The High Speed Rail (London – West Midlands) (Greatmoor Railway Sidings Etc.) Order

Environmental Statement – technical appendices
Volume 4.13:
Flood risk assessment

August 2016
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Department for Transport

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1 Introduction

1.1 Structure of the assessment

1.1.1 The water resources and flood risk assessment appendices comprise two parts:

- Volume 4.12: Environmental Statement Technical Appendix: Water resources assessment; and
- Volume 4.13: Environmental Statement Technical Appendix: Flood Risk Assessment (this appendix).

1.1.2 Maps referred to throughout the water resources and flood risk assessment appendices are contained in Maps ES-27: Surface Water Baseline, ES-28: Groundwater Baseline and ES-29: Water Framework Directive, in Volume 3: Environmental Statement Maps.

1.2 Scope of this assessment

1.2.1 This Flood Risk Assessment (FRA) considers the assessment of flood risk relating to the Proposed Scheme. The TWAO application arises as a result of the removal of existing facilities due to the HS2 Phase One scheme, but is not directly connected to or covered by the hybrid Bill. This FRA considers the flood risk to the Proposed Scheme, as well as the potential impact of the Proposed Scheme to third party (off-site) environmental receptors.

1.2.2 The assessments reported within this FRA have been carried out in accordance with the requirements of the National Planning Policy Framework (NPPF)[1] and the Planning Practice Guidance for Flood Risk and Coastal Change (PPG FRCC)[2]. The NPPF aims to prevent inappropriate development in areas at risk of flooding and to ensure that, where development is necessary in areas at risk of flooding, the Proposed Scheme is safe, without increasing flood risk elsewhere.

1.2.3 The main objectives of this study are to:

- assess the risk and implications of flooding on the site from all possible flood sources;
- consider climate change over the lifetime of the Proposed Scheme, both in the context of the Proposed Scheme as proposed, and in relation to surrounding environmental receptors;
- provide advice on the site layout and design that will ensure the safe operation of the site in an extreme flood or rainfall event, where required;
- assess the impact of the Proposed Scheme on the offsite risk of flooding; and
- provide a flood risk assessment of the site to inform the Volume 2: Main Environmental Statement (ES) and to accompany the TWAO.

[1] Department for Communities & Local Government, 2012, The National Planning Policy Framework.
[2] Department for Communities & Local Government, (Last updated 15 April 2015), Planning Practice Guidance Flood Risk and Coastal Change.

2 Flood risk assessment methodology

2.1 Source-pathway-receptor model

2.1.1 Flood risk is assessed using the source-pathway-receptor model. In this model individual sources of flooding within the study area are identified. The primary source of flooding is rainfall which is a direct source in the short-term (surface water flooding) and can lead to flooding from watercourses (river flooding) and overloaded man-made collection systems (sewer flooding) in the short or medium-term. Stored rainfall, either naturally in below ground aquifers and natural lakes or artificially in reservoirs and canals, can lead to flooding when the storage capacity of the system is exceeded. A final source of flooding arises from tidal effects and storm surges caused by low pressure systems over the sea.

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 from the Environment Agency, British Geological Survey (BGS), Canal and Rivers Trust (CRT) and Ordnance Survey (OS) that show the location of flood sources and the spatial distribution of flood risk. The associated risk magnitude is then categorised.

2.1.3 Environmental receptors considered in this assessment include the Proposed Scheme and existing development within 1km of the site boundary. The Proposed 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 environmental receptors within the study area are identified using OS mapping. 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 of the PPG FRCC.

2.1.5 The assessment then considers the vulnerability of the receptor with reference to the flood risk category of the source using Table 3 of the Planning Practice Guidance Flood Risk and Coastal Change and assesses whether the revised 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 Potential sources of flood risk

Rivers

2.2.1 The site is bounded at the northern extent by the Muxwell Brook. According to the Environment Agency flood map for planning, the site lies adjacent to Flood Zones 2 and 3.

Surface Water

2.2.2 Surface water flooding typically occurs when intense rainfall is unable to infiltrate into the ground or enter a drainage system such as a watercourse or sewer, resulting in localised flooding due to overland flow or backing up of floodwaters. Flooding events

are typically of short duration (unless there is a drainage system blockage), but can be severe. Any rain falling on the site or adjacent areas may flood the surface for a time before entering the on-site watercourses, lakes or off-site collection systems.

2.2.3 The Environment Agency publishes an online Surface Water Flooding Map, the updated Flood Map for Surface Water (uFMfSW) which shows areas at risk of flooding, as well as predicted flood depths and velocities for three design events. The mapping can be used to define the risk of flooding from surface water.

Groundwater

2.2.4 Groundwater flooding occurs when water contained within permeable soils and/or bedrock rises to a level that exceeds the ground surface elevation. It usually persists for an extended period due to the volume of the source and the slow changes in groundwater relative to surface water, but is often relatively shallow. Flooding occurs in low-lying areas or at the boundaries between permeable and impermeable soil or bedrock types. The British Geological Survey (BGS) publishes a dataset identifying the level of susceptibility to groundwater flooding from permeable superficial deposits or bedrock, which is used to assess the risk of groundwater flooding. The bedrock geology at the site is unproductive, however, there are superficial aquifers in close proximity to the site.

Drainage and Sewer Systems

2.2.5 A risk of flooding may arise from failure or blockage of surface water drainage and sewer systems. For a site in an existing Greenfield state, this risk generally only arises from surrounding highways and housing developments, and is associated with the predicted risk of flooding from surface water. Construction of a formal drainage system as part of a development introduces a risk of flooding from failure of the drainage system.

2.2.6 There are no known surface water or foul sewers crossing the site, or present in the near vicinity. Consequently, there is not currently any risk of flooding from this source.

Artificial Sources

2.2.7 Reservoir failure and overtopping, failure or overtopping of navigable waterbodies, and failure of water mains constitute the primary means of flooding from artificial sources. There are no known upstream reservoirs or canals in the vicinity of the site, nor currently any known water supply infrastructure on, or in close proximity to, the site.

2.3 Flood risk categories

2.3.1 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.

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		Outside Updated Flood Map for Surface Water (uFMfSW) extents	Surface water flooding for 1 in 1,000 years event	Surface water flooding for 1 in 100 years event	Surface water flooding for 1 in 30 years event
Groundwater	No permeable deposits	BGS Susceptibility to Groundwater Flooding (StGF) Class A	StGF Class B	StGF Class C	
Drainage and sewer systems	No sewer in vicinity of site.	Surcharge pointless than20m 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.			

2.4 Relevant regional policy

Thames Region Catchment Flood Management Plan

2.4.1 The watercourses in the area fall within the Thames Region catchment flood management plan[3] (CFMP) which covers the fluvial extent of the Thames river basin. The main messages of the CFMP revolve around the high risk of flooding to key urban centres, the majority of which lie downstream of the study area, and the predicted future increase in flood risk due to climate change. There is a high focus on managing and reducing existing flood risk in the basin through restoring and enhancing natural floodplain capacity and utilising the potential to manage floodwater through new developments, especially within the upstream tributaries. This is of particular relevance to the Muxwell Brook, where opportunities exist for at-source flood relief through natural floodplain enhancement.

2.4.2 The Thames Region CFMP states that the most sustainable approach to managing future flood risk will be to bring about adaptation of the urban environment. The CFMP indicates that strategic scale planning is key to achieving the needs of the community and managing flood risk in a more sustainable way, and that emergency planning is integral to the approach to managing extreme flood events.

[3] Environment Agency, (2008), Thames Catchment Flood Management Plan.

2.5 Local flooding planning policy documents

2.5.1 The Lead Local Flood Authority (LLFA) for this CFA is Buckinghamshire County Council (BCC). The recommendations from the BCC Preliminary Flood Risk Assessment (PFRA)[4] have been reviewed in undertaking this assessment. The draft Buckinghamshire Local Flood Risk Management Strategy (LFRMS)[5] is at the consultation stage, and was published in February 2013. The Local Authority for this CFA is Aylesbury Vale District Council (AVDC). The draft "Vale of Aylesbury Plan" core strategy is at the consultation stage.

Buckinghamshire Minerals and Waste Core Strategy

2.5.2 Paragraph 4.3 and 4.35 indicate that extraction sites will be required to consider options to alleviate flood risk through restoration solutions. Paragraphs 6.1, 6.32 and 6.37 reiterate that extraction sites should seek to reduce flood risk, including river, surface water and groundwater flooding, especially through the application of sustainable urban drainage systems (SuDS) in surface water management. This recommendation is covered by Policy CS22: Design and Climate Change.

Aylesbury Vale District Local Plan – Saved Policies

2.5.3 Since no local development framework is currently adopted for Aylesbury Vale, the Aylesbury Vale District Local Plan remains in force. Policies GP65 to GP68 relate to the water environment and flood risk, however, only GP66 "access corridors and buffers adjacent to watercourses" is saved. The remainder were withdrawn, with policy deferring to national policy and South East Plan Policies NRM1 and NRM3. The South East Plan was revoked in 2013. As a result, all relevant policy must be drawn from national guidance. Saved policy GP66 states that:

- "In riverside or canalside development proposals, the Council will require access corridors and buffers adjacent to the watercourse to: a) conserve and enhance existing areas of landscape or wildlife value; b) promote public access and provide recreational opportunity; and c) protect or enhance the environment and habitat of those watercourses."

Emerging local policy

2.5.4 The Vale of Aylesbury Plan (emerging policy) was withdrawn in January 2014. This is to be replaced by the Vale of Aylesbury Local Plan, due to be adopted in 2017. The draft Planning Policy document is due to enter consultation in July 2016. Spatial Objective 7 requires the management of the effects of climate change through avoiding development in functional floodplains and the inclusion of flood protection including the use of multi-functional green spaces. The following policies are relevant to flood risk:

- S1 Sustainable development for Aylesbury Vale, which assigns priority in granting permission for developments where the design is geared towards "meeting the effects of climate change and flooding";
- I1 Green Infrastructure, which seeks to encourage developers to implement

[4] Jacobs and BCC (2011) *Buckinghamshire County Council PFRA*
[5] BCC (2013) *Buckinghamshire County Council Local Flood Risk Management Strategy 2013 - 2018*

green infrastructure projects within Proposed Schemes to assist in flood and water resource management; and

- I4 Flooding.

2.5.5 Whilst emerging local policy will not be considered as part of application determinations, it is likely that the same principles will be viewed as material considerations in planning consultations and advice. Therefore, the provisions set forth in policy I4 should be considered during applications for development wherever possible. Policy I4 requires that:

- the sequential and exception tests (where applicable), as set out in the latest version of the SFRA, have been applied, and site-specific flood risk assessments (FRAs) compiled for all developments that could affect flood risk;
- development proposals will ensure no increase in flood risk or harm to third parties, including provision of replacement flood storage, and where possible, reduce flood risk overall;
- development proposals will ensure safety from flooding for the proposed lifetime of the development, including flood resilience and resistance measures, taking account of all forms of flooding and including appropriate allowances for climate change; and
- development proposals will include detailed drainage strategies incorporating sustainable drainage systems (SuDS) as part of any submitted application, including justification for the choice and extent of SuDS used, an indication of how water quality will be protected, and development of a management plan.

Buckinghamshire PFRA, LFRMS and SUDS guidance

2.5.6 The Buckinghamshire PFRA confirms that there are no indicative flood risk areas of national significance within Buckinghamshire. Consequently, only Stage 1 of the Flood Risk Regulations 2009 process (i.e. the PFRA) has been completed.

2.5.7 The most significant historical flood event in Buckinghamshire was caused by high groundwater levels across the Chalk aquifers, resulting in high river flows and widespread groundwater flooding in the valleys of the Chiltern Hills. The flooding occurred in the winter of 2000/2001 and is considered in the Buckinghamshire PFRA to have had "significant harmful consequences". However, the site of the Proposed Scheme is not located within this area.

2.5.8 The Buckinghamshire LFRMS guides the planning process in relation to flood risk across all categories and outlines key policies in relation to development within Buckinghamshire. Specific policies of relevance to the Proposed Scheme are:

- "Policy 6 – the LLFA will seek to reduce the risk of flooding now in a way which does not compromise the interconnected needs of the economy, society and environment in the future"; and
- "Policy 15 – sustainable drainage systems (SUDS) should be used in new developments to reduce the rate and volume of surface water runoff. Design of SUDS to meet national standards and be adopted by the SUDS Approval

Body. SUDS are expected to provide natural removal of pollutants and sediments, promote aquifer recharge, enhanced biodiversity, add aesthetic value and be easily maintainable."

2.5.9 In its capacity as lead local flood authority, BCC requires a SUDS strategy to be submitted to accompany applications for planning permission. Pre-application consultation is recommended.

Aylesbury Vale SFRA

2.5.10 The Aylesbury Vale Level 1 SFRA includes advice on planning policy within the development area, and is often used as a basis for policy setting and planning decisions. The SFRA identifies the need for surface water runoff management in the District due to particular concern over flood risk in the River Cherwell catchment of which the watercourses in the study area form a part. Infiltration based SUDS are preferred as a means of surface water management, and ground investigations are required to determine the feasibility of such techniques. In addition, opportunities are sought to enhance and supplement the existing flood storage and alleviation measures already in place for AVDC. SFRA policy indicates that:

- Management of surface runoff should use site specific and strategic SUDS measures encouraging source control where possible; and
- Proposed infrastructure should avoid interference with floodplain flow and storage where they cross existing river valleys unless they are also specifically designed as part of the strategic flood risk management options. Consultation with the EA is essential in such cases.

Aylesbury Vale WCS

2.5.11 The Aylesbury Vale Water Cycle Strategy (WCS) reviews flood risk management planning policy relevant to Aylesbury Vale, and outlines location specific concerns regarding flood risk management. The WCS identifies significant risks of fluvial flooding along the River Ray, and notes the relatively high susceptibility to groundwater flooding, particularly in Calvert Green parish. All Proposed Schemes in the Aylesbury Vale area will require detailed drainage strategies and SuDS proposals.

2.6 Design criteria

2.6.1 Although the Proposed Scheme does not form part of the Hybrid Bill application for the HS2 Phase One scheme, it is assumed that the agreed design criteria for the HS2 Phase One scheme also apply to the Proposed Scheme.

2.6.2 It is a requirement of the design that the scheme shall be protected against flooding from any source during the 1 in 1,000 years return period (0.1% annual probability) rainfall event with water levels not rising closer than 1m to the top of rail level.

2.6.3 In accordance with the NPPF, an allowance for climate change is included in the assessment. For the HS2 Phase One scheme, the agreed allowance was that peak rainfall intensity will increase by 30%, and that peak river flows will increase by 20% and 30% for Main Rivers and Ordinary Watercourses respectively. However, the

Environment Agency has recently released updated allowances for climate change that are specific to certain river basin districts[6] . The latest guidance on climate change allowances varies by development and/or receptor vulnerability, and by river catchment flood management areas. Allowances for the Thames catchment are assessed for the design life of the development, as discussed in the relevant sections of this assessment. In respect of the Proposed Scheme, the latest guidance only results in a change to the treatment of climate change allowances as they relate to peak river flows. Climate change allowances for peak rainfall intensity will remain at 30%.

[6] Environment Agency, (February 2016), *Flood risk assessments: climate change allowances*. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

3 Data sources

3.1 Primary datasets

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

3.1.2 The Proposed Scheme lies entirely outside the extent of flooding from the sea and therefore the risk of flooding from tidal sources is not considered.

3.1.3 The primary datasets 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 was undertaken on the basis of these datasets for all flood sources. Where the review indicates potentially significant impacts on the risk of flooding, or a risk of flooding to the Proposed Scheme, further investigation in the form of hydraulic modelling was 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.	Environment Agency
Surface water	uFMfSW. Local surface water flood mapping.	Environment Agency LLFA
Groundwater	Susceptibility to groundwater flooding 1:50,000 scale geological mapping (superficial and bedrock).	British Geological Survey (BGS)
Drainage and sewer systems	Sewer network plans.	Thames Water Utilities Limited (TWUL)
Artificial sources	Reservoir inundation mapping. Canal infrastructure locations. Trunk water main asset plans.	Environment Agency Canal and River Trust TWUL

3.2 Site familiarisation visits

3.2.1 The site of the Proposed Scheme was visited on two occasions. The first was undertaken in January 2013, when the Muxwell Brook upstream of the Aylesbury Link railway line, as well as parts of the downstream section and bypass channel known as the "Mega Ditch" were inspected. The Muxwell Brook was in flood during this site visit. A second visit was undertaken in April 2016 and the Muxwell Brook flow was in channel. There was no flow through the adjacent culvert and the underbridge although a non-perennial flow path was clearly evident along the natural valley located between the Proposed Scheme and Sheephouse Wood SSSI.

3.3 Hydraulic modelling

3.3.1 No hydraulic modelling of the Muxwell Brook has been undertaken to date.

4 Study area and Proposed Scheme

4.1 Topography and land use

4.1.1 The Proposed Scheme will be located on agricultural land (grazing or arable) directly to the east of the Aylesbury Link railway line. The area surrounding the Proposed Scheme is predominantly rural. The site is bounded to the north by the Muxwell Brook and Sheephouse Wood SSSI, to the east and south by agricultural land and other woodlands, and to the south by Finemere Wood nature reserve. Greatmoor Energy from Waste (EfW) facility is located on the west side of the Aylesbury Link railway line together with the current and former landfills. The nearest settlement is the village of Calvert which is approximately 1.8km north of the Proposed Scheme.

4.1.2 Both Finemere Wood SSSI and Sheephouse Wood SSSI are designated as SSSI on the basis of ancient woodland and for assemblages of plants, woodland birds and invertebrates. Finemere Wood is also a local nature reserve.

4.2 Local flood risk receptors

4.2.1 The vulnerability of each local receptor with an identified potential shared pathway within the study area is presented in Table 3. Shared pathways are defined as Flood Zone 2 or 3 of the Muxwell Brook, risk identified on the uFMfSW with either a continuous area of risk that extends to the site or an identifiable flow pathway towards or away from the site (i.e. excluding isolated ponding located off-site), risk of groundwater flooding, or a risk of flooding from artificial waterbodies in close proximity to the site. The vulnerability is classified in accordance with the recommendations of Table 2 in the PPG FRCC.

Table 3: Vulnerability of local receptors

Local receptor	Elements at risk	Vulnerability classification	Source/pathway
Romer Wood	Ancient Woodland	Water compatible	uFMfSW 1 in 30 years
Greatsea Wood	Ancient Woodland	Water compatible	uFMfSW 1 in 30 years
Sheephouse Wood SSSI	Ancient Woodland/SSSI	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C
Finemere Wood SSSI	Ancient Woodland/SSSI	Water compatible	uFMfSW 1 in 30 years
Finemerehill House	Dwelling	More vulnerable	Glacial Deposits (Pleistocene)
Woodlands Farm	Access road only to agricultural and residential properties	More vulnerable	FZ3 River Ray uFMfSW 1 in 30 years StGF Class C
Hewins Wood	Ancient Woodland	Water compatible	uFMfSW 1 in 30 years
Grendon Woods	Ancient Woodland/SSSI	Water compatible	FZ3 Muxwell Brook FZ3 River Ray uFMfSW 1 in 30 years StGF Class C

Local receptor	Elements at risk	Vulnerability classification	Source/pathway
Upper Greatmoor Farm	To be demolished under HS2 Phase One scheme	n/a	n/a
Lower Greatmoor Farm	Access road only to agricultural and residential properties	More vulnerable	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C
Moor Farm	Access road only to agricultural and residential properties	More vulnerable	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C
Calvert landfill and Greatmoor EfW facility	Landfill and waste management facilities	Less vulnerable	FZ3 Muxwell Brook uFMfSW 1 in 30 years
Knowlhill Farm	Dwelling and agricultural buildings	More vulnerable	uFMfSW 1 in 100 years
Claydon Estate	Agricultural land	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C
Land north-east of Aylesbury Link railway line and south of Sheephouse Wood SSSI	Agricultural land owned by FCC and tenanted by Portway Farm	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C
Land south-west of Aylesbury Link railway line and south of Calvert landfill	Agricultural land owned by FCC and tenanted by Portway Farm	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C
Land east of Hewin's Wood	Agricultural land owned by Oak Tree Farm, Quainton	Water compatible	uFMfSW 1 in 30 years
Land between conventional rail lines and north of Woodlands Farm	Land owned by DfT	Water compatible	uFMfSW 1 in 30 years
Land north-east of Aylesbury Link railway line and south of Finemere Wood	Land owned by Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust	Water compatible	uFMfSW 1 in 30 years

4.3 Description of Proposed Scheme

4.3.1 The Proposed Scheme is to be situated at Greatmoor, Buckinghamshire between Sheephouse Wood SSSI and near Bridleway QUA/36, where the sidings can be connected to the Aylesbury Link railway line. There will be a haul road connecting the sidings to FCC's private access road to the Greatmoor EfW facility and the Calvert landfill via Bridleway GUN/28 accommodation green overbridge.

4.3.2 The Proposed Scheme is defined as all railway, bridges, public rights of way, vehicular and pedestrian accesses, yard, slab, gantry cranes, spoil grabs, lighting and mitigation works, including earthworks, drainage, fencing, planting and power connections required to replicate the function of the existing sidings operated by FCC and Network Rail at Calvert.

4.3.3 The Proposed Scheme comprises the following :

- the 'operational sidings' situated between Sheephouse Wood SSSI and Bridleway GUN/28 comprising two pairs of twin tracks with a minimum length of 440m, each pair with a connected head shunt of min. 35m to enable engine release / run-a-round, with at least one line to the 'reception sidings';
- the 'operational sidings' will include a yard, slab and vehicle access with mobile rail mounted gantry crane facilities, capable of handling and stacking two containers and wide enough for twin tracks, a vehicle access for loading and unloading trucks and an adjacent strip for container storage;
- Bridleway GUN/28 accommodation green overbridge, which is a component of the HS2 Phase One scheme, will need to be widened to include vehicular access to the sidings and lengthened to span the additional track linking the operational and reception sidings. The green corridor and the accommodation access as shown in the HS2 Phase One scheme remain with a noise/light fence barrier separating the vehicle access and the green corridor. The vehicle access ties in with the existing FCC access road from the A41 to the Greatmoor EfW facility and Calvert landfill site which is realigned to the west of the Proposed Scheme;
- the 'operational sidings' will include a moving spoil grab and be capable of servicing either side of the spoil sidings;
- the 'reception sidings' are situated between Bridleway GUN/28 and just beyond Bridleway QUA/36 comprising two railway tracks, connected to the 'operational sidings as described above; and
- a connection to the mainline (Network Rail's Aylesbury Link railway line) will be provided at each end of the 'reception sidings' in order to allow trains to arrive from the north and the south.

5 Existing flood risk to Proposed Scheme

5.1 Historical flooding incidents

5.1.1 According to the Buckinghamshire PFRA, and Aylesbury Vale SFRA, there are no reported incidents of the site having flooded in the past. However, since the site of the Proposed Scheme is relatively remote, and there are no houses or other buildings in the area, it is unlikely that records would have been collected. Evidence collected during site visits suggests that the Muxwell Brook and the adjacent valley floods on a regular basis, however it is unknown to what extent surrounding land may be affected.

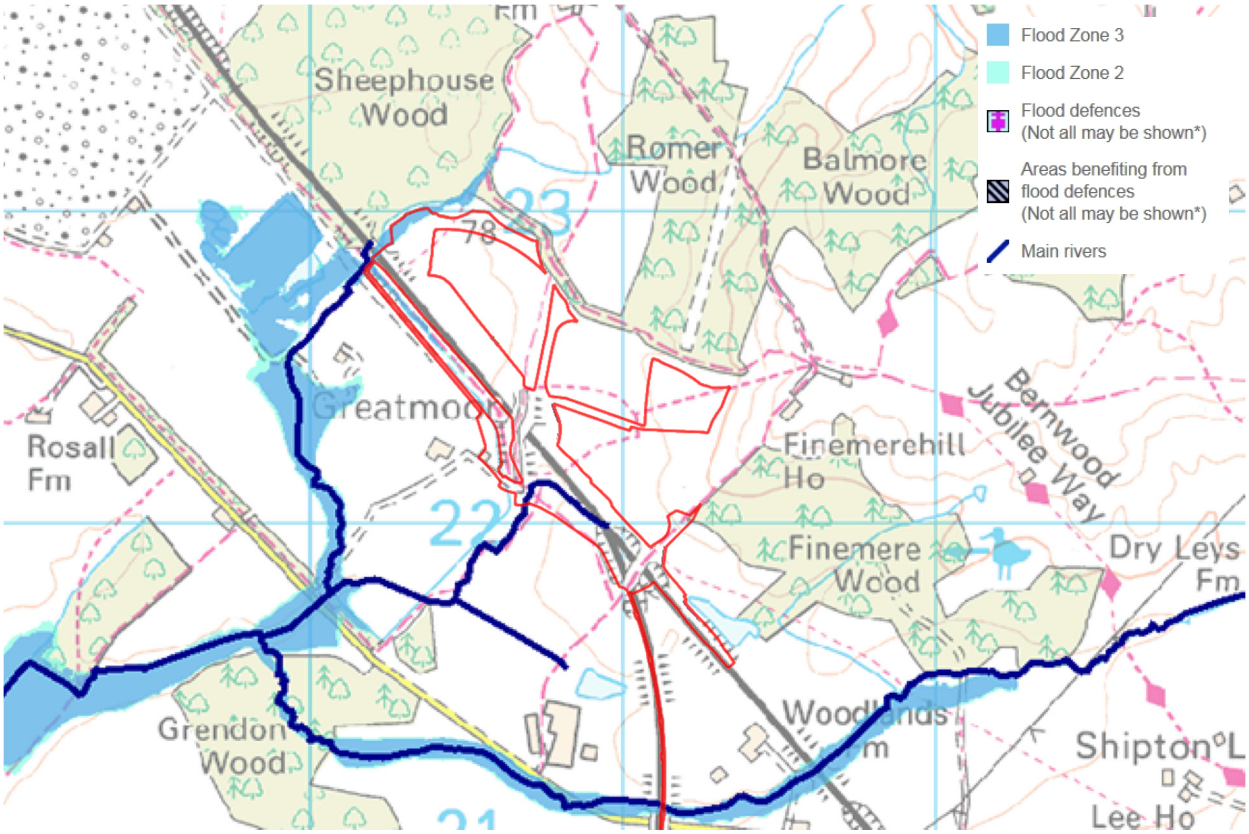
5.2 Risk of flooding from rivers

5.2.1 According to the latest Environment Agency flood map for planning, the majority of the Proposed Scheme is located within Flood Zone 1, as shown in Figure 1. However, the boundary of the site overlaps at the northern extent with Flood Zones 2 and 3 of the Muxwell Brook. Flood Zone 2 comprises "land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1% - 1%) in any year". Flood Zone 3 comprises "land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) in any year". The flood zone maps ignore the

presence of flood defence barriers, though flood storage areas may be included, depending on the hydraulic modelling undertaken. Additionally, the predicted effects of climate change are not included in the flood zone mapping.

5.2.2 The only elements that fall within Flood Zone 3 are the access track to the northern-most balancing pond, which forms part of the current design for the Proposed HS2 Phase One Scheme.

Figure 1: Environment Agency Flood Map for Planning[7]



Mechanism of flooding

5.2.3 The Muxwell Brook has a catchment size of approximately 4km2 at the intersection with the Proposed Scheme resulting in an estimated 1 in 100 years return period (1% annual probability) peak flood flow of approximately 8.5m3/s (calculated using the ReFH2 rainfall runoff methodology). The corresponding 1 in 1000 years return period (0.1% annual probability) flow is 13.6m3/s, 60% higher. The Muxwell Brook flows beneath the Aylesbury Link railway line embankment in a 1' 6" (.45m) Vitrified Clay Network Rail Culvert (Muxwell Brook Culvert). The base of the natural valley crosses the Aylesbury Link railway line embankment around 100m south of the culvert conveying the watercourse suggesting that the Muxwell Brook channel, which flows along the southern boundary of Sheephouse Wood SSSI, has historically been diverted away from its natural course. During the site walkover survey of the area undertaken in January 2013 out-of-channel flow was observed along the base of the natural valley discharging via the existing underbridge and adjacent culvert (existing 3' (0.91m) brick Network Rail culvert – Greatmoor No. 4 Culvert). The existing access underbridge was flooded with standing water. Although the survey was undertaken

[7] Contains Environment Agency information © Environment Agency and database right 2016

during the winter months there had been no exceptional rainfall events in the recent past. In addition, silt deposits and vegetation damage observed within the valley suggested that more significant flooding of the valley had recently been experienced. Therefore, the access underbridge may experience flooding on a relatively frequent basis.

5.2.4 In association with the mineral extraction works at the Calvert landfill site the Muxwell Brook has been subject to a significant diversion downstream of the Aylesbury Link railway line embankment (to the west side). Known as the Mega Ditch the diverted channel runs southeast alongside the existing railway for approximately 700m before turning perpendicular away from the route to the south. The channel is understood to carry the majority of flow of the Muxwell Brook around the perimeter of the site returning to the natural channel at the Edgcott to Shipton Lee Road. According to the Muxwell Brook Reinstatement and Realignment report[8] the channel was designed with sufficient capacity to fully convey the 1 in 100 years return period (1% annual probability) flood flow. Following restoration works for the Greatmoor EfW facility, the Mega Ditch will continue to serve as a flood relief channel carrying approximately 40% of baseflow at all times and the majority of the flow during flood events with a 1 in 20 years return period (5% annual probability) or greater.

Flood levels

5.2.5 A comparison of the outline of each flood zone with LiDAR for this crossing suggest a 1 in 1000 years return period (0.1% annual probability) flood water level of no more than 76m AOD. The ground level of the floodplain is approximately 74-75m AOD. In the absence of detailed modelling, and on the basis that no works are proposed within the flood zone extents for the Muxwell Brook, the 1 in 1000 years return period (0.1% annual probability) flood level and outline has been used to define the 1 in 100 years return period (1% annual probability) flood including an allowance for climate change. This is a conservative approach, since the calculated 1 in 1000 years return period (0.1% annual probability) flow is 60% higher than that calculated for the 1 in 100 years return period (1% annual probability).

Risk of flooding to operational elements

5.2.6 All elements of the Proposed Scheme, with the exception of the access track to the northernmost balancing pond, lie outside of the area at risk of flooding from rivers according to the Environment Agency Flood Zone Maps. The closest elements to the Muxwell Brook are the sidings themselves, which are to be set at 80m AOD, some 4m above the maximum predicted flood water level in the Muxwell Brook. The access track to the balancing pond, which passes through the Sheephouse Wood SSSI underbridge, forms part of the Proposed HS2 Phase One Scheme, and is therefore included in the baseline. No modifications to this track relative to the baseline are proposed within the floodplain of the Muxwell Brook as part of the Proposed Scheme.

5.2.7 As part of the Proposed Scheme, track drainage from the proposed HS2 Phase One scheme will be conveyed around the northern perimeter of the access road to the balancing ponds. The potential route for conveying track drainage crosses the Muxwell Brook flood flow route which can currently flow through the access

[8] FCC Environment Ltd (2012), *Muxwell Brook Reinstatement and Realignment Report*

underbridge in extreme events. Provision therefore needs to be made to ensure that the flood flow route for the Muxwell Brook is maintained such that there is no increase in flood risk. It is also necessary to ensure that flood water from the Muxwell Brook cannot flow into the balancing ponds. There are several options which will be considered at the detailed design stage.

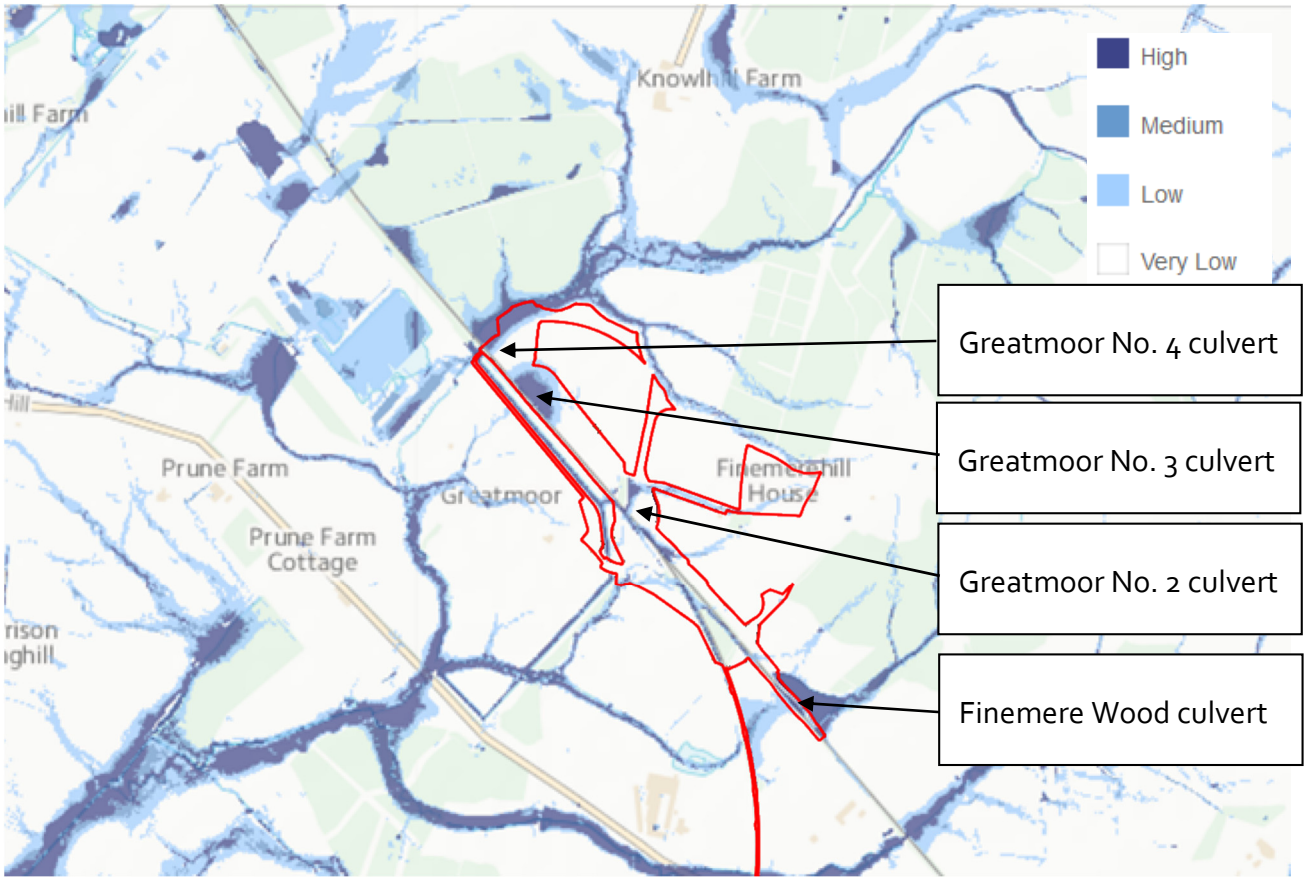
5.2.8 Consequently, there is no significant risk of flooding from rivers to the Proposed Scheme.

5.3 Risk of flooding from surface water

5.3.1 Surface water flooding is defined as the extent of flooding from rainfall prior to collection of water into natural or artificial drainage. Flooding typically occurs when intense rainfall is unable to infiltrate into the ground or enter a drainage system such as a watercourse or sewer, resulting in localised flooding due to overland flow or backing up of floodwaters. Flooding events are typically of short duration (unless there is a drainage system blockage), but can be severe.

5.3.2 The Environment Agency Flood Map for Surface Water (uFMfSW) shows the areas at risk from surface water flooding. Areas of the site are shown to be at varying risk, with the most significant risks (1 in 30 years return period or 3.3% annual probability) associated with the natural valleys of the Muxwell Brook and a tributary towards the south of the Proposed Scheme at Finemere Wood SSSI, plus four dry valleys between the two watercourses, as shown in Figure 2. Since the uFMfSW typically does not include culverts, dry valleys upstream of the existing embankment are clearly shown, and generally present a worst-case illustration of the likely flood extent for each scenario.

Figure 2: Environment Agency online updated Flood Map for Surface Water[9]



5.3.3 The majority of the operational elements of the Proposed Scheme will be raised significantly above surrounding ground, to 80m AOD, and are consequently not at significant risk of flooding from surface water. This includes the area of ponding upstream (northeast) of Greatmoor No. 3 culvert (near the south easterly corner of the two proposed balancing ponds).

5.3.4 The exception to this is to the south of the Proposed Scheme, where the reception sidings, to be constructed in cutting up to 2.1m deep, are located within the area at risk from the southernmost dry valley. The risk of flooding in this dry valley is classified as "Low", and it is proposed to collect surface water into a drain along the north-eastern side of the Proposed Scheme, to be discharged to a culvert under the Proposed Scheme at the northern extent of the reception sidings (Greatmoor No. 2 Culvert). The drain will be sized to convey the calculated 1 in 100 years return period (1% annual probability) flow including an allowance for climate change of 30%. This drain will therefore prevent overland flow from entering the cuttings.

5.3.5 The overall risk of flooding from surface water to operational elements of the Proposed Scheme is therefore low.

5.4 Risk of flooding from groundwater

5.4.1 According to the Buckinghamshire PFRA maps, the probability of groundwater flooding from the superficial deposits at the site is low to moderate. However, there are no areas shown at risk on the groundwater emergence map.

[9] Contains Environment Agency information © Environment Agency and database right 2016

5.4.2 The site is not located above any bedrock or superficial strata that are designated as aquifer according to Environment Agency records. The surface bedrock at the site is the West Walton Formation and the Weymouth Member (Oxford Clay Formation), both of which are unproductive (non-water bearing) strata. There are no superficial deposits on the Proposed Scheme site, with the exception of Alluvium deposits along the valleys of the Muxwell Brook and the tributary at Finemere Wood SSSI. These alluvial deposits are classified as Secondary A aquifers, and may therefore contain some groundwater. According to the BGS susceptibility to groundwater flooding dataset, there is a risk of groundwater emerging at the surface within these alluvial deposits.

5.4.3 Groundwater levels in the alluvium are likely to be heavily influenced by water levels in the associated watercourses. All elements of the Proposed Scheme are located above the level of the watercourses, and it is therefore highly unlikely that the Proposed Scheme is at risk of flooding from groundwater from these sources.

5.4.4 In addition, there are glacial deposits to the east and north of the Proposed Scheme that are classified as Secondary Undifferentiated aquifers. These may also contain some groundwater. However, they are located sufficiently distant from the Proposed Scheme that any emergence above ground level would follow natural flow paths and be contained within the areas shown to be at risk of flooding from surface water. There are no potable source protection zones in the vicinity of the site. The risk of flooding from groundwater, independent from the risk of flooding from rivers or surface water, is therefore negligible.

5.5 Risk of flooding from drainage systems

5.5.1 There is no existing formal drainage present on the site. Consequently there is no risk of flooding from failure of the existing surface water collection systems. The surface water drainage strategy will be designed to contain the 1 in 100 years return period (1% annual probability) rainfall event, including an allowance for climate change of 30%, without causing flooding of operational areas. The drainage system will be designed to incorporate SuDS and take account of ground level gradients, such that the risk of buildings becoming flooded in the event of drainage system failure or more extreme events is minimised. Therefore, the Proposed Scheme will not be at significant risk of flooding from drainage systems.

5.6 Risk of flooding from artificial sources

5.6.1 Reservoir failure and overtopping, failure or overtopping of navigable waterbodies, and failure of water mains constitute the primary means of flooding from artificial sources. There are no known upstream reservoirs or canals in the vicinity of the site, nor currently any known water supply infrastructure on, or in close proximity to, the site.

5.7 Summary of baseline flood risk

Table 4: Summary of baseline flood risk for all sources of flooding

Source of flooding	Location of flooding source	Flood risk category	Elements at risk	Assessment of risk
Rivers	Muxwell Brook	Very High	No operational elements	No significant risk
Surface Water	Rain falling on site Muxwell Brook, Finemere Wood Tributary 4x Dry Valleys	Very High	Operational elements at or below ground level	Surface water intercepted by drains along the west-side of the Proposed Scheme designed to convey the 1 in 100 years return period (1% annual probability) flow including an allowance for climate change. No significant risk.
Groundwater	Superficial deposits	High	No significant risk to facilities	Any groundwater emergence will follow surface water flow paths and be collected into local watercourses.
Artificial Waterbodies	None identified	n/a	n/a	n/a

6 Post-development flood risk assessment

6.1 Local receptors

6.1.1 In addition to the risk of flooding that exists to the Proposed Scheme, there is potential for the Proposed Scheme to affect the risk of flooding to third party receptors by altering flow mechanisms for the range of flood sources. All local receptors with a potential flood risk impact pathway are identified in Section 5.2 of this report. For the Proposed 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 Proposed Scheme. Table 5 summarises the shared pathways between the Proposed Scheme and each receptor, and identifies cases where no shared pathway exists.

Table 5: Shared flood risk pathways

Local receptor	Vulnerability classification as per the NPPF	Pathway	Shared pathway between Proposed Scheme and receptor
Romer Wood ancient woodland	Water compatible	uFMfSW 1 in 30 years	Approx. 1km upstream of Proposed Scheme (along natural valleys)
Greatsea Wood ancient woodland	Water compatible	uFMfSW 1 in 30 years	Approx. 1.2km upstream of Proposed Scheme (along natural valleys)
Sheephouse Wood ancient woodland/SSSI	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Adjacent to Proposed Scheme
Finemere Wood ancient woodland/SSSI	Water compatible	uFMfSW 1 in 30 years	Approx. 100m upstream of Proposed Scheme
Finemerehill House	More vulnerable	Glacial Deposits (Pleistocene)	No proposed works within aquifer – no shared pathway
Woodlands Farm access road	More vulnerable	FZ3 River Ray uFMfSW 1 in 30 years StGF Class C	No proposed works within River Ray catchment – no shared pathway
Hewins Wood ancient woodland	Water compatible	uFMfSW 1 in 30 years StGF Class C	Approx. 500m downstream of Proposed Scheme
Grendon Wood ancient woodland/SSSI	Water compatible	FZ3 Muxwell Brook FZ3 River Ray uFMfSW 1 in 30 years StGF Class C	Approx. 900m downstream of Proposed Scheme (along natural valleys)
Lower Greatmoor Farm access road	More vulnerable	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Approx. 800m downstream of Proposed Scheme (along natural valleys)
Moor Farm access road	More vulnerable	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Approx. 300m downstream of Proposed Scheme
Calvert Landfill and Greatmoor EfW facility	Less vulnerable	FZ3 Muxwell Brook uFMfSW 1 in 30 years	Immediately downstream of Proposed Scheme

Local receptor	Vulnerability classification as per the NPPF	Pathway	Shared pathway between Proposed Scheme and receptor
Knowlhill Farm	More vulnerable	uFMfSW 1 in 100 years	Approx. 1km upstream of Proposed Scheme
Claydon Estate agricultural land	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Adjacent to Proposed Scheme
Agricultural land north-east of Aylesbury Link railway line and south of Sheephouse Wood SSSI	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Adjacent to Proposed Scheme
Agricultural land south-west of Aylesbury Link railway line and south of Calvert Landfill	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Adjacent to Proposed Scheme
Agricultural land east of Hewins Wood	Water compatible	uFMfSW 1 in 30 years	Adjacent to Proposed Scheme
DfT land between conventional rail lines and north of Woodlands Farm	Water compatible	uFMfSW 1 in 30 years	Immediately downstream of Proposed Scheme
Nature reserve land north-east of Aylesbury Link railway line and south of Finemere Wood	Water compatible	uFMfSW 1 in 30 years	Immediately upstream of Proposed Scheme

6.1.2 There is also the potential for the Proposed Scheme to change the baseline risk of flooding on the site as described in Section 5 of this report. Though designed such that the risk of flooding at the site is minimised and managed, any change to the baseline risk of flooding could impact on the assessment of flood risk to the Proposed Scheme. All sources of flood risk discussed in Section 5 of this report are therefore reconsidered regardless of the presence or otherwise of third party local receptors.

6.2 Impact on risk of flooding from rivers

6.2.1 Under the Proposed Scheme there will be no development within the area at risk of flooding from the Muxwell Brook which could affect flood flow mechanics or displace flood water.

6.2.2 The proposed sidings extend into the area recommended under the proposed HS2 Phase One Scheme for replacement floodplain storage for the Muxwell Brook. This area will therefore be re-shaped by extending the area to the north-east. The detailed design of this storage area will be determined as part of the Proposed HS2 Phase One Scheme.

6.2.3 There will be no significant impact on the risk of flooding from rivers as a result of the Proposed Scheme.

6.3 Impact on the risk of flooding from surface water

6.3.1 Overland flow of surface water will be collected into channels designed to convey the 1 in 100 years return period (1% annual probability) runoff including an allowance for climate change, and discharged beneath the Proposed Scheme in culverts. By

collecting surface water in this manner, the areas shown to be at risk of flooding from surface water on the eastern side of the existing conventional rail embankment will no longer be at risk of flooding. This is particularly relevant to the area of ponding upstream of Greatmoor No. 3 culvert. The Proposed Scheme will occupy the area currently shown as at risk of surface water flooding. Surface water from the sidings will be collected, attenuated in balancing ponds and discharged at the equivalent Greenfield rate to the Greatmoor No. 3 culvert.

6.3.2 A new ditch will be constructed along the north eastern perimeter of the Proposed Scheme, diverting surface water from the existing ditch east of the proposed Bridleway GUN/28 accommodation green overbridge and access road overbridge. This drain will intercept any overland flow from the east and northeast flowing towards the proposed balancing ponds and will be sized to convey the calculated 1 in 100 years return period (1% annual probability) flow including an allowance for climate change of 30%.

6.3.3 The same principle applies to the proposed ditch along the north eastern perimeter of the reception sidings as described in paragraph 5.3.4. The outfall for this new ditch will be the Greatmoor No. 2 culvert.

6.3.4 There is a source of a ditch on the western side of the existing haul road and southeast of Greatmoor No. 2 culvert. The proposed haul road diversion will be south of the existing ditch and the ditch will therefore not be lost. A short culvert will be required to convey flows in the ditch below the proposed Bridleway GUN/28 accommodation green overbridge and access road overbridge downstream of where this ditch joins the ditch flowing from the Greatmoor No. 2 culvert.

6.3.5 A ditch is proposed along the north eastern perimeter of the Proposed Scheme southeast of Bridleway QUA/36 accommodation green overbridge. This ditch will outfall to the existing fishing lake. No extension of the Finemere Wood SSSI culvert is necessary as the existing culvert already extends from the fishing lake, beneath the Aylesbury Link railway line and approximately 100m across the field west of the Aylesbury Link railway line. The Proposed Scheme is within this margin.

6.3.6 Consequently, there will be no significant impact on the risk of flooding from this source as a result of development within the area of risk.

6.3.7 There is an additional potential impact on flood risk from surface water arising due to the introduction of impermeable surfaces onto the site, and the effect that this has on the rates and volumes of surface water runoff. The Proposed Scheme drainage will be designed in accordance with the following technical standards:

- The design shall ensure no overall increase in flood risk during events up to and including the design event (100 year flow plus climate change);
- a 30% allowance for climate change will be applied;

Railway drainage

- railway drainage shall be a dedicated system to intercept surface and groundwater within and around the perimeter of the Proposed Scheme, keeping rail and non-rail drainage systems separate;

- perimeter drainage will be provided along all embankments to prevent flow onto surrounding land, and to keep rail drainage and land drainage runoff separate- perimeter land drainage will not connect to rail drainage attenuation ponds;
- perimeter drainage will be designed to prevent flooding of the Proposed Scheme in the 1 in 1000 year event; trackside drainage will be sized to convey the flow for a rainfall event with a return period of 1 in 5 years (plus 30% allowance for climate change) without surcharging;
- cut-off ditches shall be sized (as a minimum) to convey the 1 in 30 year event (plus 30% allowance for climate change);
- design of surface water management shall comply with the best practice and SuDS hierarchy;
- the design of surface water management systems will ensure overall run-off rates are reduced to greenfield values, for the annual average rainfall event, and for those with a return period 30 years and 100 years (including climate change allowance);

Buildings and facilities drainage

- buildings and facility drainage shall be kept separate from all other drainage systems;
- rainwater and foul water drainage shall be kept separate;
- surface flows from land surrounding buildings and facilities shall be collected into a perimeter drainage system designed to the same standards as railway drainage as outlined above;

Highway and access drainage

- positive drainage will be provided for overbridges and underbridges including approaches to collect all runoff in a controlled manner and prevent erosion;
- perimeter drainage will be provided along all embankments to prevent flow onto surrounding land, and to keep highways and land drainage runoff separate;
- drainage system shall be designed to ensure no surcharge during a 1 in 1 year rainfall event, and no flooding during a 1 in 5 event;
- surface water flows in excess of the calculated equivalent greenfield rate shall be fully attenuated, up to the 1 in 100 year rainfall event (including climate change allowance);
- perimeter drainage shall be designed to a 1 in 75 year rainfall event (including climate change allowance);
- attenuation ponds shall be designed in accordance with CIRIA C753 'The SUDS Manual' to attenuate flows for rainfall events up to a 100 year return period plus climate change allowance, using a storm duration that generates the highest storage requirement when applying a flat maximum allowable

discharge (equivalent to the present-day greenfield runoff rate);

- drainage systems will be designed to include potential inflows of groundwater, including the sizing of attenuation facilities; and
- the design of highway and access drainage will ensure no increase in the risk of flooding and the flood routing of excess surface flows shall be checked to ensure that there is no risk to property.

6.3.8 The detailed design of drainage will be subject to the restrictions outlined above. Runoff from the Proposed Scheme will be intercepted and discharged at rates attenuated to the equivalent Greenfield runoff rate up to and including the 1 in 100 years return period (1% annual probability) rainfall event including a 30% allowance for climate change. No runoff onto surrounding ground will be permitted, and likewise no runoff from surrounding ground will be permitted onto the area of the Proposed Scheme. A commitment to ensure that flood risk is not increased elsewhere is maintained in the standards of design, and shall be proven during detailed design of the drainage for the Proposed Scheme. Consequently, there will be no significant impact on the risk of flooding elsewhere due to rainfall.

6.4 Impact on the risk of flooding from groundwater

6.4.1 According to the water resources assessment (Volume 4.12: Environmental Statement Technical Appendix: Water resources assessment), the Proposed Scheme will not significantly affect groundwater levels in the aquifers surrounding the site. As a result, the Proposed Scheme will not affect the risk of flooding from groundwater to vulnerable local receptors.

6.5 Impact on the risk of flooding from drainage systems

6.5.1 The Proposed Scheme will incorporate a newly designed system of surface water and foul water collection and disposal. Discharge will be to the local watercourses at rates attenuated to the equivalent Greenfield runoff rate, as appropriate.

6.5.2 The Proposed Scheme will not have an effect on flooding of any of the identified receptors from underground surface and foul water collection systems.

6.6 Impact on the risk of flooding from artificial sources

6.6.1 There are no areas on the site that are currently at risk of flooding from canals, reservoirs or water mains. The Proposed Scheme will not discharge water to, nor otherwise materially affect, the structural integrity or capacity of artificial sources. Consequently, there are no shared pathways between the Proposed Scheme and potential receptors in relation to the risk of flooding from artificial sources, and no effect on the risk of flooding from such sources.

6.7 Summary of potential impacts and effects on flood risk

Table 6: Summary of potential impacts and effects on flood risk

Receptor	Vulnerability classification	Pathway	Impacts and effects
Proposed Scheme	N/A	Rivers	There are no works proposed within the area at risk of flooding from rivers. Mitigation for the HS2 Phase One scheme is affected, but will be designed accordingly in a slightly altered location. No significant effects expected.
		Surface water	Rainfall to be collected and discharged surface watercourses, having been attenuated to equivalent Greenfield rates. No significant effects expected.
		Groundwater	No significant effects expected.
		Drainage systems	No significant effects expected.
		Artificial sources	No effects expected
Romer Wood ancient woodland	Water compatible	uFMfSW 1 in 30 years	No upstream effects expected
Greatsea Wood ancient woodland	Water compatible	uFMfSW 1 in 30 years	No upstream effects expected
Sheephouse Wood ancient woodland/SSSI	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Mitigation proposed under Proposed HS2 Phase One Scheme will be reconfigured. Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected. No significant effect on the risk of flooding from groundwater expected.
Finemere Wood ancient woodland/SSSI	Water compatible	uFMfSW 1 in 30 years	Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected.
Hewins Wood ancient woodland	Water compatible	uFMfSW 1 in 30 years StGF Class C	Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected. No significant effect on the risk of flooding from groundwater expected.
Grendon Woods ancient woodland/SSSI	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Mitigation proposed under Proposed HS2 Phase One Scheme will be reconfigured. Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected. No significant effect on the risk of flooding from groundwater expected.
Lower Greatmoor Farm access road	More vulnerable	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Mitigation proposed under Proposed HS2 Phase One Scheme will be reconfigured. Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected. No significant effect on the risk of flooding from groundwater expected.

Receptor	Vulnerability classification	Pathway	Impacts and effects
Moor Farm access road	More vulnerable	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Mitigation proposed under Proposed HS2 Phase One Scheme will be reconfigured. Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected. No significant effect on the risk of flooding from groundwater expected.
Calvert landfill and Greatmoor EfW facility	Less vulnerable	FZ3 Muxwell Brook uFMfSW 1 in 30 years	Mitigation proposed under Proposed HS2 Phase One Scheme will be reconfigured. Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected.
Knowlhill Farm	More vulnerable	uFMfSW 1 in 100 years	No upstream effects expected
Claydon Estate agricultural land	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Mitigation proposed under Proposed HS2 Phase One Scheme will be reconfigured. Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected. No significant effect on the risk of flooding from groundwater expected.
Agricultural land north-east of Aylesbury Link railway line and south of Sheephouse Wood SSSI	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Changed configuration of Proposed HS2 Phase One mitigation will alter the impact on agricultural land but does not constitute a significant effect. No further significant effects expected. No significant effect on the risk of flooding from groundwater expected.
Agricultural land south-west of Aylesbury Link railway line and south of Calvert landfill	Water compatible	FZ3 Muxwell Brook uFMfSW 1 in 30 years StGF Class C	Mitigation proposed under Proposed HS2 Phase One Scheme will be reconfigured. Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected. No significant effect on the risk of flooding from groundwater expected.
Agricultural land east of Hewins Wood	Water compatible	uFMfSW 1 in 30 years	Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected.
DfT land between conventional rail lines and north of Woodlands Farm	Water compatible	uFMfSW 1 in 30 years	Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected.
Nature reserve land north-east of Aylesbury Link railway line and south of Finemere Wood	Water compatible	uFMfSW 1 in 30 years	Surface water will be collected into ditches and discharged at attenuated rates. No significant effect on the risk of flooding from rivers or surface water expected.

7 Flood risk management measures

7.1 Risk of flooding from rivers

Risk of flooding on-site

7.1.1 The Proposed Scheme does not lie within the area shown to be at risk of flooding from the Muxwell Brook on the Environment Agency Flood Zone maps. Elements of the Proposed Scheme that are closest to this location are raised on embankment.

7.1.2 The access track to the northern balancing pond lies within Flood Zone 3 of the Muxwell Brook. However, this track is part of the proposed HS2 Phase One Scheme, and will not be altered by the Proposed Scheme. Consequently, this does not form part of the Proposed Scheme, and is not assessed further.

7.1.3 There is no significant risk of flooding to the Proposed Scheme from the Muxwell Brook.

Impact of Proposed Scheme on flood risk

7.1.4 The Proposed Scheme is designed such that there will be no increase in ground levels within the modelled extent of the 1 in 100 years return period (1% annual probability) flood event including an allowance for climate change. As a result, no additional replacement flood storage will be required for the proposed landscaping and re-grading works. Should ground raising within the floodplain become necessary (including temporary works), alternative flood storage will be provided to the same volume as that lost, at the same level, in 100mm increments, as per standard Environment Agency guidelines.

7.2 Risk of flooding from surface water

Risk of flooding on-site

7.2.1 Surface water flowing overland towards the Proposed Scheme will be intercepted by drains along the west-side of the Proposed Scheme designed to convey the 1 in 100 years return period (1% annual probability) flow including an allowance for climate change. These drains pass beneath the Proposed Scheme in culverts designed to the same standard. Consequently, there will be no significant risk of flooding from surface water to the Proposed Scheme, and no further mitigation is required.

Impact of Proposed Scheme on flood risk

7.2.2 There is a potential for the Proposed Scheme to affect the risk of flooding from surface water due to a change in the runoff rates and volumes from developed areas of the site. Surface water will be collected and discharged to local watercourses at equivalent Greenfield rates. Surface water falling on the sidings will be collected into new ditches and balancing ponds and discharged beneath the Proposed Scheme using extended existing culverts to the Mega Ditch on the south side of the Aylesbury Link railway line. All surface water falling on the access road will discharge via attenuation ponds to the local ditch network in the same way.

7.2.3 The Proposed Scheme will not increase the rates or volumes of runoff leaving the site and therefore no additional mitigation is required.

7.3 Risk of flooding from groundwater

7.3.1 There will be no significant risk of flooding from groundwater to the Proposed Scheme, nor any anticipated effects on the risks of flooding from groundwater within the study area arising from the Proposed Scheme. Therefore, no specific mitigation will be required.

7.4 Risk of flooding from drainage systems

7.4.1 There will be no significant risk of flooding from drainage systems to the Proposed Scheme, nor any anticipated effects on the risks of flooding from drainage systems within the study area arising from the Proposed Scheme. Therefore, no specific mitigation will be required.

7.5 Risk of flooding from artificial sources

7.5.1 There will be no significant risk of flooding from artificial sources to the Proposed Scheme, nor any anticipated effects on the risks of flooding from artificial sources within the study area arising from the Proposed Scheme. Therefore, no specific mitigation will be required.

8 Conclusions

8.1 Summary

8.1.1 The HS2 Phase One scheme results in the removal of existing sidings associated with the Greatmoor EfW facility and Calvert landfill. These sidings were due to be replaced north of Sheephouse Wood SSSI, however, an application is being sought under TWAO to provide replacement sidings in a location south of Sheephouse Wood SSSI, closer to the Greatmoor EfW facility and Calvert landfill, away from the village of Calvert.

8.1.2 Located on agricultural land to the east of the existing Aylesbury Link railway line, the Proposed Scheme includes sidings, associated material transfer infrastructure, a haul road and will involve modifications to the green overbridge structure, part of the Proposed HS2 Phase One Proposed Scheme, to enable vehicle movements to convey material from the sidings to the Greatmoor EfW facility and Calvert landfill site.

8.1.3 The study area includes all areas within 1km of the site boundary. The study area includes areas at risk of flooding from the following sources:

- areas at risk of flooding from the Muxwell Brook;
- areas at risk of surface water flooding, largely due to the existing conventional rail embankment which crosses a number of dry and natural stream valleys; and
- areas at risk of flooding from groundwater in alluvial deposits along the Muxwell Brook and a tributary stream arising in Finemere Wood.

8.1.4 With the exception of an access track to a balancing pond located towards the northern extent of the Proposed Scheme, no works will take place within the area at risk of flooding from the Muxwell Brook. This access track forms part of the proposed HS2 Phase One Scheme, and is therefore part of the baseline. No modifications to this access track, relative to the HS2 Phase One scheme, are proposed. The Proposed Scheme extends into the area set aside as replacement floodplain storage for the proposed HS2 Phase One Scheme, which will be moved upstream as a result. This will not affect the impact of the proposed HS2 Phase One Scheme, as the mitigation for that scheme will be designed to take this alteration into consideration. Consequently, the Proposed Scheme is not at significant risk of flooding from the Muxwell Brook, and will not affect the risk of flooding elsewhere from this source due to displacement of flood water or obstruction of flood flows.

8.1.5 The Proposed Scheme will result in ground works within areas at risk of flooding from surface water. The majority of these works will involve raising of ground levels, with the exception of the reception sidings, which are located below existing ground level within an area at risk of flooding. The Proposed Scheme will incorporate a newly designed system of surface water and foul water collection and disposal. Discharge will be to the local watercourses at rates attenuated to the equivalent Greenfield runoff rate, as appropriate. Therefore, the areas shown at risk of surface water flooding will no longer exist in current form.

8.1.6 Interceptor drains and balancing ponds are included in both the Proposed Scheme and the proposed HS2 Phase One Scheme, and will all be designed to convey the 1 in 100 years return period (1% annual probability) flood flows including an allowance for climate change. All balancing ponds will discharge at attenuated rates to the local watercourse. As a result, the Proposed Scheme is not at significant risk of flooding from this source, and will not affect the risk of flooding elsewhere from surface water.

8.1.7 There is a risk of groundwater flooding from water contained within the alluvial deposits along the Muxwell Brook and Finemere Wood SSSI tributary. Groundwater levels are expected to be closely related to water levels and thus no substantial additional risk of flooding exists. The water resources assessment for the Proposed Scheme concluded that no effect on groundwater levels is expected. Therefore the Proposed Scheme is not expected to affect the risk of flooding elsewhere from groundwater.

8.1.8 As a result of proposed mitigation measures, there will be no significant increase in the risk of flooding to third party receptors arising from the scheme.

8.2 Residual flood risks to Proposed Scheme

8.2.1 The Proposed Scheme does not lie within areas shown to be at significant risk of flooding from rivers, groundwater or artificial waterbodies. The majority of the Proposed Scheme is raised above surrounding ground, with the only exception being the reception sidings, which are at risk of flooding from overland flow along the Finemere Wood tributary. Surface water flowing overland towards the Proposed Scheme will be intercepted by drains along the west-side of the Proposed Scheme designed to convey the 1 in 100 years return period (1% annual probability) flow including an allowance for climate change, and will not flood into the cutting.

8.3 Residual effects of the Proposed Scheme on flood risk

8.3.1 Replacement flood storage will be provided for any losses arising due to structures, built volume or ground raising within the modelled 1 in 100 years return period floodplain, including an appropriate allowance for climate change. Storage will be replaced by volume at the same level from which it was removed in 100mm increments as per standard Environment Agency methodology. Replacement storage in all cases will be provided prior to construction. No works will be undertaken within the flood zones of the Muxwell Brook, however the proposed sidings fall within the area proposed for replacement flood storage for the HS2 Phase One scheme. Consequently, mitigation proposed as part of the HS2 Phase One scheme will be modified to ensure sufficient mitigation is provided.

8.3.2 Rain falling on impermeable surfaces will be collected and discharged to nearby watercourses, having first been passed through appropriate SuDS features to attenuate runoff rates to the equivalent Greenfield rate for each drainage catchment, for all events up to and including the 1 in 100 years return period rainfall event including an allowance for climate change. The total volume and peak rates of runoff discharging to the local watercourses during extreme rainfall events will be equal to or less than existing discharge rates.

8.3.3 Drainage attenuation and balancing ponds proposed as mitigation for the HS2 Phase One scheme will be displaced by the Proposed Scheme. These ponds will be replaced to the same capacity and specification, prior to commencement of any works within the area of the HS2 Phase One Scheme mitigation.

8.3.4 There will be no significant residual adverse effects of the Proposed Scheme on the risk of flooding elsewhere.

8.4 Compliance with local planning policy

8.4.1 By avoiding increasing the risk of flooding to all local receptors, as well as attenuating all runoff to calculated greenfield runoff rates, the Proposed Scheme is in accordance with the Thames Region CFMP, the Buckinghamshire Minerals and Waste Core Strategy, the Buckinghamshire LFRMS and the Aylesbury Vale SFRA.

8.4.2 The use of SuDS in the form of drainage channels and ponds is in accordance with national SuDS policy as well as the Buckinghamshire Minerals and Waste Core Strategy, the Buckinghamshire LFRMS, the Aylesbury Vale WCS and the Aylesbury Vale SFRA.

8.4.3 The provision of woodland habitat creation areas alongside watercourse corridors is in accordance with the provisions of Aylesbury Vale District Local Plan saved policy GP66. Further opportunities exist in the design of the proposed woodland habitat creation to take advantage of the natural attenuation and water distribution properties of woodland in reducing downstream flood risk, which should be explored in the detailed design of both the proposed HS2 Phase One and Proposed Scheme woodland habitat creation planting schemes.

8.4.4 Emerging local policy promotes planning for future climate change and the design of development to be sensitive to the promotion of green spaces. SuDS are encouraged. The Proposed Scheme is in accordance with these aims.