared flood risk pathways

Local receptor	Vulnerability classification	Source/pathway	Shared pathway between scheme and receptor
Iver Heath Golf Course	Less vulnerable	River flooding - Flood Zone 3 Surface water – high	Potential increase in fluvial flood risk due to scheme.
Sawyers Green Farm	Less vulnerable	River flooding Flood Zone 3 Surface water - low	Potential increase in fluvial flood risk due to scheme.
Rosewood Kennels	Less vulnerable	River flooding - Flood Zone 2 Surface water - low	Potential increase in fluvial flood risk due to scheme.
Grand Union Canal	Water-compatible development	River flooding – Flood Zone 1 Surface water – very low	No shared pathway
Dis-used open fields/land between Grand Union Canal and Great Western Main Line	Less vulnerable	River flooding - Flood Zone 3 Surface water – medium Black Park Lake	Potential increase in fluvial and surface water flood risk due to scheme.
Agricultural land south of Grand Union Canal and west of Hollow Hill Lane	Less vulnerable	River flooding - Flood Zone 3 Surface water – low Black Park Lake	Potential increase in fluvial and surface water flood risk due to scheme.
Langley Connect	Less vulnerable	River flooding - Flood Zone 3 Surface water - medium	Potential increase in fluvial flood risk due to scheme
Great Western Main Line and Langley Station	Essential infrastructure	River flooding - Flood Zone 3 Surface water – very low	Potential increase in fluvial flood risk due to scheme
Chequers Bridge Cottages	More vulnerable	River flooding - Flood Zone 2 Surface water – low Black Park Lake	Potential increase in fluvial flood risk due to scheme
Agricultural land east of Market Lane and south of Great Western Main Line	Less vulnerable	River flooding - Flood Zone 3 Surface water – high Black Park Lake	Potential increase in fluvial flood risk due to scheme
Re-aligned Hollow Hill Lane	Essential infrastructure	River flooding - Flood Zone 3	Potential increase in fluvial flood risk due to scheme

Source: Mott MacDonald, 2015

7.1.2 Though designed such that the probability of the scheme flooding in any given year is less than 1 in 1,000, any change to the baseline risk of flooding (compared to the pre-scheme, existing conditions) could impact on the assessment of flood risk to the scheme. All cases of flood risk discussed in Section 6 of this report are therefore reconsidered regardless of the presence or otherwise of third party local receptors.

7.2 Impact on risk of flooding from rivers

7.2.1 The scheme crosses the Horton Brook, posing a restriction to flood flows, both within the channel and on the floodplain. The scheme will be on an embankment across the watercourse and associated floodplain. The Horton Brook will be diverted with a new culvert to be installed through the scheme embankment to allow flood flows to pass.

7.2.2 The key receptors that may be affected by this change are summarised in Table 6.

7.2.3 The potential effects of the scheme have been assessed using hydraulic modelling to understand the impact on water levels upstream and downstream of the scheme. A summary of the impacts on water levels is provided in Table 7 below.

Table 7 : Impact on water levels due to scheme, 1 in 100 year event + climate change

Location	Maximum change in flood level, 1 in 100 year (1%) including climate change (mm)	Post scheme 1 in 100 year (1%) climate change level (mAOD)	Total length of reach with increased water levels (m)
Upstream of grand union canal	+70	27.54	225
Dis-used open fields/land between Grand Union Canal and scheme Embankment	+100	27.30	213
Area between proposed embankment and Great Western Main Line	-30	25.98	124
Downstream Great Western Main Line	0	25.82	0

Source: Mott MacDonald, 2015

7.2.4 Due to the impacts identified in Table 7, mitigation in the form of replacement floodplain storage and a flood defence is proposed to minimise impact to local receptors. The mitigation measures and resulting impact to receptors is discussed further in Section 7.8.

7.3 Impact on risk of flooding from surface water

7.3.1 The scheme crosses the Horton Brook and an un-named drain. During a heavy rainfall event, surface water flows overland and collects in these water courses.

The scheme may prevent surface water runoff from flowing overland into these watercourses, and may instead cause it to back up behind the new embankment. The proposed diversion of Horton Brook and new culvert beneath the scheme railway embankment is designed collect and divert the extreme surface water runoff flows, such that the impact on the risk of surface water flooding is negligible, resulting in a neutral effect on local receptors.

7.3.2 On and off track drainage systems will be designed in accordance with the relevant design guides and regulations and consequently no increase in the risk of flooding arising from overloaded drains is anticipated. There is the potential for the site drainage system capacity to be exceeded during an extreme rainfall event. The system should be designed such that any excess drainage water not contained within the system is able to flow freely away from the track and scheme areas away from critical equipment.

7.4 Impact on risk of flooding from groundwater

7.4.1 The area of the scheme is shown to have low to moderate risk of groundwater flooding. The scheme will be on an embankment crossing the Horton Brook and associated low-lying area, and there will therefore be no impact on the risk of flooding from groundwater along these raised sections.

7.5 Impact on risk of flooding from drainage systems

7.5.1 The scheme will not pass through any urban areas. Highway drainage for all new or realigned roads will be designed in accordance with the relevant design guides and regulations and consequently no increase in the risk of flooding arising from overloaded highway drains is anticipated. The Hollow Hill Lane drainage on the re-aligned roadway will comprise a gravity system with a pump station and rising main just north of Chequers Bridge. The pumps will be sized accordingly using relevant design standards. Track drainage systems should be designed to minimise the potential risk of flooding from these sources.

7.6 Impact on risk of flooding from artificial sources

7.6.1 The scheme is within an area with a residual risk of impounded reservoir failure or canal breach. It is noted that these maps do not show the complete residual risk of failure as they do not show inundation for all possible failure types and locations. The scheme has been designed to have no significant impact on the risk of flooding from rivers and any mitigation measures employed apply equally to the effect on the risk of flooding from artificial sources. The Environment Agency reservoir inundation mapping only displays the residual risk of failure of artificial water bodies with a capacity above 25,000m^2, which are covered under Reservoirs Act 1975 (as amended by the Flood and Water Management Act 2010). The act requires the reservoir undertaker to maintain their reservoirs such that the annual probability of a breach of the reservoir is 1 in 50,000. Although there is a potential impact on the residual risk of flooding from the reservoir, the likelihood of such flooding occurring is low.

7.6.2 The CRT has provided information regarding the inspection and maintenance regime of the Grand Union Canal embankment at the north extent of the site area for the scheme. While the potential consequence of canal breach is potentially severe, the likelihood of breach of the canal embankment is low given the regular maintenance regime of the southern embankment.

7.6.3 The impact of the scheme on the actual risk of flooding from impounded reservoir failure or canal breach will be negligible.

7.7 Summary of potential impacts and effects on flood risk

7.7.1 The scheme has the potential to impact flood risk to third parties and local receptors. The proposed mitigation measures to address the impacts are described in the following Sections.

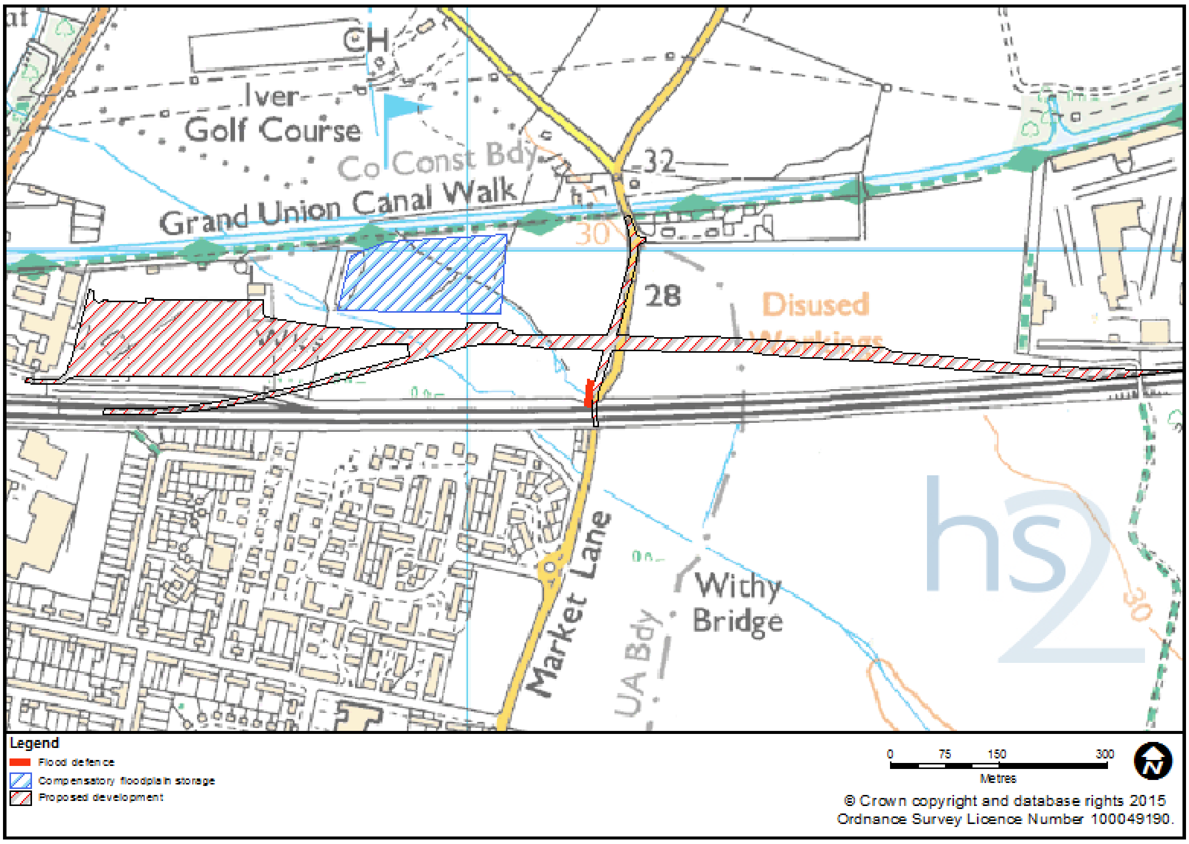
7.8 Proposed mitigation measures

7.8.1 The scheme will be raised above the 1 in 1000 year (0.1%AEP) peak flood level and is therefore not considered to be at risk from this event.

7.8.2 Replacement floodplain storage will be provided upstream of the scheme to mitigate for the volume of floodplain lost as a result of the proposed railway embankment (see Figure 9). The replacement floodplain storage upstream of the embankment will be located on the left bank of the Horton Brook, between the Grand Union Canal and the proposed railway embankment.

7.8.3 To reduce the increased risk of flooding on the proposed re-alignment of the Hollow Hill Lane, a flood defence will be provided to limit flood flows onto the Hollow Hill Lane. A figure showing the location of the replacement floodplain storage and proposed flood defence are shown on Figure 9.

Figure 9 : Proposed replacement floodplain storage and flood defence



7.8.4 Hydraulic modelling of the proposed mitigation measures shows that for the 1 in 100 year fluvial event under climate change conditions, the resulting impact of the scheme in combination with the proposed mitigation measures results in a null impact for fluvial flood risk on receptors outside of the scheme Area. Further details of the assessment are provided in the Model Report.

7.8.5 The design of the Proposed Scheme to date provides the level of detail necessary for the purposes of the Bill and the requirements of the Environmental Impact Assessment Regulations. The level of detailed design necessary to enable the Proposed Scheme to be constructed has yet to be carried out, and will not be completed until after the Bill has secured Royal Assent.

7.9 Summary of post-development flood risk, mitigation measures and local receptors

7.9.1 A number of potential pathways and receptors have been identified and summarised in Table 6.

7.9.2 Based on the potential impact of the scheme on the flood risk to local receptors, mitigation measures in the form of replacement floodplain storage and a flood defence are proposed.

7.9.3 Hydraulic modelling and further assessment of the post-scheme measures for all sources of flood risks shows that the scheme, in combination with the proposed mitigation measures, have a null impact on local receptors. Further details are provided in the Model Report.

8 Residual risks

8.1 Residual flood risk to scheme

8.1.1 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 risk from rivers

8.1.2 There is a risk of culvert blockage in the vicinity of the scheme. The culverts most likely to cause a detrimental impact on flood levels to the scheme are the existing culvert beneath the Great Western Main Line, and the proposed culvert beneath the scheme embankment.

8.1.3 Hydraulic modelling has been undertaken to understand the impact of potential blockage to flood levels in the vicinity of the scheme. Table 8 provides the outcome of the blockage on water levels at the scheme.

Table 8 : Residual risk of culvert blockage and impact on water levels

Location	Change in flood levels due to Grand Union Canal culvert blockage [70% blockage] (mm)	Change in flood levels due to West Main Line culvert blockage [70% blockage] (mm)	Change in flood levels due to proposed embankment culvert blockage [10% blockage] (mm)
Iver Heath Golf Course	0	0	0
Sawyers Green Farm	+250	+50	0
Rosewood Kennels	+250	+50	+10
Dis-used open fields/land between Grand Union Canal and scheme embankment	-760	+50	+20
Area between proposed embankment and Great Western Main Line	-260	+160	-10
Chequers Bridge Cottages	N/A	+50	0

Source: Mott MacDonald, 2015

8.1.4 As part of detailed design, it is recommended that appropriate provisions are made to minimise the risk of culvert blockage, such as installations of trash screens where appropriate. Guidance should be provided for vegetation maintenance, regular inspections of debris build-up, and other measures as part of an Operation and Maintenance Manual.

Residual flood risk from surface water and minor watercourses

8.1.5 All culverts within the scheme are to be designed with minimum internal headroom of 300mm above the design floodwater level to minimise the risk of blockage. It is therefore not expected that there be any significant increased risk of flooding from surface water or minor watercourses arising from potential blockage of new culverts.

Residual flood risk from groundwater

8.1.6 Groundwater levels rise and fall relatively slowly and for any change to occur in the risk of flooding from this source, below ground intervention is required. The risk of flooding from groundwater already considered therefore presents an absolute risk and there are no significant residual risks from this source.

Residual flood risk from drainage systems

8.1.7 There is a potential that the site drainage system capacity is exceeded during an extreme rainfall event, or that a drainage outfall is blocked. The system should be designed such that any excess drainage water not contained within the system is able to flow freely away from the track and scheme areas away from critical equipment.

Residual flood risk from artificial sources

8.1.8 The assessment of risk from reservoir failure and canal breach assumes the most extreme case of flooding from these sources, i.e. total failure or breach. Therefore it is considered that there are no further residual risks from these sources.

8.2 Residual effects of the scheme on flood risk

8.2.1 All culverts within the 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 risk arising from the introduction of culverts within the scheme.

8.2.2 The mitigation measures include a flood defence to limit flood waters from flowing onto the Hollow Hill Lane. If this flood defence were to fail, this would cause flooding onto Hollow Hill Lane, with potentially high velocities and flood hazard. An appropriate inspection and maintenance regime for the flood defence should be prepared to minimise the risk of failure. The mitigation scheme introduces replacement floodplain storage as part of the scheme. Guidance should be provided for vegetation maintenance, regular inspections of debris build-up, and other measures as part of an Operation and Maintenance Manual to ensure safe operation of the replacement floodplain storage at all times, including during times of flooding.

9 Conclusions

9.1 Summary

9.1.1 The scheme proposed as part of the Heathrow Express Depot relocation to Langley, Slough will comprise a rail depot and associated rail embankments within the Horton Brook floodplain between the Grand Union Canal and the existing Great Western Main Line.

9.1.2 The proposed route and depot will cross the Horton Brook and an un-named drain.

9.1.3 This assessment considers areas at risk of flooding from all sources, including tidal, fluvial, surface water, ground water, drainage systems and artificial sources.

9.1.4 The scheme has been designed to be at least 1m above design floodwater levels. Design standards are such that no flooding of the scheme is expected in the design flood events (events up to and including the 1 in 1000 year event including climate change) under normal operating conditions.

9.1.5 The scheme has been shown to be at low risk from surface water flooding, groundwater flooding, flooding from drains and flooding from artificial sources.

9.1.6 In order to prevent an increase of flood risk to third parties and local receptors due to the scheme, the following mitigation measures will be included:

- provision of replacement floodplain storage;
- flood defence to limit an increase in flooding to the re-aligned Hollow Hill Lane;
- design of culverts with internal headroom and allowances for siltation to minimise the changes of blockage or future capacity restrictions; and
- inclusion of a 30% allowance for climate change on all river flows.

9.1.7 Residual risks such as culvert blockage, failure of upstream reservoirs or canal breach or overtopping, pose an additional flood risk to the scheme; however, these risks are either unlikely to exceed the risk of fluvial flooding, or are beyond normal design standards as they are considered to be residual risks. Flood Emergency Plans for the scheme should be produced to identify how emergency evacuation would be undertaken, for instance in the event of a reservoir failure or breach of the canal.

9.2 Compliance with planning policy

Sequential test

9.2.1 The NPPF Sequential Test aims to steer new development to areas of the lowest probability of flooding. The NPPF states that only where there are no reasonably available sites in Flood Zones 1 or 2 should decision-makers consider the suitability of sites in Flood Zone 3, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

9.2.2 Since submission of the Hybrid Bill, it was determined that the relocation of the HEx depot to alternative locations within the North Pole Depot would affect the operation of the Intercity Express Programme (IEP) Depot and compromise the ability to maintain and operate the Great Western Main Line and/or preclude planned redevelopment in the area. Therefore, alternative site and local alternatives were identified and appraised by Network Rail, the Department of Transportation and HS2. Network Rail has considered alternative depot locations and appraised them using its Governance for Railway Investment Projects (GRIP) process, which considers environmental impacts, engineering requirements and cost. The alternatives considered are described within Section 6.6, main ES volume 4: Off-route effects.

9.2.3 The Langley location was identified as the preferred options because all of the other sites either:

- did not work in operational terms;
- were not of sufficient size;
- required significant additional works to the network;
- had significant planning constraints;
- had potential to disrupt other rail services; and/or,
- would be comparatively more costly to construct.

9.2.4 The Langley location was identified as the preferred option for operational reasons and could be constructed more quickly, and it was determined that the risk associated with construction within the floodplain could be mitigated through the design.

Exception test

9.2.5 The NPPF Exception Test is outlined in the NPPF as follows:

- it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared; and
- a site-specific FRA must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

9.2.6 The scheme and mitigation measures meet the design standards as set out previously in this report, and hydraulic modelling shows that the scheme and mitigation measures have no negative increase in flood risk outside of the proposed development area.

9.2.7 The scheme is therefore considered to meet the requirements of the Sequential and Exception Tests as set out in the NPPF.

10 References

Canal and River Trust (2014), *CRT Mandatory Standard: Asset Inspection Procedures (AIP2014), MS-Tech-9 Issue 5.*

Department for Communities and Local Government (2012), *National Planning Policy Framework.*

Department for Communities and Local Government (originally published in 2014 and updated March 2015), *Planning Practice Guidance web-based resource for the National Planning Policy Framework.*

Environment Agency, *Flood Map for Planning, Risk of Flooding from Reservoirs, Risk of Flooding from Surface Water*. http://apps.environment-agency.gov.uk/wiyby/default.aspx. Accessed July 2015.

JBA (2010), *Chalvey Ditches Flood Risk Mapping Study, Volume 2: Modelling Report.*

WSP (2011), *Preliminary Flood Risk Assessment, Slough Borough Council.*

WSP (2012), *Slough Surface Water Management Plan, Slough Borough Council.*

Environmental topic:	Water resources and flood risk assessment	WR
Appendix name:	Flood risk modelling	002
Community forum area:	Heathrow Express Depot, Langley	HEX

Contents

List of tables

Appendix A

List of figures

1 Introduction

1.1 Structure of the modelling report

1.1.1 This report is comprised of the following sections:

- Introduction;
- Hydrology;
- Baseline hydraulic modelling;
- Scheme scenarios;
- Conclusions; and
- Assumptions.

1.2 Scope of this assessment

1.2.1 This document presents an assessment of the fluvial flood risk from the Horton Brook at Langley, for the existing (baseline) and post-development (scheme) scenarios. A 1D-2D linked ISIS-TUFLOW site specific model has been developed in order to investigate the impact of the scheme within the floodplain and inform the Flood Risk Assessment (provided as a separate document).

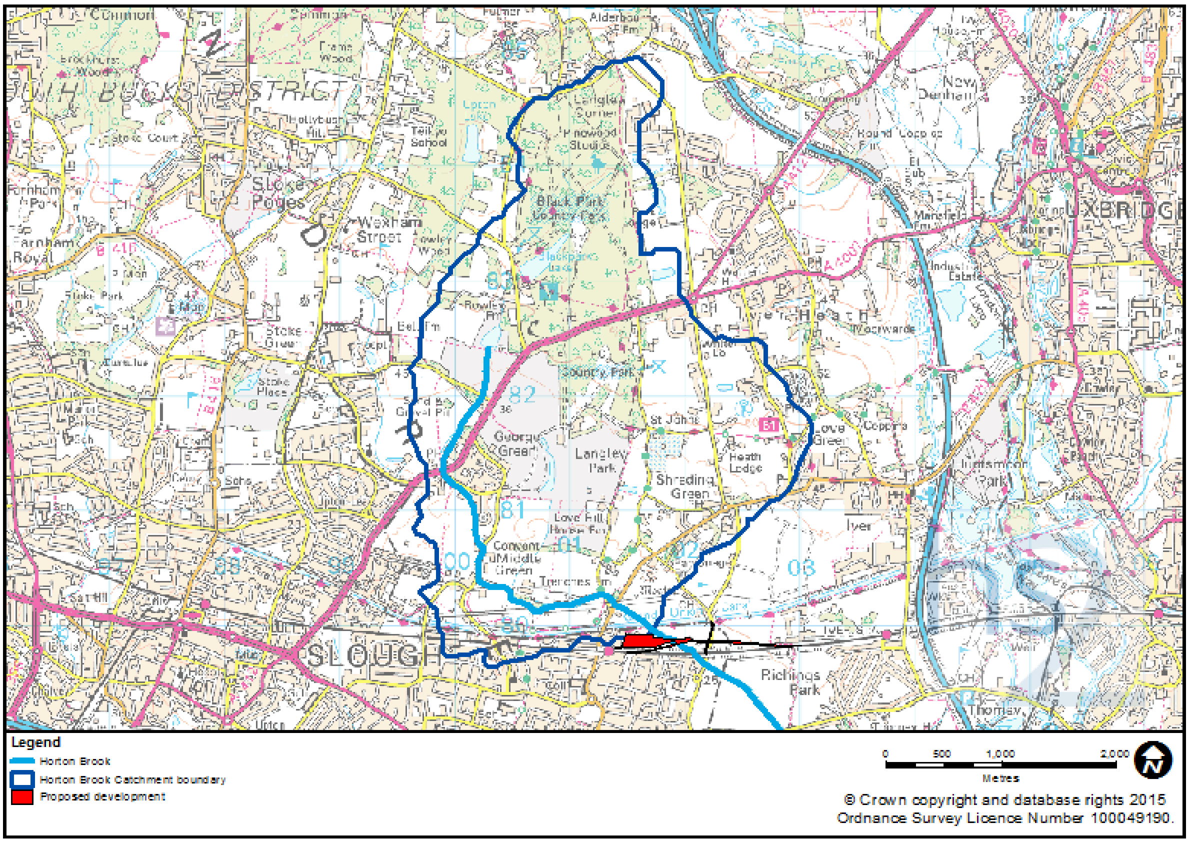
1.2.2 The catchment hydrology is reported in Section 2. Flood water levels, depths and floodplain extents are reported for the baseline (Section 3) and scheme scenarios (Section 4). Section 5 includes conclusions and recommendations and Section 6 covers assumptions and limitations of the hydrology and hydraulic modelling.

2 Hydrology

2.1 Location plan and topography

2.1.1 The study catchment is in the predominantly rural upper reaches of the Horton Brook, which rises in the vicinity of Iver Heath and flows in a south, south easterly direction towards the eastern part of Slough. The greater Horton Brook catchment flows throughout the complex system of watercourses and wetlands in the area of the Colne Valley and eventually discharges into the River Thames.

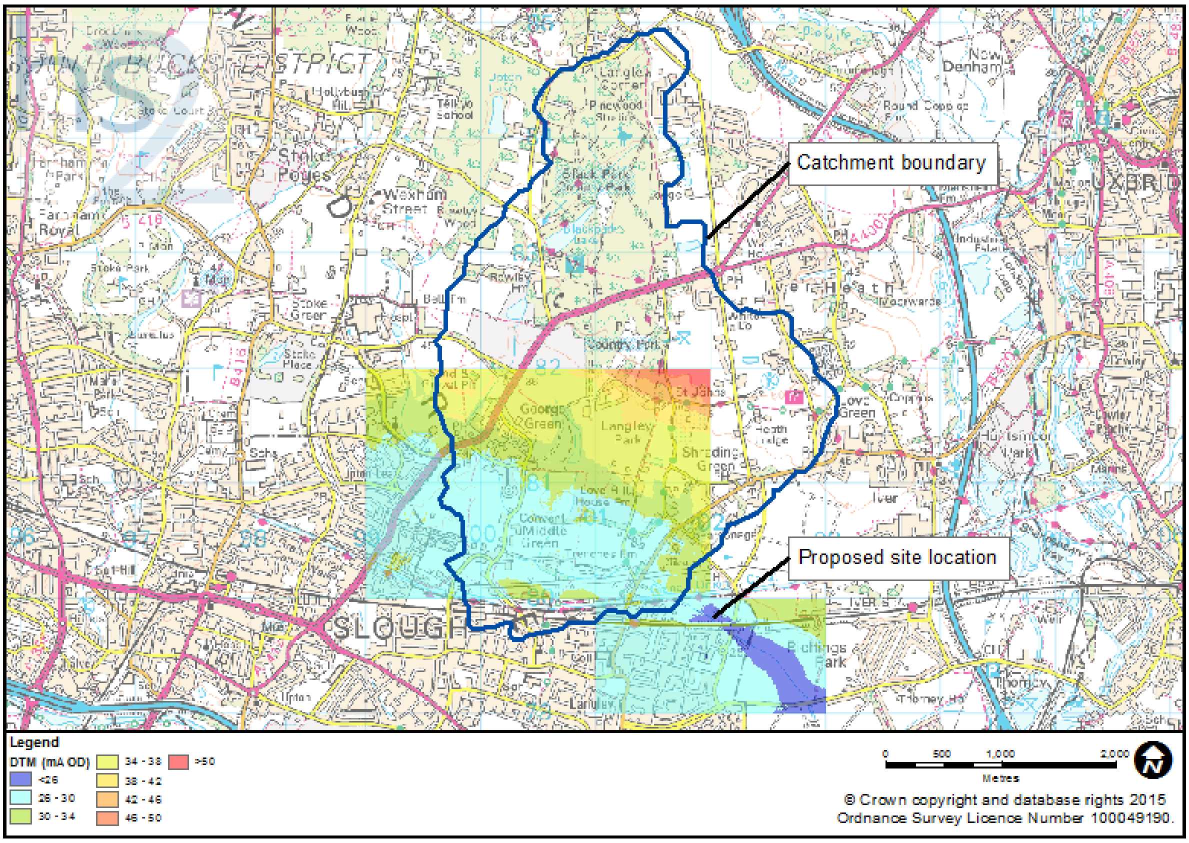
Figure 1 : Location and extent of the Horton Brook study catchment



2.1.2 The catchment of Horton brook to the study area contains a very few urban areas; these include parts of Iver, Iver Heath, Shedding Green and the north of Langley. Most of the catchment is a mixture of grassland, arable, woodland (country parks) with some small water bodies. The topography of the study catchment is generally wide and flat, sloping in a south easterly direction.

2.1.3 Figure 2 shows the light detection and ranging (LiDAR) ground surface information of the Horton Brook catchment and the area of the scheme.

Figure 2 : Topography of the Horton Brook Catchment

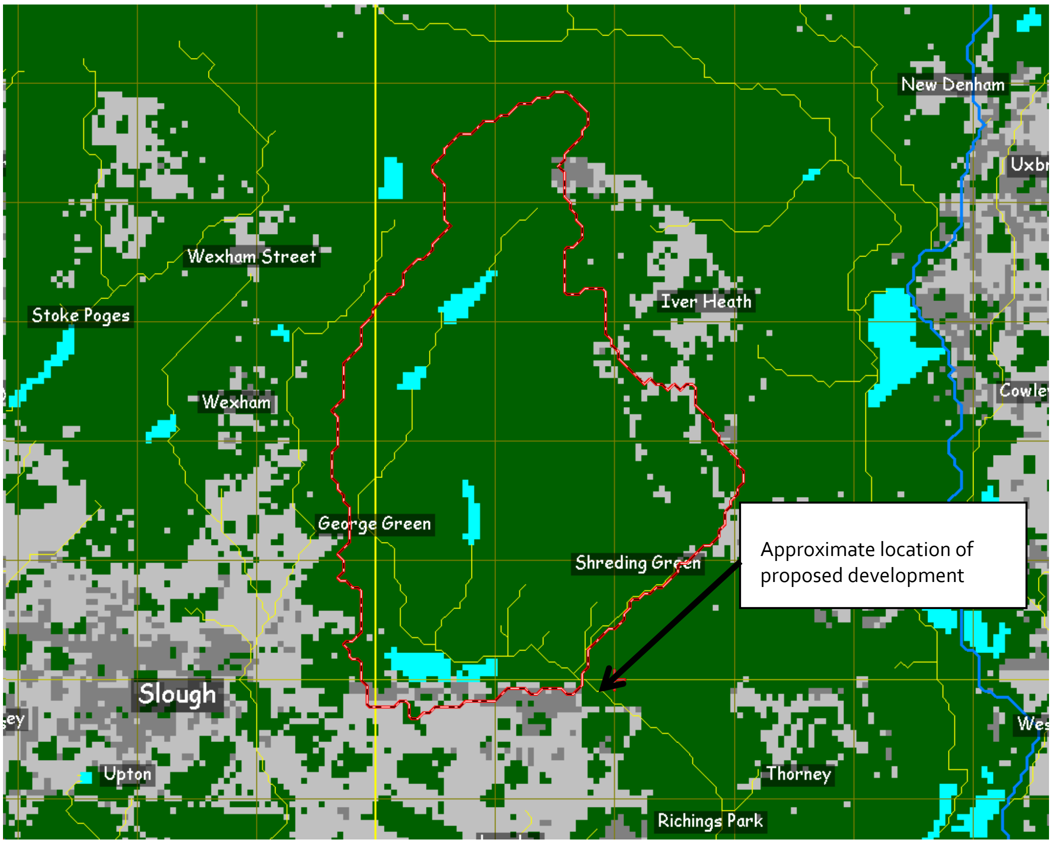


2.2 Hydrological context

2.2.1 The Horton Brook study catchment (extracted from the FEH CD ROM[1]) is shown in Figure 3 below and has an area of approximately 10.6km^2 at the crossing of the scheme at Langley. The associated catchment descriptors for the catchment are shown in Table 1.

[1] FEH CD ROM Version 3.

Figure 3 : FEH CD-ROM view of the Horton Brook at Langley



Source: FEH CD ROM, 2015.

Table 1 : Catchment descriptors

Catchment Descriptor	Value
AREA	10.6
BFIHOST	0.469
DPLBAR	3.33
DPSBAR	15.2
FARL	0.907
FPEXT	0.1934
PROPWET	0.29
SAAR	642
SPRHOST	37.9
URBEXT2000	0.037

Source: FEH CD ROM, 2015.

2.2.2 The catchment slope is gentle (DPSBAR = 15.2) and the longest drainage path in the catchment is 7.45km. The climate and soil catchment descriptors show that the catchment is relatively dry with an annual average rainfall of 642mm/year and a low proportion of time annually where soils are considered to be 'wet' (PROPWET=0.29). There is also significant attenuation due to reservoirs and lakes within the catchment (FARL=0.907).

2.2.3 The catchment is categorised as 'slightly urban' in the Flood Estimation Handbook[2] (FEH) standards, with an urban extent value (in the year 2000) of 0.037. The urban areas are Langley, Iver, Iver Heath and Shredding Green. These more urbanised areas are on the outer fringes of the study catchment (see Figure 3).

2.2.4 The natural catchment of the Horton Brook has several smaller drainage streams that flow into it along the length of the watercourse and several lakes. The Horton Brook is an ungauged catchment.

2.2.5 The catchment does not display any unusual features such as high permeability, high urbanisation or extensive floodplain storage or washland areas. It is therefore assumed that the FEH hydrological peak flow estimation methodologies will apply.

2.3 Hydrological assessment

2.3.1 A hydrological assessment of the Horton Brook was undertaken as part of the JBA (2010) Chalvey Ditches Flood Risk Mapping Study[3]. This study was provided as part of the data request to the Environment Agency (EA) and reviewed for suitability for the current assessment. It was concluded that since there have been updates in the HiFlows dataset since 2010, a hydrological update was required.

2.3.2 Due to a lack of flow gauging at the study catchment of interest, ungauged hydrological flood peak estimations were carried out using the FEH methodologies, including the Revitalised Flood Hydrograph Rainfall-Runoff Method (ReFH) and the FEH Statistical method. These were both compared for suitability for the derivation of peak flows and were utilised as part of this study.

2.3.3 Peak flow estimates were calculated for the 2, 5, 10, 20, 50, 75, 100, 200, 1000 year return periods. Climate change has been applied to 100, 200 and 1000 year return periods using a 30% increase in flows for ordinary watercourses.

2.4 Ungauged catchment methodology

ReFH method

2.4.1 The ReFH method was undertaken using the ISIS version 3.7.0.233, using the catchment descriptors obtained from the FEH CD ROM. Standard ReFH design

[2] Flood Estimation Handbook, Volume 5: Catchment Descriptors, NERC (CEH), 2008.
[3] JBA (2010) Chalvey Ditches Flood Risk Mapping Study, Volume 2: Modelling Report.

rainfall was applied with a critical storm duration of 8.7 hours (duration recommended by the software), with a time step of 0.52 hours.

2.4.2 Design flows derived from ISIS are shown in Table 2 below.

Table 2 : ReFH peak flows for Horton Brook

Return Period	Flow (m3/s)
2	2.45
5	3.22
10	3.81
20	4.44
50	5.41
75	5.91
100	6.30
200	7.45
1000	11.41

Source: ISIS v.3.7.0.233.

2.4.3 ReFH is also used to inform the hydrograph shape for the catchment, by scaling the hydrograph to a FEH Statistical peak flow and used for the derivation 1000 year flow (the 'hybrid method'). The hybrid method 1000 year flow is the ratio of the 1000 year ReFH and 100 year ReFH flows multiplied by the 100 year FEH Statistical flow.

FEH statistical method

2.4.4 The Index Flood (QMED), also defined as the '2 year flow', was derived from catchment descriptors and was not donor adjusted due to a lack of good quality gauging data in the area. WINFAP[4] did locate a gauge that appeared to be a good match in terms of catchment descriptors; however this was not used due to the distance between centroids of 55km. This finding agreed with the JBA (2010) report.

2.4.5 Using WINFAP FEH 3 (version 3) with HiFlows dataset 3.3.4 (August 2014) a pooling group was derived for Horton Brook and assessed for suitability. Pooling stations were removed and added in terms of their catchment descriptor suitability, permeability, and gauge quality information. The final pooling group showed a heterogeneity (H2) value of 1.757, indicating that 'the pooling group

[4] WINFAP-FEH Version 3.0.003.

(see Appendix A) may possibly be homogenous and a review is optional'. This was deemed suitable for the catchment and the Generalised Logistic (GL) distribution was chosen (as recommended by the goodness-of-fit test in WINFAP) to derive growth factors. The growth factors and flows generated from these are shown in Table 3. The 100 year growth factor is between the expected range of 2.1 to 4.0.

Table 3 : Growth factors for Horton Brook

Return Period	Growth Factor	Flow (m^3/s)
2	1.000	1.27
5	1.451	1.85
10	1.777	2.26
20	2.247	2.64
50	2.649	3.37
75	2.908	3.70
100	3.104	3.95
200	3.622	4.61
1000	5.124	7.16*

Source: WINFAP FEH 3.

* Hybrid method applied (see Section 2.4.3).

Climate change

2.4.6 Climate change is added by scaling the peak flows by an extra 30%, as agreed with HS2 for non-Main River watercourses.

Comparison with JBA (2010) peak flows

2.4.7 Table 4 below shows the FEH Statistical design peak flows derived as part of this study and the previous JBA (2010) study. Both studies follow the same methodology, including the derivation of the 1000 year flow using the hybrid method. The newly derived hydrology is 2-6% smaller than the JBA study for all return periods, with the exception of the 1000 year return period where the flow is 5% higher than the JBA study. Due to the availability and the assumption that a newer HiFlows dataset will provide more representative pooling groups, the new hydrology will be used for the hydraulic modelling.

Table 4 : ReFH peak flows for Horton Brook

Return period	FEH statistical flow 2015 study (m^3/s)	JBA (2010) study flow (m^3/s)	Comparison new hydrology to JBA 2010 study (%)
2	1.27	1.30	-2%
5	1.85	1.90	-3%
10	2.26	N/A	N/A
20	2.64	2.80	-6%
50	3.37	N/A	N/A
75	3.70	3.80	-3%
100	3.95	4.10	-4%
200	4.61	4.80	-4%
1000	7.16	6.80	+5%

Source: ISIS v.3.7.0.233 and JBA (2010).

2.5 Final design peak flows

2.5.1 Table 5 below shows the final design peak flows for the ReFH and FEH Statistical methods.

Table 5 : Final peak design flows for Horton Brook

Return period	FEH statistical flow (m^3/s)
2	1.27
5	1.85
10	2.26
20	2.64
50	3.37
75	3.70
100	3.95
200	4.61
1000	7.16*

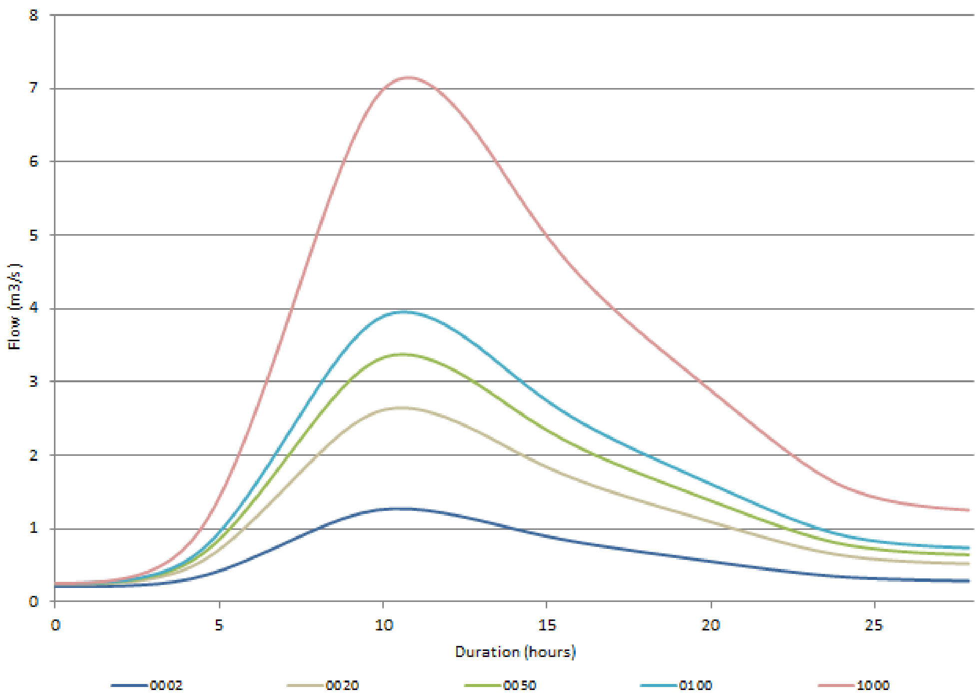
Source: ISIS v.3.7.0.233.

* Hybrid method applied (see Section 2.4.3).

2.5.2 The ReFH method, although suitable for use on this catchment, has not been chosen for peak flows, as the flows are overly conservative and not representative of the catchment (QMED is almost 50% higher than FEH Statistical).

2.5.3 ReFH has been used to derive a representative hydrograph shape for the catchment, based on catchment descriptors. Using ISIS the hydrographs were scaled to all final design peak flows derived by the FEH Statistical method. These hydrographs are displayed in Figure 4.

Figure 4 : Final hydrographs for all key return periods



Source: Mott MacDonald, 2015.

3 Baseline hydraulic modelling

3.1 Model definition

3.1.1 The hydraulic model incorporated part of an existing model (Chalvey Ditches Flood Risk Mapping Study undertaken by JBA in 2010) upstream of Grand Union Canal and a newly built model downstream, which was constructed using ISIS-TUFLOW by Mott MacDonald. The model utilised ISIS (Version 6.5.1.75) to represent the 1D channel, and TUFLOW (Version 2013-12-AB-iSP-w64) to simulate the floodplain at the downstream extent where the proposed development is located.

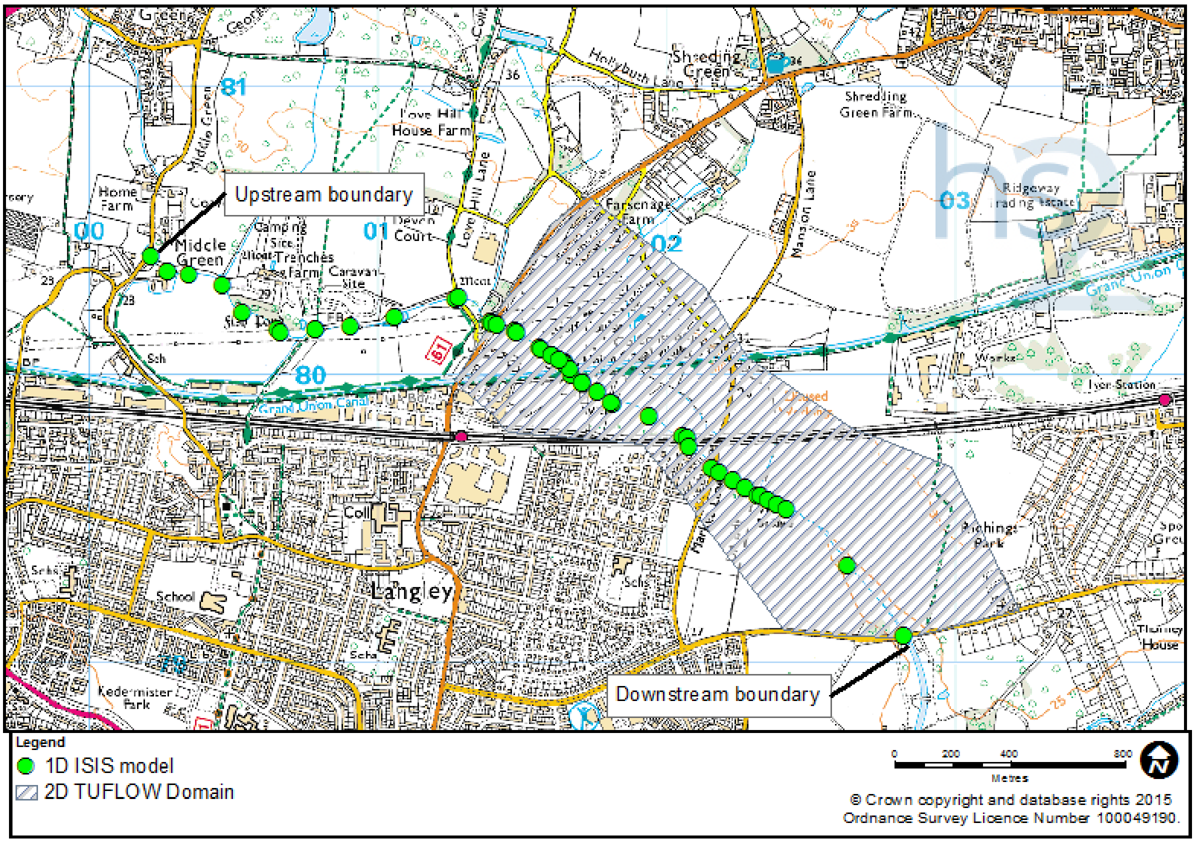
3.1.2 The scheme comprises a replacement depot and associated rail embankments within the Horton Brook floodplain between the Grand Union Canal and the existing Great Western Main Line. A 1D-2D linked model was used to accurately represent the flow pattern both in channel and out-of-bank to identify the flood risk to and from the scheme.

3.1.3 For the river reach between Grand Union Canal to North Park Road, ISIS cross sections and structures are represented in the hydraulic model based on a watercourse survey collected by Maltby Land Surveys Ltd. on 31 March 2015. Model components upstream were taken from the existing 2010 Chalvey Ditch model. The topography of the model was based upon 1m resolution LiDAR ground elevation data. A uniform 5m TUFLOW grid was used, as this was considered appropriate given the size and scale of the model. The LiDAR was reviewed and no modifications have been made to the cell resolution or base LiDAR.

3.2 Model boundaries

3.2.1 The 1D ISIS model schematic and the extent of the 2D TUFLOW domain are shown in Figure 5.

Figure 5 : Overview of the Horton Brook model



3.2.2 The model upstream flow-time boundary is set at Middle Green, which is an appropriate distance upstream to not be influenced by the potential effect of the scheme. The inflow hydrographs have been calculated as described in Section 2.

3.2.3 The model downstream boundary (normal depth boundary) is located at North Park Road, which is an appropriate distance downstream of the scheme to ensure there is no boundary effect on the area of concern upstream.

3.3 Roughness coefficients and structural definitions

3.3.1 The roughness coefficients for the ISIS cross sections were represented using Manning's n roughness coefficient, with the in-channel value of 0.04 and out-of-bank value of 0.06, based on the observation of the vegetated channel.

3.3.2 Ordnance Survey (OS) Mastermap layers were used in the 2D area to define different land uses. The roughness values applied are listed in Table 6.

Table 6 : Manning's roughness values

Material type	Manning's roughness value
Building	0.3
Natural Surface	0.05
General surface	0.04
Inland Water	0.035
Landform	0.04
Trees	0.07
Path	0.03
Railway	0.04
Road	0.015
Roadside (roads tracks and paths)	0.02
Structure	0.3
Unclassified or broken	0.04
Hard surface, standing areas, work yards	0.05

Source: Chow, V.T. (1973) Open-Channel Hydraulics. McGraw-Hill.

3.3.3 The raised embankments of the Grand Union Canal and the existing Great Western Main Line were represented in the 2D domain of the model using the LiDAR Digital Terrain Model (DTM). The following structures were represented in the 1D ISIS model:

- culvert under the Grand Union Canal;
- culvert under the Great Western Main Line;
- culverts under road B470;
- culverts under Market Lane;
- access bridge to golf course;
- Withy Bridge; and
- several foot bridges near golf course

3.4 Baseline model

3.4.1 The baseline model represents the current state, pre-scheme condition.

Flood depth and levels

3.4.2 Visual illustrations of the flood mechanisms and modelled flood levels and depths for the return period of 100yr plus climate change event are provided in Figure 6 and Figure 7. A summary of the 1 in 100 year plus climate change flood levels is provided in Table 7.

Figure 6 : 100yr plus climate change flood levels for baseline model

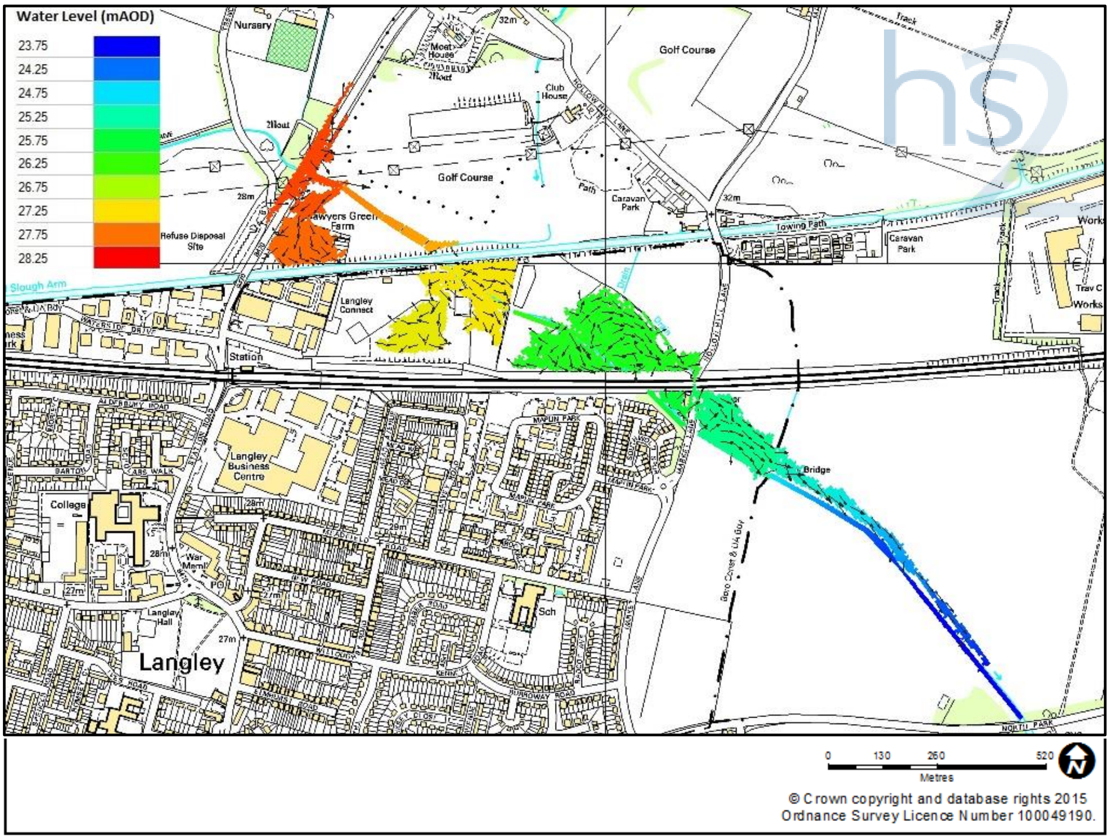
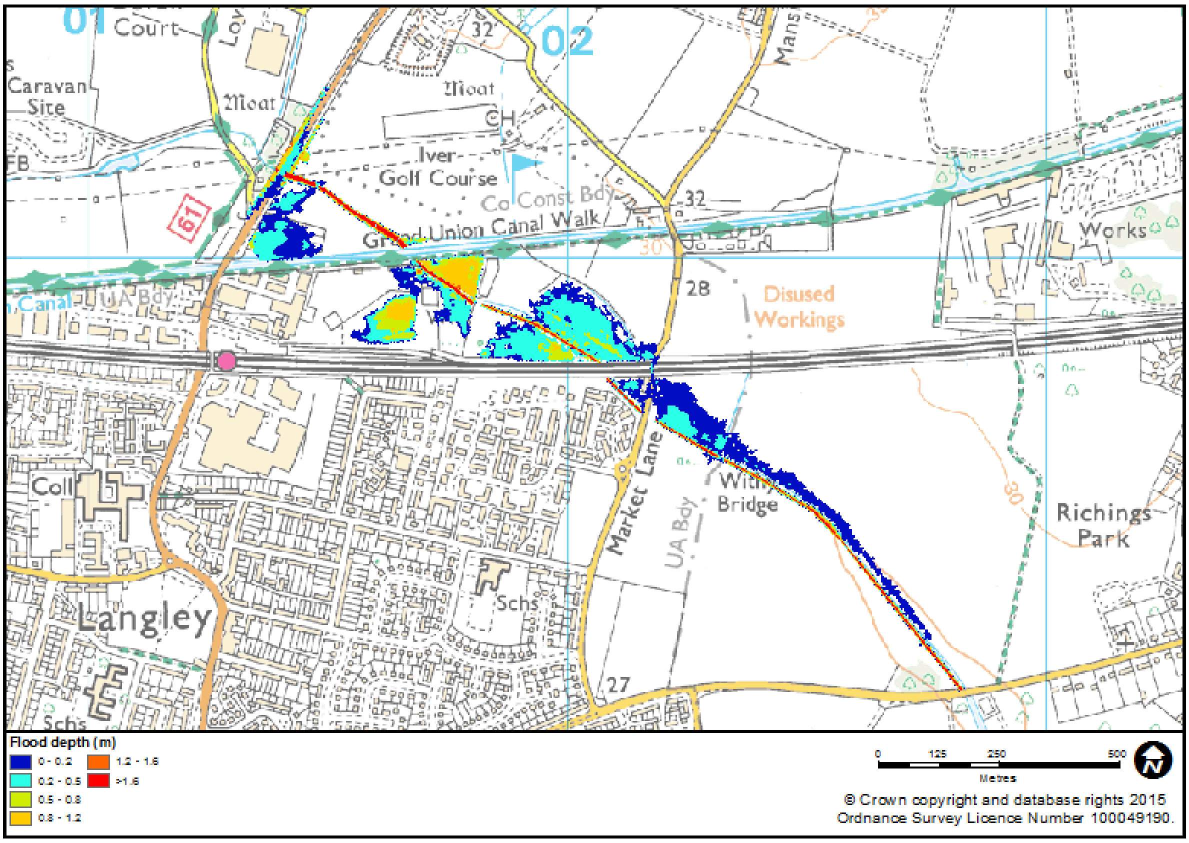


Figure 7 : 100yr plus climate change flood depths for baseline model



Flood velocities

3.4.3 Modelled flood velocities are generally very low within the floodplain and considerably higher within the channel. The highest velocities on the floodplain occurred between the canal and the railway, on average approximately 0.15m/s during the 1 in 100 year plus climate change event. Channels velocities are shown to reach to approximately 1.2m/s in open channel during the 1 in 100 year plus climate change event.

Sensitivity testing

3.4.4 The baseline model was tested for culvert blockages at two different locations, i.e., 70% blockage at the culvert under the Grand Union Canal, and 70% blockage at the culvert under the Great Western Main Line, for both 1 in 100yr plus climate change event and 1 in 1000yr plus climate change event.

3.4.5 For the 1 in 100yr plus climate change event, the canal blockage increased the maximum water level by 0.7m immediately upstream of the Grand Union Canal, with the effect of raised water level to the upstream reach at Trenches Farm, 400m downstream of the upstream boundary. Water levels downstream the canal area were lowered by 0.6m, and further downstream lowered on an average of 0.2m.

3.4.6 For the 1 in 100yr plus climate change event, the railway blockage caused 0.22m water level increase immediately upstream of the railway, and affected up to 300m reach upstream. Water levels between the railway and Market Lane were lowered on an average of 0.18m.

3.4.7 An inflow sensitivity test was undertaken for 100yr plus climate change event. A different storm duration of 12.5 hr was used for the inflow hydrograph. This resulted in an increase in flood level of 0.04m.

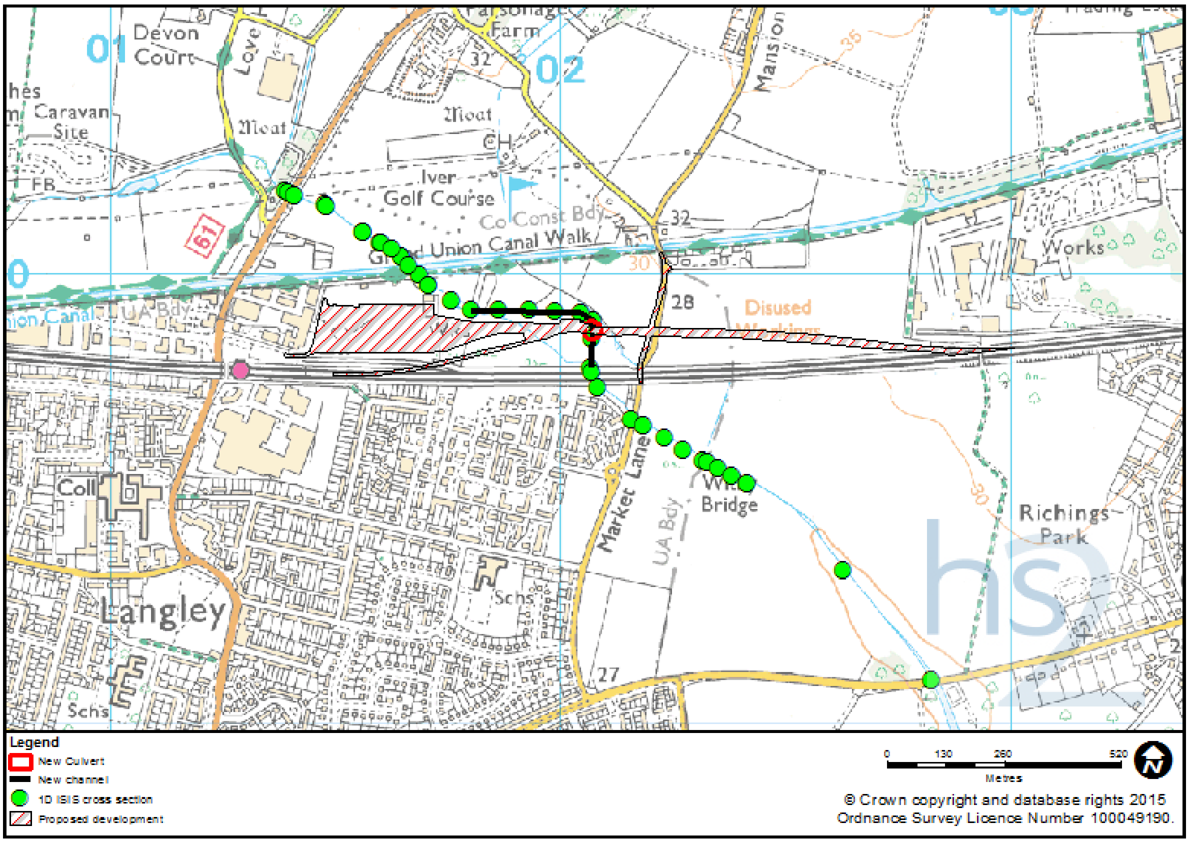
4 Scheme scenarios

4.1 Scheme modelling methodology

Hydraulic modelling

4.1.1 The purpose of this modelling exercise is to assess the impact of the scheme on flood water levels in the vicinity of Langley. The proposed depot will be built on a raised embankment in the Horton Brook floodplain between Grand Union Canal and the Great Western Main Line. The watercourse will be diverted from its current alignment to cross the depot embankment at the new culvert shown in Figure 8. Some meandering to the channel may be applied to the watercourse diversion. The ground level of the proposed embankment is approximately 29 mAOD.

Figure 8 : Post scheme plan view



4.2 Scheme model results

Flood depth and levels

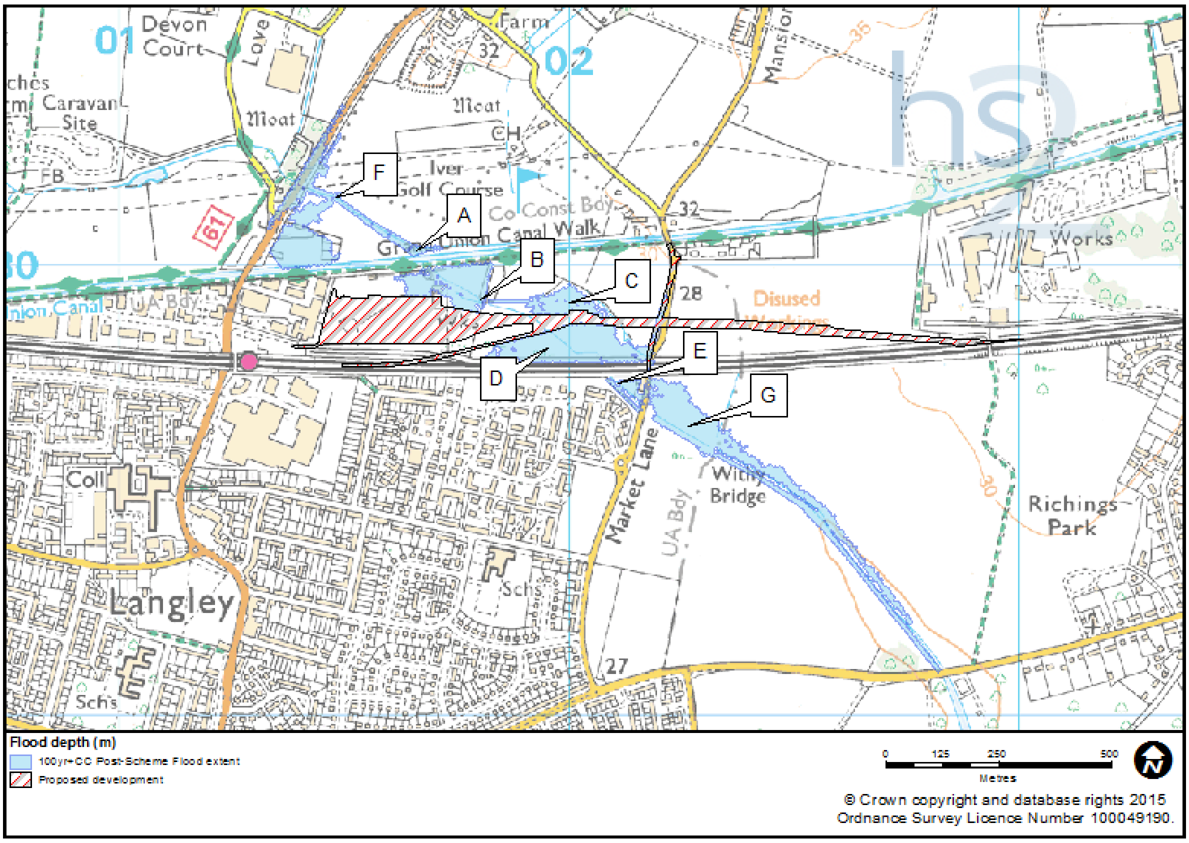
4.2.1 Table 7 shows the flood level comparison between pre and post scheme on selected locations. The point locations are as in Figure 9.

Table 7 : Water level comparison between pre scheme and post scheme scenarios for the 1 in 100 year + CC scenario

Location	Pre scheme (mAOD)	Post scheme (mAOD)	Difference (m)
A	27.47	27.54	+0.07
B	27.2	27.3	+0.10
C	26	26.12	+0.12
D	26.01	25.98	-0.03
E	25.82	25.82	0.00
F	27.93	27.93	0.00
G	25.41	25.41	0.00

Source: Mott MacDonald, 2015.

Figure 9 : Pre and post-scheme reference locations for Table 7.



4.2.2 Visual illustrations of the flood mechanisms and modelled flood depths for the return period of 100yr plus climate change event can be seen in Figure 10 and Figure 11.

Figure 10 : 100yr plus climate change flood levels for post scheme model

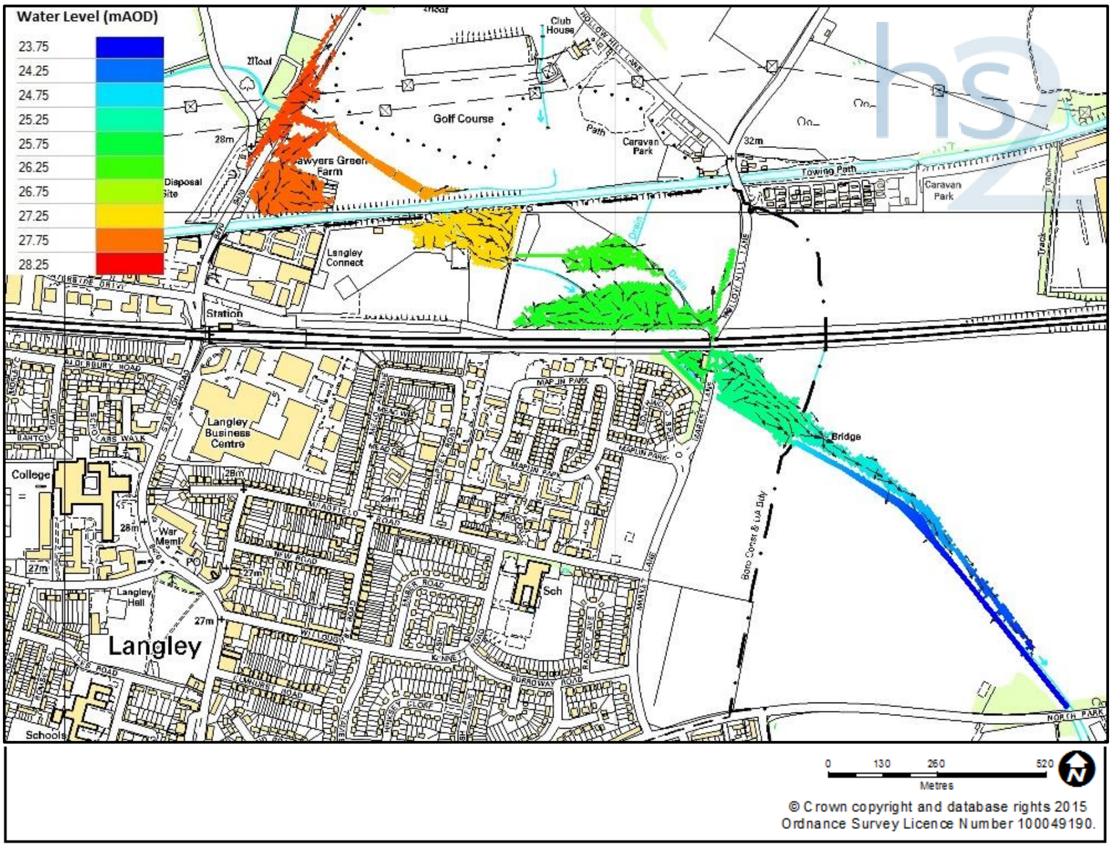
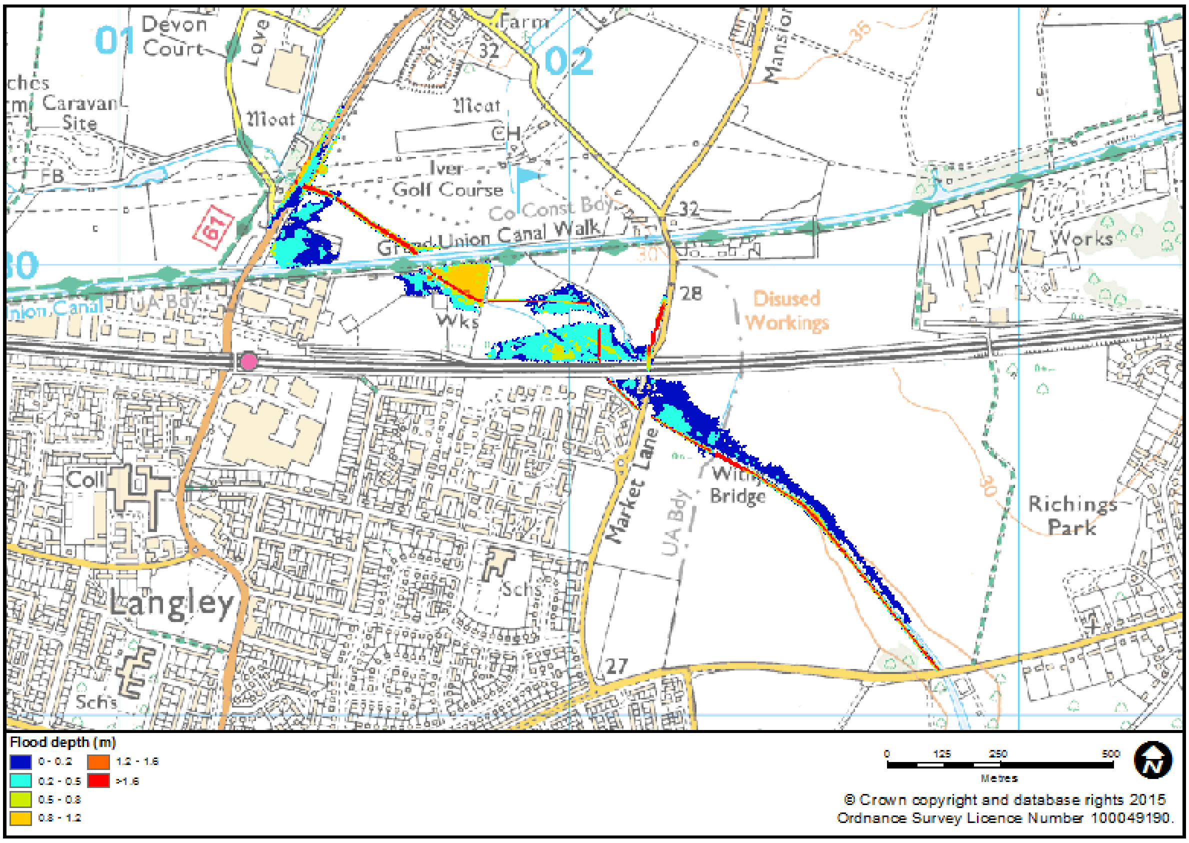


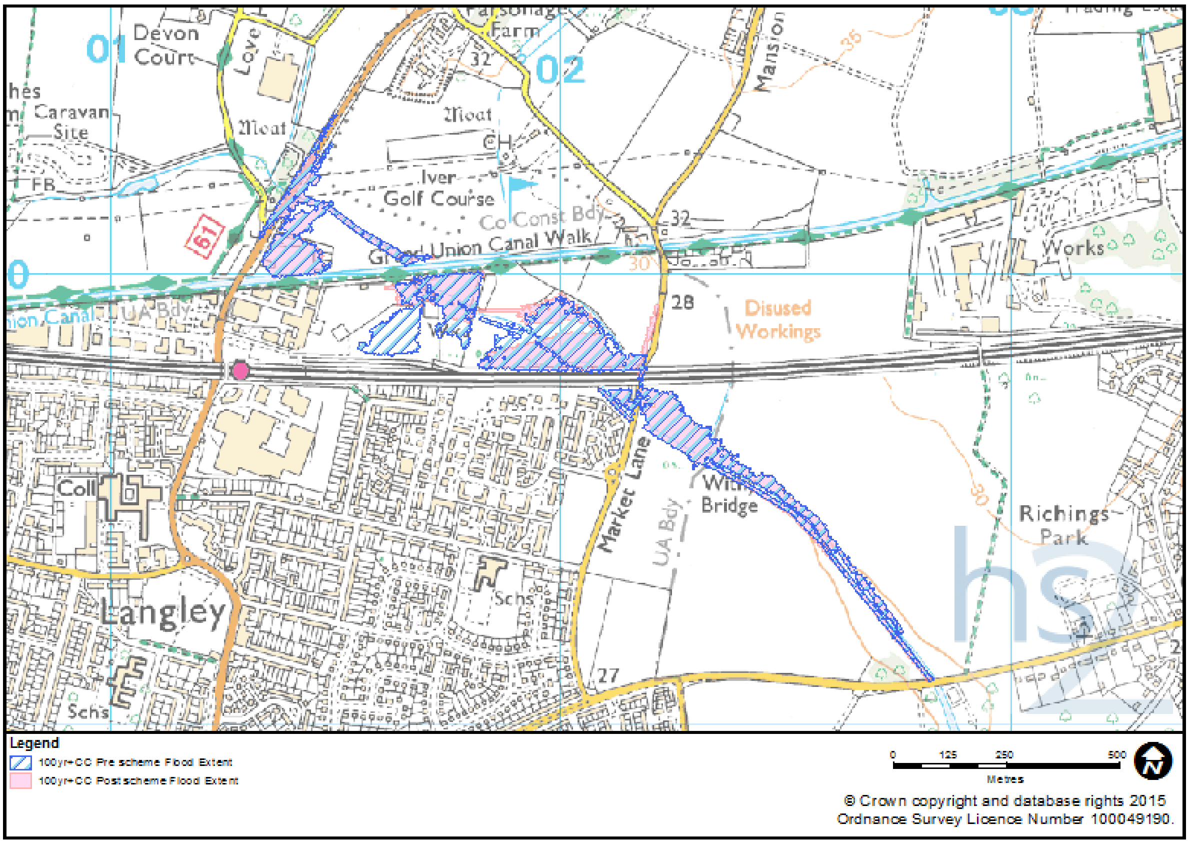
Figure 11 : 100yr plus climate change flood depths for post scheme model



Floodplain extents

4.2.3 The flood extent comparison between post scheme and pre scheme scenario for the 100yr plus climate change is shown in Figure 12.

Figure 12 : Flood extent comparison for 100yr plus climate change



Sensitivity testing

4.2.4 The post scheme model was tested against blockages at three different locations, i.e., 70% blockage at the culvert under the Grand Union Canal, 70% blockage at the culvert under the railway, and 10% blockage at the new culvert under the proposed development. The canal and railway blockage has similar effects as described in 3.4.5 and 3.4.6. The new culvert blockage results in a 0.1m increase in flood levels upstream of the diverted channel for the 1 in 100yr plus climate change event.

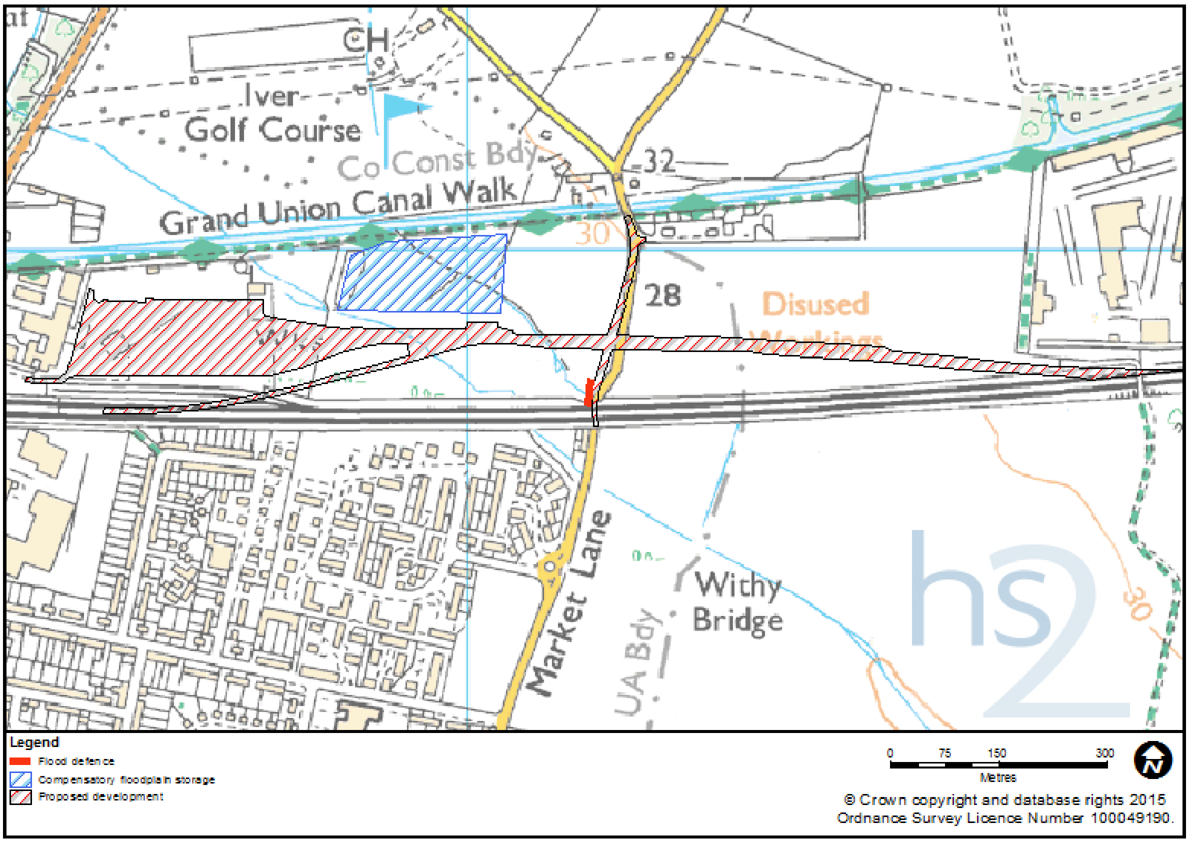
4.3 Scheme with mitigation scenario

4.3.1 As discussed in Section 4.2, the scheme has the potential to impact flood risk to third parties. Mitigation measures are proposed to reduce the impact of the scheme, for events up to and including the 1 in 100 year plus climate change.

4.3.2 The proposed mitigation scheme at the site includes replacement floodplain storage upstream of the new culvert and a flood defence west of Hollow Hill Lane North to limit overflow of floodwaters onto Hollow Hill Lane. The storage capacity has been represented in the model with 21,000 cubic metres storage volume which compensates for the floodplain volume lost due to the footprint of the proposed scheme. The flood defence is represented in the model as a 40m long embankment that restricts flow onto Hollow Hill Lane.

4.3.3 Figure 13 shows the locations of the proposed mitigation measures. The design of the scheme to date provides the level of detail necessary for the purposes of the Bill and the requirements of the Environmental Impact Assessment Regulations. The level of detailed design necessary to enable the scheme to be constructed has yet to be carried out, and will not be completed until after the Bill has secured Royal Assent. Further detail of the design of these measures will be undertaken during the detailed design stage.

Figure 13 : Location of mitigation measures



4.3.4 Table 8 shows the peak level comparison between the post-scheme scenario with mitigation and the pre scheme conditions. The point locations are as in Figure 9.This shows a decrease or null impact on water levels at all locations, except at location C, where there is an increase in 0.11m. This increase is mainly due to the diversion of the watercourse, resulting in additional water in this location where it previously was not routed through. This point is within the proposed site area and the proposed replacement floodplain storage. It is therefore considered that there is no change in flood risk outside the site with mitigation measures in place.

Table 8 : Water level comparison between pre scheme and mitigation scheme

Location	100yr+CC pre scheme water levels (mAOD)	100yr+CC post scheme water levels with mitigation scheme (mAOD)	Difference in water level (m)
A	27.47	27.43	-0.04
B	27.20	27.18	-0.02
C	26.00	26.11	+0.11
D	26.01	25.99	-0.02
E	25.82	25.82	0.00
F	27.93	27.92	-0.01
G	25.41	25.41	0.00

Source: Mott MacDonald, 2015.

5 Conclusions

5.1.1 A site specific 1D-2D linked model was constructed to inform the Flood Risk Assessment. A site visit and watercourse survey were undertaken to inform the model build. Subsequently, the model was used (i) to assess the level of baseline flood risk to the site, (ii) to test the impact on flood risk due to the construction of the scheme at Langley, and (iii) to test mitigation options so as to identify the most appropriate mitigation solutions.

5.1.2 A hydrology assessment was conducted to determine design flows for a range of return periods. Six flood events have been included in the hydraulic modelling including the 2 year, 20 year, 100 year and 1000 year return period, and the 100 year and 1000 year return periods with an allowance of 30% for climate change.

5.1.3 The baseline modelling results suggest that the proposed scheme is at risk of flooding from Horton Brook. Modelling of the post-scheme scenario with the construction of the depot, new diversion channel and culvert shows an impact on flood water levels at the scheme area and to local receptors.

5.1.4 Due to the potential impacts on flood risk to third parties, mitigation measures in the form of replacement floodplain storage and flood defence are proposed to minimise the impact on flood risk. Hydraulic modelling of the post-scheme impacts due to the scheme in combination with mitigation measures shows a null impact on flood risk to third parties .

5.1.5 The accuracy of the model is considered sufficient to provide the information required for this baseline and post scheme impact assessment. The model results should not be used for any purpose other than those specified in this report.

6 Assumptions

6.1 General

6.1.1 This section of the report lists the key assumptions and limitations of the hydrological calculations and hydraulic modelling carried out for this study. It is important to note that the model has not been calibrated due to lack of calibration data in this catchment.

6.2 Hydrology

6.2.1 Due to a lack of gauge data on the Horton Brook and within the Slough area, the QMED from catchment descriptors was used. This assumes that the QMED from catchment descriptors (and the QMED equation) is suitable.

6.2.2 There is no flow gauging on the Horton Brook. Flow gauging would help to inform the QMED flow for the catchment and provide a more accurate indication of the flow regimes.

6.2.3 Due to the difficulty in estimating flows in excess of 1000 years, the Hybrid Method has been used for a conservative estimate; this itself is a limitation of our knowledge for flows for extreme return periods.

6.3 Use of existing models

6.3.1 The existing model is the Datchet Common Brook / Horton Brook hydraulic model constructed for the Chalvey Ditches SFRM project (JBA, 2010). It is a 1D-2D linked model covering the Datchet Common Brook and part of Horton Brook area from Rowley Lake to the Grand Union Canal. Part of this model was used and combined with a new bespoke hydraulic model constructed in the site area for the scheme. It is assumed that the elements used from the 2010 model are fit for purpose.

6.4 Hydraulic modelling

6.4.1 This assessment includes the known flood risks from the Horton Brook within the study area.

6.4.2 The upstream model has been truncated from an existing model. This upstream extent has also been simplified to remove some structures at Trenches Farm, Mobile Homes Park and Trenches Lane. This will give a conservative estimation for the downstream flood risk assessment for the scheme. To minimise stability issues , a 1D only ISIS model was applied from Middle Green to the B470. The floodplain was represented using extended channel sections in the ISIS model. Due to the restriction of flow into the scheme area due to the culvert at the Grand Union Canal, changes upstream of this area have a negligible impact on the flood levels and flows in the scheme area.

6.4.3 ISIS nodes HOR01_1150 and HOR01_1041 were copied from the closest survey cross sections, in order to incorporate the surveyed structure dimensions. Their invert levels were modified in accordance with the channel slope.

6.4.4 Downstream boundary node HOR01_NP was copied from its upstream surveyed cross section HOR01_0000, with the invert level modified to fit the channel slope.

6.4.5 Inflow hydrographs were calculated for the catchment upstream of the Grand Union Canal, and was used as input at Middle Green which is approximately 1.7km upstream of the scheme.

6.5 Model parameters

6.5.1 Infiltration losses have not been applied.

6.5.2 Roughness coefficients of the study area have been defined using Manning's n roughness values for a selection of land use types. The land uses were obtained from OS Mastermap data.

6.5.3 The upstream and downstream model extents have been located a sufficient distance from the scheme to ensure the model boundaries do not influence the modelled flood extents at the site.

6.5.4 Hydrological inflows have been applied in the model as point inflows.

6.6 Structures

6.6.1 The dimensions of key structures in the study area were surveyed. In some cases the nearest cross section was copied and the invert level was modified in accordance with the slope of the watercourse.

6.6.2 The potential head loss at structures due to skew was not considered in the model.

6.7 Post-processing of results

6.7.1 All two-dimensional model results have been processed to a grid resolution of 2.5m, which is half of the modelled grid size. This is considered a suitable level of detail for this study.

6.7.2 The TUFLOW flood outlines presented in this report have not undergone any post-processing such as smoothing of edges or filling in of dry islands.

Appendix A – Pooling Groups

Table 9 : A1 - Initial pooling group

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
27073 (Brompton Beck @ Snainton Ings)	0.885	32	0.813	0.197	-0.022	0.62
20002 (West Peffer Burn @ Luffness)	1.572	41	3.299	0.292	0.015	2.259
26802 (Gypsey Race @ Kirby Grindalythe)	2.019	13	0.109	0.261	0.199	0.526
203046 (Rathmore Burn @ Rathmore Bridge)	2.033	30	10.934	0.136	0.091	1.049
25019 (Leven @ Easby)	2.148	34	5.538	0.347	0.394	1.008
27051 (Crimple @ Burn Bridge)	2.199	40	4.539	0.222	0.149	1.159
36010 (Bumpstead Brook @ Broad Green)	2.217	45	6.759	0.418	0.228	1.644
72014 (Conder @ Galgate)	2.251	45	17.703	0.193	0.059	0.894
41020 (Bevern Stream @ Clappers Bridge)	2.29	43	13.49	0.214	0.208	0.841
33054 (Babingley @ Castle Rising)	2.3	36	1.129	0.214	0.069	0.223
73015 (Keer @ High Keer Weir)	2.312	21	12.239	0.156	0.001	0.706
44008 (South Winterbourne @ Winterbourne Steepleton)	2.427	33	0.42	0.395	0.332	1.047
27010 (Hodge Beck @ Bransdale Weir)	2.428	41	9.42	0.224	0.293	0.917
47022 (Tory Brook @ Newnham Park)	2.451	19	7.331	0.257	0.071	0.406
45816 (Haddeo @ Upton)	2.517	19	3.456	0.324	0.434	1.438
33032 (Heacham @ Heacham)	2.534	44	0.461	0.315	0.099	1.264

Total		**536**				
Weighted means				**0.259**	**0.162**	

Source: WINFAP FEH 3.

Table 10 : A2 - Final pooling group

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
20002 (West Peffer Burn @ Luffness)	1.572	41	3.299	0.292	0.015	1.477
25019 (Leven @ Easby)	2.148	34	5.538	0.347	0.394	1.023
27051 (Crimple @ Burn Bridge)	2.199	40	4.539	0.222	0.149	0.627
36010 (Bumpstead Brook @ Broad Green)	2.217	45	6.759	0.418	0.228	2.341
41020 (Bevern Stream @ Clappers Bridge)	2.29	43	13.49	0.214	0.208	0.976
27010 (Hodge Beck @ Bransdale Weir)	2.428	41	9.42	0.224	0.293	1.017
36003 (Box @ Polstead)	2.657	49	3.841	0.31	0.109	0.686
36004 (Chad Brook @ Long Melford)	2.677	45	4.938	0.306	0.199	0.29
28058 (Henmore Brook @ Ashbourne)	2.678	14	9.006	0.168	-0.102	1.809
53017 (Boyd @ Bitton)	2.738	39	13.073	0.243	0.112	0.189
34005 (Tud @ Costessey Park)	2.74	51	3.146	0.281	0.181	0.365
39033 (Winterbourne Stream @ Bagnor)	2.783	50	0.393	0.336	0.369	1.2
Total		**492**				
Weighted means				**0.282**	**0.188**	

Source: WINFAP FEH 3.

Environmental topic:	Ecology	EC
Appendix name:	Supplementary amphibian data	001
Community forum areas:	Heathrow Express Depot Langley	HEX

Contents

1 Introduction

1.1.1 This document is an appendix which forms part of Volume 5 of the Supplementary Environmental Statement 3 (SES3) and the Additional Provision 4 Environmental Statement (AP4 ES). The ecological baseline data detailed within this document relates to modifications to the area around the proposed Heathrow Express Depot (Hex), Langley.

1.1.2 This appendix details supplementary ecological baseline data collected during 2015 relating to amphibians. The focus of amphibian survey work undertaken during 2015 has been the use of environmental DNA (eDNA[1]) testing to determine the presence or likely absence of great crested newt (GCN). This has included survey both at newly accessible pond locations and at locations where constraints in previous surveys have provided an incomplete data set. In advance of these works further pond scoping visits and Habitat Suitability Index (HSI) surveys have been undertaken at land parcels which have not previously been accessed for survey.

1.1.3 The document should be read in conjunction with Volume 2 (Community forum area (CFA) reports), Volume 3 (route-wide effects assessment) and Volume 4 (off-route effects assessment) of the SES3 and the AP4 ES.

2 Methodology

2.1 Introduction

2.1.1 Details of the methodologies utilised for scoping, walkover and HSI surveys are provided in the Technical Note: Ecological Field Survey Methods and Standards (FSMS) which is included within Volume 5: Appendix CT-001-000/2 of the main Environmental Statement (ES).

2.1.2 This baseline report focuses on supplementary data collected during 2015 that was not included in the Volume 5 Technical Appendices of either the main ES or the SES1 and AP2 ES.

2.1.3 The use of eDNA testing was not approved by Natural England until spring 2014 and therefore was not included within the Technical Note: Ecological Field Survey Methods and Standards that accompanied the main ES (see Volume 5: Appendix EC-002-003 of the main ES). The methodology utilised during eDNA surveys undertaken in 2015 is included within Addendum 4 to the Scope and Methodology Report. This document is included as Volume 5: Appendix CT-001-000/5 of the SES3 and the AP4 ES.

2.1.4 No traditional amphibian surveys using quantitative techniques (e.g. torchlight survey and bottle trapping), have been undertaken during 2015. The eDNA surveys undertaken during 2015 aimed to further develop the understanding of where GCN populations will be subject to impacts as a consequence of the scheme, and determine those locations where further survey using traditional quantitative techniques will be

[1] Environmental DNA is that which is released into the water by plants and animals in a host of ways: from their skin, faeces, mucous, hair, eggs and sperm, or when they die. It provides a means to undertake a diagnostic test to determine the presence or likely absence of a specific target species.

required in the future to inform any application for a European Protected Species Mitigation Licence.

2.2 Deviations, constraints and limitations

2.2.1 The main constraint to the surveys in 2015 was the lack of access to ponds at the following sites listed in Table 1.

Table 1: Updated summary of all locations where requirement for amphibian survey has been identified but no access was available for survey

Ecology survey code	Location	Ordnance Survey (OS) grid reference	Initial survey prescription based on scoping exercise	CFA No.	Approximate distance from the scheme (m) and orientation
010-AH1-HEx001 010-AH1-HEx009	Land to the east of Trenches Lane	TQ 013 802	HSI + presence/absence	HEx - Vol 4	Two waterbodies 150m east of the scheme
010-AH1-HEx012	Land to the north of the Grand Union Canal	TQ 007 806	HSI + presence/absence	HEx - Vol 4	One waterbody 10m west of the scheme.
010-AH1-HEx003 010-AH1-HEx004 010-AH1-HEx005 010-AH1-HEx006 010-AH1-HEx007	Land to the west of Thorney Lane South	TQ 035 801	HSI + presence/absence	HEx - Vol 4	Two waterbodies 90m north of the scheme. Three waterbodies 160m north of the scheme.

3 Baseline

3.1 Field survey

eDNA presence/absence surveys

3.1.1 The results of eDNA presence/absence surveys undertaken during 2015 are detailed within Table 2.

Table 2: Summary of results from 2015 amphibian eDNA presence/absence surveys

Ecology survey code	Location	OS grid reference	Date water sample taken	Approximate % pond margin accessible	Presence of inflows	GCN eDNA test result	CFA No.	Approximate distance from the scheme (m) and orientation
010-AA3-HEx011	Concrete lined former attenuation pond	TQ 016 799	30 June 2015	90%	No inflows present	Negative (GCN likely absent)	HEx - Vol 4	Within an area of land required for the construction and operation of the scheme.
010-AA3-HEx010	Section of Horton Brook	TQ 017 799 to TQ 017 799	30 June 2015	50%	Present and wet	Negative (GCN likely absent)	HEx - Vol 4	Within an area of land required for the construction and operation of the scheme.

4 Discussion of results

4.1 HEx Depot

4.1.1 The absence of GCN has been confirmed in the concrete lined former attenuation pond and in part of Horton Brook in the land required for the proposed HEx depot to the east of the Canal Wharf Industrial Estate. However, it is assumed that a medium population of GCN may still be present in ponds that could not be accessed for survey to the east of Trenches Lane, west of Thorney Lane South and the north of the Grand Union Canal.

Environmental topic:	Ecology	EC
Appendix name:	Supplementary Ecological Baseline Data	001
Community forum areas:	Off-route	005

Contents

1 Introduction

1.1.1 This document is an appendix which forms part of Volume 4 of the Supplementary Environmental Statement 3 (SES3) and the Additional Provision 4 Environmental Statement (AP4 ES). The ecological baseline data detailed within this document relates to the off route sections of the proposed scheme.

1.1.2 This appendix details supplementary ecological baseline data collected during 2015 relating to amphibians. The focus of amphibian survey work undertaken during 2015 has been the use of environmental DNA (eDNA[1]) testing to determine the presence or likely absence of great crested newt. This has included surveys both at newly accessible pond locations and at locations where constraints in previous surveys have provided an incomplete data set. In addition further pond scoping visits and Habitat Suitability Index (HSI) surveys have been undertaken at land parcels which have not previously been accessed for survey.

1.1.3 The document should be read in conjunction with Volume 4 (off-route effects assessment) of the SES3 and the AP4 ES.

[1] Environmental DNA is that which is released into the water by plants and animals in a host of ways: from their skin, faeces, mucous, hair, eggs and sperm, or when they die. It provides a means to undertake a diagnostic test to determine the presence or likely absence of a specific target species.

2 Methodology

2.1.1 Details of the methodologies utilised for scoping, walkover and HSI surveys are provided in the Technical Note: Ecological Field Survey Methods and Standards (FSMS) which is included within Volume 5: Appendix CT-001-000/2 of the main ES.

2.1.2 The scoping and desk study exercises undertaken in 2012 and 2013 can be found in Volume 5: Appendix EC-001-003 of the main ES. The scoping and desk study exercises undertaken in 2014 can be found in Volume 5: Appendix EC-001-003 of the SES and AP2 ES. This baseline report focuses on supplementary data collected during 2015 that was not included in the Volume 5 Technical Appendices of either the main ES or the SES and AP2 ES. This includes a further scoping exercise carried out in 2015 based on the AP2 revised scheme which informed the scope of survey visits undertaken during the period May to end of June 2015. The AP4 revised scheme has also been subject to scoping. However as the location of proposed amendments was only confirmed in July 2015 it was not possible to include these locations within the scope of eDNA surveys.

2.1.3 The use of eDNA testing was not approved by Natural England until spring 2014 and therefore was not included within the Technical Note: Ecological Field Survey Methods and Standards that accompanied the main ES (see Volume 5: Appendix CT-001-000/2 of the main ES). The methodology utilised during eDNA surveys undertaken in 2015 is included within Addendum 4 to the Scope and Methodology Report (SMR). This document is included as Volume 5: Appendix CT-001-000/5 of the SES3 and the AP4 ES.

2.1.4 No traditional amphibian surveys using quantitative techniques (e.g. torchlight survey and bottle trapping), have been undertaken during 2015. The eDNA surveys undertaken during 2015 aimed to further develop the understanding of where great crested newt populations will be subject to impacts as a consequence of the scheme, and determine those locations where further survey using traditional quantitative techniques will be required in the future to inform any application for a European Protected Species Mitigation Licence.

2.2 Deviations, constraints and limitations

2.2.1 Within each area there are locations where surveys have been constrained or limited, and also where deviations to the methodology have occurred. The principal constraint and limitation to eDNA surveys was restricted access to the perimeter of water bodies due to dense vegetation or health and safety constraints such as steep banks. In these cases, sampling locations could not be spaced evenly around the entirety of the water body margin but were distributed evenly across the accessible margin as deemed appropriate by the surveyor. However, all other elements of the methodology were carried out according to the specification in the FSMS (samples taken at appropriate time of year, full 20 samples taken, samples taken from most appropriate locations in water body near potential great crested newt egg laying sites and open water areas which great crested newt use to display during the breeding season). The accessibility of the pond margin for each survey location is summarised in Section 3 below.

2.2.2 In accordance with the advice in the methodology provided by DEFRA (Biggs *et. al*, 2014)2, negative results of eDNA from samples water bodies may be considered unreliable where access to the perimeter of water bodies is significantly restricted, where sampling is restricted to very shallow water (where great crested newts are unlikely to be present) or where numbers of great crested newts are very low.

2.2.3 Professional judgement has been applied to each negative result where access was restricted, to determine the reliability of the result. Where negative results are considered unreliable, these are indicated in Table 3. All water bodies where negative results are considered unreliable will be subject to further assessment.

2.2.4 Great crested newts may be present in water bodies with very slow flowing water. However, the eDNA sampling methodology has been designed for sampling of ponds at and at present is not endorsed by Natural England for the sampling of large linear water bodies such as canals. Flowing water may remove eDNA evidence for the presence of great crested newts. Sampling was carried out in canals and ditches where flowing water was present as any positive results would assist with assessment. However, all negative results from flowing water have been regarded as unreliable for concluding likely absence and these water bodies will be subject to further assessment.

2.2.5 Inconclusive results of water sample analysis are likely to be the result of degradation of the sample or where the presence of particulates and pollutants, such as oils, in the sample inhibits the analysis. Laboratory results of samples from eight water bodies were inconclusive. In these eight cases, the laboratory did not detect any degradation of the sample and the conclusion is that the presence of particulates and pollutants affected the analysis. Inconclusive results are recorded in Section 3.

2.2.6 Table 1 sets out the details of those water bodies which were identified from the scoping exercises, undertaken between 2012 and 2015, as requiring further survey (i.e. HSI and/or presence/absence survey) and there remains a requirement for further survey (i.e.have not been fully surveyed in 2015 or in previous years due to access limitations).

Table 1: Updated summary of locations where requirement for amphibian survey has been identified but no access was available for survey

Ecology survey code	Location	Ordnance Survey (OS) grid reference	Initial survey prescription based on scoping exercise	CFA No.	Approximate distance from the scheme (m) and orientation
030-AA-H2C002	South-east of Hill Ridware	SK 074172	HSI + Presence/Absence	Off-route	260 E
030-AA-H2C003	West of Mavesyn Ridware	SK 073172	HSI + Presence/Absence	Off-route	220 SE

[2] Biggs J, Ewald N, Valentini A, Gaboriaud C, Griffiths RA, Foster J, Wilkinson J, Arnett A, Williams P and Dunn F (2014). Analytical and methodological development for improved surveillance of the Great Crested Newt. Defra Project WC1067. Freshwater Habitats Trust: Oxford

Ecology survey code	Location	Ordnance Survey (OS) grid reference	Initial survey prescription based on scoping exercise	CFA No.	Approximate distance from the scheme (m) and orientation
030-AA-H2C004	South-east of Hill Ridware	SK 076174	HSI + Presence/Absence	Off-route	210 S
030-AA-H2C005	South-east of Hill Ridware	SK 069174	HSI + Presence/Absence	Off-route	Adjacent to land required for the construction and operation of the scheme
030-AA-H2C006	West of Rake End	SK 072178	HSI + Presence/Absence	Off-route	30 N
030-AA-H2C007	West of Rake End	SK 075180	HSI + Presence/Absence	Off-route	170 NW
030-AA-H2C008	West of Rake End	SK 074181	HSI + Presence/Absence	Off-route	230 NW
030-AA-H2C009	West of Rake End	SK 075181	HSI + Presence/Absence	Off-route	230 NW
030-AA-H2C010	South of Ten Acre Covert	SK 069176	HSI + Presence/Absence	Off-route	20 SW
030-AA-H2C011	South of Ten Acre Covert	SK 067177	HSI + Presence/Absence	Off-route	90 SW
030-AA-H2C012	Ten Acre Covert	SK 067178	HSI + Presence/Absence	Off-route	10 NE
030-AA-H2C013	North of Ten Acre Covert	SK 067179	HSI + Presence/Absence	Off-route	Adjacent to land required for the construction and operation of the scheme
030-AA-H2C014	North of Ten Acre Covert	SK 066180	HSI + Presence/Absence	Off-route	50 NE
030-AA-H2C015	North-west of Ten Acre Covert	SK 065179	HSI + Presence/Absence	Off-route	Adjacent to land required for the construction and operation of the scheme

Ecology survey code	Location	Ordnance Survey (OS) grid reference	Initial survey prescription based on scoping exercise	CFA No.	Approximate distance from the scheme (m) and orientation
030-AA-H2C016	West of Ten Acre Covert	SK 065178	HSI + Presence/Absence	Off-route	Adjacent to land required for the construction and operation of the scheme
030-AA-H2C017	South of Cawarden Springs Wood	SK 061179	HSI + Presence/Absence	Off-route	50 SW
030-AA-H2C018	North of Cawarden Springs Wood	SK 063182	HSI + Presence/Absence	Off-route	230 NE
030-AA-H2C025	North-east of Rugeley	SK 052187	HSI + Presence/Absence	Off-route	Adjacent to land required for the construction and operation of the scheme
030-AA-H2C026	North-east of Rugeley	SK 048193	HSI + Presence/Absence	Off-route	60 NE
030-AA-H2C028	North-east of Rugeley	SK 047194	HSI + Presence/Absence	Off-route	150 NE
030-AA-H2C029	North-east of Rugeley	SK 047195	HSI + Presence/Absence	Off-route	160 NE
030-AA-H2C037	South-west of Colton	SK 042203	HSI + Presence/Absence	Off-route	160 N
030-AA-H2C039	North of Rugeley	SK 035201	HSI + Presence/Absence	Off-route	170 SW
030-AA-H2C040	East of Bishton	SK 031210	HSI + Presence/Absence	Off-route	10 W
030-AA-H2C041	East of Bishton	SK 030210	HSI + Presence/Absence	Off-route	10 S
030-AA-H2C042	East of Bishton	SK 029210	HSI + Presence/Absence	Off-route	40 S
030-AA-H2C046	North of Bishton	SK 022212	HSI + Presence/Absence	Off-route	40 NE

Ecology survey code	Location	Ordnance Survey (OS) grid reference	Initial survey prescription based on scoping exercise	CFA No.	Approximate distance from the scheme (m) and orientation
030-AA-H2C054	North of Colwich	SK 013214	HSI + Presence/Absence	Off-route	90 N
030-AA-H2C055	North of Colwich	SK 013214	HSI + Presence/Absence	Off-route	120 N
030-AA-H2C058	West of Colwich	SK 006211	HSI + Presence/Absence	Off-route	Adjacent to land required for the construction and operation of the scheme
030-AA-H2C059	West of Little Haywood	SK 003214	HSI + Presence/Absence	Off-route	70 N
030-AA-H2C060	West of Little Haywood	SK 002214	HSI + Presence/Absence	Off-route	230 NW
030-AA-H2C077	North of Rugeley	SK 039199	HSI + Presence/Absence	Off-route	10 SW
030-AA-H2C079	West of Little Haywood	SK 000212	HSI + Presence/Absence	Off-route	170 W
030-AA-H2C083	North of Rugeley	SK 038204	HSI + Presence/Absence	Off-route	170 NE
030-AA-H2C084	West of Colton	SK 036206	HSI + Presence/Absence	Off-route	Within an area of land required for the construction and operation of the scheme
030-AA-L2H001	East of Nether Stowe	SK 128110	HSI + Presence/Absence	Off-route	240 NE
030-AA-L2H002	East of Nether Stowe	SK 127111	HSI + Presence/Absence	Off-route	150 NE
030-AA-L2H003	North of Nether Stowe	SK 123115	HSI + Presence/Absence	Off-route	Within an area of land required for the construction and operation of the scheme

Ecology survey code	Location	Ordnance Survey (OS) grid reference	Initial survey prescription based on scoping exercise	CFA No.	Approximate distance from the scheme (m) and orientation
030-AA-L2H004	North of Nether Stowe	SK 124116	HSI + Presence/Absence	Off-route	60 NE
030-AA-L2H012	East of Elmshurst	SK 118123	HSI + Presence/Absence	Off-route	Within an area of land required for the construction and operation of the scheme

3 Baseline

3.1 Field Survey

Habitat suitability index/walkover surveys

3.1.1 Following the completion of 2015 walkover surveys, incorporating a HSI survey (where appropriate), the water bodies identified in Table 2 were scoped out of the assessment.

Table 2: Summary of locations where requirement for further survey was scoped out following 2015 walkover survey

Ecology survey code	Location	OS grid reference	Brief rationale for scoping out	CFA No.	Approximate distance from the scheme (m) and orientation
030-AA-H2C057	Colwich	SK 012212	Fast flowing stream	Off-route	Within an area of land required for the construction and operation of the scheme

eDNA presence/absence surveys

3.1.2 The results of eDNA presence/absence surveys undertaken during 2015 are detailed within Table 3.

Table 3: Summary of results from 2015 amphibian eDNA presence/absence surveys

Ecology survey code	Location	OS grid reference	Date water sample taken	Approximate % pond margin accessible	Presence of inflows	Great crested newt eDNA test result	CFA No.	Approximate distance from the scheme (m) and orientation
030-AA-H2C036 (pond)	South-west of Colton	SK 042202	29 June 2015	50	No inflows present	Negative (GCN assumed absent)	Off-route	100 N
030-AA-H2C056 (canal)	South of Little Haywood	SK 007211	03 June 2015	50	No inflows present	Negative (Inconclusive)	Off-route	Within an area of land required for the construction and operation of the scheme
030-AA-H2C061 (ditch)	West of Colwich	SK 008210	20 May 2015	100	Present and wet	Negative (Inconclusive)	Off-route	Adjacent to land required for the construction and operation of the scheme
030-AA-H2C076 (canal)	North of Rugeley	SK 038197	10 June 2015	50	Present and wet	Negative (Inconclusive)	Off-route	10 SW

Key:

Negative (Inconclusive): -eDNA survey undertaken and a negative test result obtained. However, result considered inconclusive based on level of survey constraints, and professional judgement.

Negative (GCN assumed absent): eDNA survey undertaken and a valid negative test result obtained.

4 Discussion of results

4.1.1 For the wider scheme water bodies with the confirmed presence of great crested newt populations have been separated into clusters which are likely to support metapopulations. The assumed metapopulations have been assigned from desk study data undertaken in 2012/13, presence/absence survey results from 2012 to 2014 and eDNA survey results from 2015; no terrestrial survey has taken place. The assumed metapopulations are defined as a cluster of ponds supporting great crested newt within 250m of one another. The boundaries of the assumed metapopulations include breeding habitat, non-breeding aquatic habitat and terrestrial habitat, where the latter is not separated from the breeding ponds by a barrier to newt dispersal. Professional judgement has then been used to define the boundaries of some assumed meta-populations.

4.1.2 As no new great crested newt populations were confirmed in the off-route section of the scheme, resulting from the 2015 survey, no assumed metapopulations have been identified within these areas.

4.1.3 For the off-route section of the scheme there were a total of 41 water bodies for which surveys were proposed during 2015. Of these, 36 water bodies had no access, and a further water body was scoped out in 2015 following initial walkover / HSI surveys. The remaining four water bodies were scoped in for further assessment, as follows:

- one water body is within the land required for construction of the AP4 revised scheme; and
- three water bodies are outside of the land required for construction of the AP4 revised scheme but within 100m.

eDNA surveys were undertaken at four water bodies within the area. One result was negative and great crested newts are assumed absent. Three results were negative but unreliable for concluding likely absence.

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