A1 Birtley to Coal House

Scheme Number: TR010031

6.3 Environmental Statement – Appendix 13.1 Flood Risk Assessment

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 6

August 2019

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedures) Regulations 2009

A1 Birtley to Coal House

Development Consent Order 20[xx]

Environmental Statement - Appendix

Regulation Reference:	APFP Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010031
Application Document Reference	TR010031/APP/6.3
Author:	A1 Birtley to Coal House Project Team, Highways England

Version	Date	Status of Version
Rev 0	14 August 2019	Application Issue

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1. INTRODUCTION

1.1. APPOINTMENT AND BRIEF

1.1.1. WSP UK Ltd (WSP) was commissioned by Highways England to undertake a Flood Risk Assessment (FRA) to support the Environmental Impact Assessment (EIA) and DCO Application for the A1 Birtley to Coal House Scheme (the Scheme).

1.1.2. This assessment has been undertaken in accordance with the guidelines set out in the National Policy Statement for National Networks (NPS NN) (2014) and the "National Planning Policy Framework" 2018 (NPPF), the associated Planning Practice Guidance (PPG) and the Design Manual for Roads and Bridges (DMRB) Volume 11 Section 3 Part 10 (HD45/09), Road Drainage and the Water Environment (**Ref 1.1**).

1.1.3. The assessment includes the following:

- Confirmation of the sources of flooding which may affect the Scheme.
- A quantitative assessment of the risk of flooding to the Scheme and to adjacent sites because of the Scheme.
- Identification of possible measures which could reduce flood risk to acceptable levels and a summary of residual risks.
- A summary of the proposed surface water drainage strategy.

1.2. SITE LOCATION

1.2.1. The Scheme is located between junction 65 (Birtley) and a point just north of junction 67 (Coal House) (**Figure 1**) on the Newcastle/Gateshead Western Bypass (NGWB) which is located on the A1. It is approximately 6.5km in length and will take place on part of Highways England's strategic road network.

1.3. SCHEME DESCRIPTION

1.3.1. A full description of the Scheme is provided in **Chapter 2** of the Environmental Statement (ES), with its extent shown in **Figure 1** below (a full-size version of this figure and other key figures **8**) are provided in **Appendix E** of this FRA). In summary the Scheme is 6.5km in length and consists of widening the existing carriageway between junction 67 (Coal House) and junction 65 (Birtley) to provide additional lanes and increase capacity. The widening would be mainly online, with a short section of realignment offline where the Scheme crosses the East Coast Mainline (ECML) between junction 67 (Coal House) and Smithy Lane Overbridge. The main areas of land take required for the Scheme relate to this realignment for the replacement of the existing Allerdene Bridge over the ECML and the creation of a southbound verge associated with the road widening between junction 66 (Eighton Lodge) and junction 65 (Birtley).

1.3.2. The realigned Allerdene Bridge will either be constructed as a single span crossing of the ECML, with embanked carriageways either side or a multi-span viaduct with shorter embankments. If an embankment and bridge solution is used, the existing Allerdene Burn

will be culverted, whereas if the viaduct option is chosen, the watercourse would be in open cut beneath the viaduct.

1.3.3. The Scheme aims to increase capacity along this section by widening the carriageways to allow for the provision of additional lanes. Most of the work would take place within the existing highway boundary. However, some additional land would be required alongside the A1 at certain points to enable the additional carriageway to be constructed. The Scheme would also include changes to signage and road markings just south of junction 68 (Lobley Hill), to the north of junction 67 (Coal House).

1.3.4. Two main construction compounds and two working construction compounds will be set up to enable the works to be built. The main construction compounds will include staff parking, site accommodation, materials storage, road sweepings management, facilities to wash vehicles and plant and vehicle maintenance areas. The main compounds will be secure - gated, fenced and 24 hour security provided, will be hard surfaced and will implement a one way system. The compounds will be located as follows:

- Junction 66 Eighton Lodge compound - to the north of the A1, north-east of Eighton Lodge roundabout.
- Junction 67 Coal House compound - to the south of the A1, east of Coal House roundabout on Northern Gas Network (NGN) land.

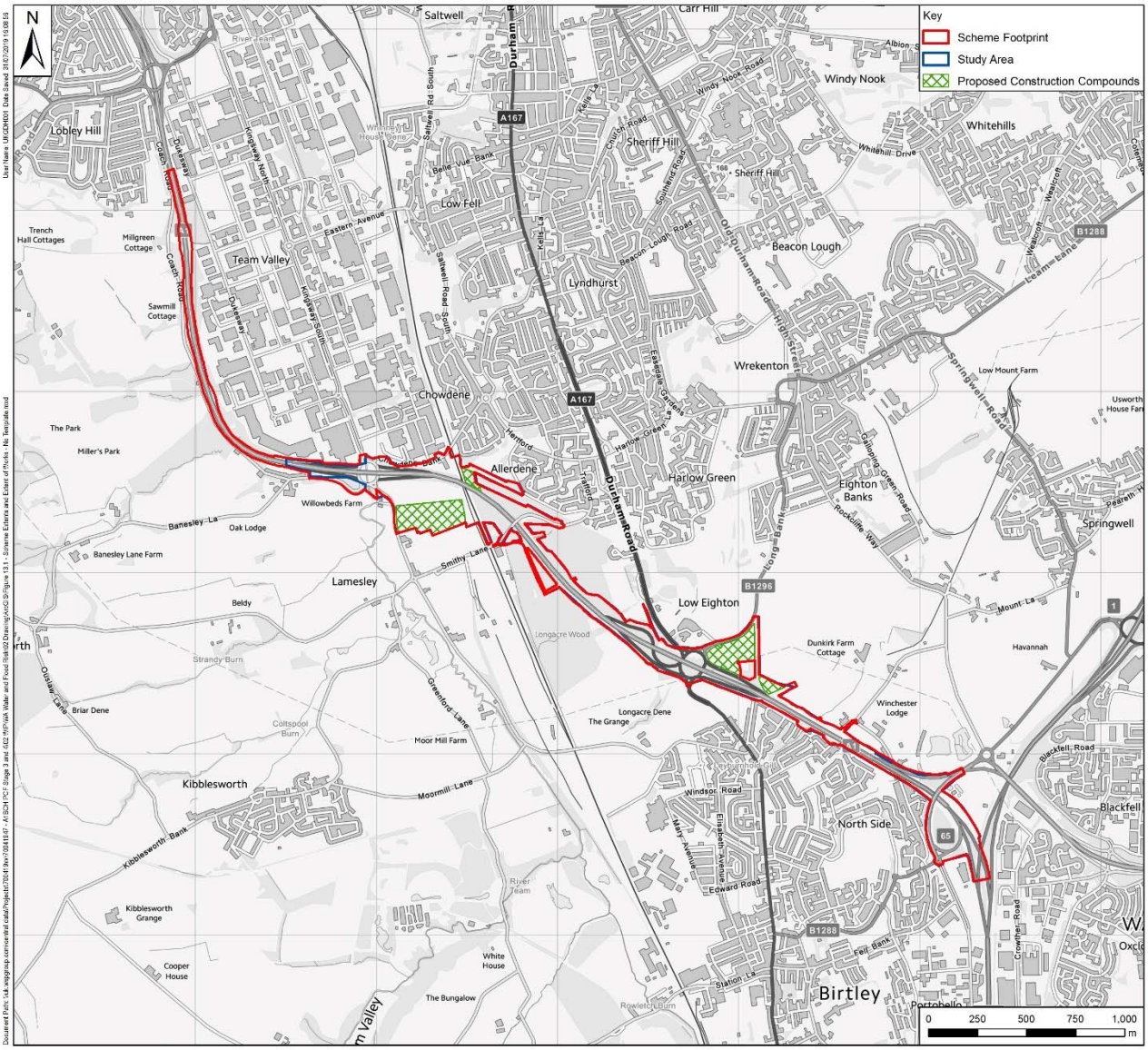
1.3.5. The working compounds will be smaller compound areas set up to enable specific works at Longbank Bridleway Underpass (widening) and Allerdene Bridge (demolition) and will comprise a secure fenced and gated area with site welfare, parking and materials storage. The working compounds are located as follows:

- Longbank compound - to the north of the A1, west of Longbank Bridleway Underpass.
- Allerdene compound - to the north-east of the existing Allerdene Bridge.

1.3.6. NGN apparatus would be diverted and relocated to the south of the Scheme on a site previously used by NGN as a gas storage array which was dismantled and reinstated approximately ten years ago. The diversion works would be undertaken by NGN.

1.3.7. A new Above Ground Installation (AGI) would be constructed to the south of the Scheme. The AGI would comprise of two sets of regulators to carry out pressure reduction across two tiers, new filters, a boiler house package, new heat exchangers, a backup generator and electrical and instrumentation (E and I) kiosk. A new access road to serve the AGI would be created off Lamesley Road. The AGI would be bounded by a 2.4m high steel security fence with a further timber post and wire fence surrounding this. Further information is provided in **Chapter 2 The Scheme** of the ES **(Application Document Reference: TR010031/App/6.1).**

Figure 1 - Scheme Footprint and Scheme Extents



2. ASSESSMENT METHODOLOGY

2.1. DEFINITION OF FLOOD RISK

2.1.1. Flood risk is the product of the likelihood or chance of a flood occurring (flood frequency) and the consequence or impact of the flooding (flood consequence).

FLOOD FREQUENCY

2.1.2. Flood frequency is identified in terms of the return period and annual probability. For example, a 1 in 100 year flood event has a 1% annual probability of occurring. **Table 2-1** provides a conversion between return periods and annual flood probabilities.

Table 2-1 - Flood probability conversion table

Return Period (Years)	2	5	10	20	50	100	200	1000
Annual Probability %	50	20	10	5	2	1	0.5	0.1

2.2. POTENTIAL SOURCES OF FLOODING

2.2.1. In accordance with NPPF, the following sources of flooding have been considered in this assessment:

- Fluvial flood risk from nearby watercourses
- Tidal flood risk
- Surface water flooding from within the Scheme Extent of Works and adjacent land
- Surcharging of sewers and other infrastructure
- Groundwater flooding
- Flood risk from other artificial sources such as canals and impounded reservoirs
- Change in surface water runoff as a result of the Scheme leading to increased areas of impermeable surfaces and thus higher runoff rates.

2.3. POTENTIAL EFFECTS OF CLIMATE CHANGE

2.3.1. Scientific consensus is that the global climate is changing as a result of human activity. While there remain uncertainties as to how a changing climate will affect areas already vulnerable to flooding, it is expected to increase risk significantly over time. For the UK, projections of future climate change indicate that more frequent short-duration high-intensity rainfall events and more frequent periods of long-duration rainfall could be expected.

2.3.2. Updated climate change recommendations were published by the EA in February 2016 and have been updated a number of times since. At the time of writing, the latest version was dated 15 February 2019 (**Ref 1.2**). The impacts of climate change are expected to increase over time and the EA guidance provides a range of estimates for increases in peak river flow,

peak rainfall intensity and sea level rise over the next 100 years. This is reflected by larger allowances recommended for developments with a longer design life.

2.3.3. The precise extent of the impacts of climate change is unknown. This is reflected in the EA's guidance which provides 'Central', 'Higher Central' and 'Upper End' estimates that are based on the 50th, 70th and 90th percentile predictions for climate change.

2.3.4. The increases in peak fluvial flows are also expected to vary depending on geographical location. To account for this the EA guidance divides England into eleven river basin districts. The Scheme is located within the Northumbria River Basin District. **Table 2-2** shows the recommended increase in peak river flow in this district.

Table 2-2 - Recommended peak river flow allowances for the Northumbria River Basin District

	Allowance category	Total potential change anticipated 2017 - 2039	Total potential change anticipated 2040 - 2069	Total potential change anticipated 2070 - 2115
Peak river flow allowances	Upper End	20%	30%	50%
	Higher Central	15%	20%	25%
	Central	10%	15%	20%

2.3.5. **Table 2-3** below summarises the EA's guidance for increases to peak rainfall intensity throughout England.

Table 2-3 - Peak rainfall intensity allowance in small and urban catchments

	Allowance category	Total potential change anticipated 2017 - 2039	Total potential change anticipated 2040 - 2069	Total potential change anticipated 2070 - 2115
Peak rainfall intensity allowance	Upper End	10%	20%	40%
	Central	5%	10%	20%

2.3.6. The Scheme is planned to be constructed and opened in 2023 and the service life of the drainage assets that it will comprise is 60 years. The Highways England guidance for the Scheme (provided via their Safety Engineering and Standards (SES) team during a meeting on 15 February 2017) is that the climate change rainfall intensities are to be increased by

20%. The allowances to be used in the assessment and design of the Scheme and taking into account the development's vulnerability are as follows

- 25-50% increase in peak river flow allowances by 2115; which has been used for the Allerdene Burn hydraulic model as it has been developed as a fluvial model.
- 20-40% increase in peak rainfall intensity by 2115, which has been used to increase the peak river flows for the River Team model as this has been developed as a direct rainfall model.
- In terms of the surface water drainage the 20% allowance will be applied in accordance with **Section 5.2** below.

2.3.7. It is understood that the Environment Agency are currently revising the climate change allowances as detailed above following the publication of new climate projections in United Kingdom Climate Projections 2018 (UKCP18). The Environment Agency in their document (*Using 'Flood risk assessments: climate change allowances' following publication of new climate projections in UKCP18*) (**Ref 1.2**) consider that allowances detailed above are still the best national representation of how climate change is likely to affect flood risk for:

- Peak river flow
- Peak rainfall intensity

2.3.8. This position and use of these climate change allowances has been agreed with the Environment Agency.

2.3.9. However, in the case of sea level rise then the guidance for this type of scheme (at the time of writing, again set out in *Using 'Flood risk assessments: climate change allowances' following publication of new climate projections in UKCP18*) is that

> *"in exceptional cases where developments are very sensitive to flood risk and have a lifetime of at least 100 years, we recommend you assess the impact of both the current allowance in 'Flood risk assessments: climate change allowances' and the 95th percentile of UKCP18 'RCP 8.5' scenario (high emissions scenario) standard method sea level rise projections of UKCP18, and plan according to this assessed risk. You will need to calculate sea level rise allowances beyond 2100 by extrapolating the UKCP18 dataset."*

2.3.10. The lower reaches of the River Team are tidally influenced (this is beyond the Scheme Extents) due consideration needs to be given to the potential implications of future sea level rise. However, in this instance it was not felt appropriate to undertake further assessment within the hydraulic model given that:

- The Normal Tide Level (NTL) is at a weir over 3km from the site.
- The OS mapping indicates a change in level of between 5m and 10m between the site and the NTL.

2.3.11. Therefore, it has been agreed with the Environment Agency that no further assessment was required within the hydraulic model, which as constructed by the Environment Agency includes an adequate representation of the tidal boundary.

2.4. HYDRAULIC MODELLING

2.4.1. Scheme specific hydraulic modelling has been undertaken within ICM, in accordance with Methods E and F of HD45/09 and is detailed in **Appendix A** herein, this has focused on:

- The fluvial flood regime for the River Team and Allerdene Burn.
- The surface water flood risk at junction 66 (Eighton Lodge). This has been carried out because the Environment Agency's Risk of Surface Water Flooding maps do not give an accurate representation due to the existing culvert and drainage channel not being sufficiently represented in the original surface water flood risk model. As Methods E and F of HD45/09 (**Ref 1.1**) do not directly cover surface water modelling (this has become a more prevalent modelling technique since the publication of HD45/09), the modelling that has been completed is in broad accordance with these methods, where relevant, and in accordance with the accepted good practice.

2.5. LEGISLATIVE FRAMEWORK AND GUIDANCE

2.5.1. The coordination of policies for the water environment is managed by the UK Government. Many flood risk and water quality requirements are set at European level, which are then transposed into UK law. The EA has a strategic overview regarding the management of all of sources of flooding and an operational responsibility for managing the risk of flooding from main rivers, reservoirs, estuaries and tidal sources. Lead Local Flood Authorities (LLFAs) are responsible for managing the risk of flooding from local sources, including surface water, groundwater and ordinary watercourses.

2.5.2. The applicable legislative framework is summarised below.

EUROPEAN POLICY

Water Framework Directive (2000/60/EC)

2.5.3. The overall objective of the Water Framework Directive (WFD) is to bring about the effective co-ordination of water environment policy and regulation across Europe. The main aims of the legislation are to ensure that all surface water and groundwater reaches 'good' status (in terms of ecological and chemical quality and water quantity, as appropriate), promote sustainable water use, reduce pollution and contribute to the mitigation of flood and droughts.

2.5.4. The WFD also contains provisions for controlling discharges of dangerous substances to surface waters and groundwater and includes a 'List of Priority Substances'. Various substances are listed as either List I or List II substances, with List I substances considered the most harmful to human health and the aquatic environment. The purpose of the directive is to eliminate pollution from List I substances and reduce pollution from List II substances.

Groundwater Directive (2006/118/EC)

2.5.5. This Groundwater Directive aims to set groundwater quality standards and introduce measures to prevent or limit pollution of groundwater, including those listed with the 'List of Priority Substances'. The directive has been developed in response to the requirements of

Article 17 of the WFD, specifically the assessment of chemical status of groundwater and objectives to achieve 'good' status.

NATIONAL POLICY

National Policy Statement for National Networks (NPS NN) (2014)

2.5.6. Flood risk is covered as a specific generic impact in **paragraphs 5.90 to 5.115** of the NPS NN, which outline that:

- The Scheme should be supported by a FRA in accordance with the NPPF (2019).
- Surface water discharge should be such that the volumes and peak flow rates of surface water leaving the site are no greater than the rates prior to the proposed project.
- Opportunities can be taken to lower flood risk by improving flow routes, flood storage capacity and using SuDS.

2.5.7. Road drainage and the water environment is also referred to in the following sections of the NPS NN:

- Pollution control and other environmental protection regimes: **paragraphs 4.48 to 4.56**.
- Water quality and resource is discussed in **paragraphs 5.219 to 5.231**.

National Planning Policy Framework 2019

2.5.8. The NPPF (2019) sets out the Government's planning policies for England, providing a framework within which local councils can produce their own plans that better reflect the specific needs of their communities. Planning Practice Guidance (PPG) has been published alongside the NPPF to set out how certain policies, including those relating to flood risk, should be implemented.

2.5.9. The NPPF and relevant PPG identify how new developments must take flood risks into account, including making an allowance for climate change impacts, and steer development to those areas at lowest risk.

2.5.10. The NPPF identifies Flood Zones in relation to flood frequency. The zones refer to the probability of river (fluvial) and sea (tidal) flooding, whilst ignoring the presence of defences. **Table 2-4** summarises the relationship between Flood Zone category and the identified flood risk.

Table 2-4 - Flood zones

Flood Risk Area	Identification	Annual probability of fluvial flooding	Annual probability of tidal flooding
Zone 1	Low probability	< 0.1%	< 0.1%
Zone 2	Medium probability	1% - 0.1%	0.5% - 0.1%
Zone 3a	High probability	>1%	>0.5%
Zone 3b*	Functional Floodplain	>5%	>5%

*The definition of the functional floodplain should take account of local circumstances. The annual flood probability is stated as a starting point for consideration.

FLOOD CONSEQUENCES

2.5.11. The consequence of a flood event describes the potential damage, danger and disruption caused by flooding. This is dependent on the mechanism and characteristics of the flood event and the vulnerability of the affected land and land use.

2.5.12. The NPPF, which is capable of being an important and relevant consideration in respect of the Scheme, identifies five classifications of flood risk vulnerability and provides recommendations on the compatibility of each vulnerability classification with the Flood Zones, as shown in **Table 2-5**. Full details of the Flood Zones and flood risk vulnerability classifications can be found in the Flood risk and coastal change PPG (**Ref 1.3**) to the NPPF.

Table 2-5 - Flood risk vulnerability and flood zone compatibility

EA Flood Zone	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	×	Exception test required	✓
Zone 3b*	Exception test required	✓	×	×	×

✓ Development considered acceptable
× Development considered unacceptable

2.5.13. The NPPF requires a risk based sequential approach to determine the suitability of land for development, The Scheme is classed as Essential Infrastructure under the NPPF. Essential Infrastructure within Flood Zone 3 requires application of the Sequential Test and Exception Test to be passed before it is considered to be acceptable. The only part of the Scheme which is located in Flood Zone 3 are the piers beneath the Kingsway Viaduct, along with the western on/off slips at this location (but only in the climate change scenario). It should also be noted that the Environment Agency have informed WSP that the published Flood Map for Planning has been superseded by the River Team model, the results of which should be used in its place. This new mapping has yet to be published.

2.5.14. The Sequential Test is applied to determine that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development proposed. In terms of the Sequential Test the location of the Scheme is driven by the need to enhance the existing highway, which cannot be relocated into lower flood zones and will need to cross the flood plain of the River Team. Therefore, no other locations can be considered. Furthermore, the Scheme is largely located in Flood Zone 1, with only the piers of the Kingsway Viaduct in Flood Zones 2 and 3, as it is elevated above the floodplain of the Allerdene Burn. There are areas of Flood Zones 2 and 3 that border the Scheme on a bridge crossing the ECML and the Kingsway Viaduct respectively. All other sources of flooding have been considered and are detailed in the following sections of this FRA.

2.5.15. The Exception Test determines whether the benefits of the Scheme will outweigh the potential flood risk and that the development can be made safe from flooding. For the Exception Test to be passed in terms of the NPPF:

- It must be demonstrated that the development provides wider sustainability benefits to the community which outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared.
- A site-specific flood risk assessment 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.

2.5.16. In terms of the Exception Test, this FRA demonstrates that the Scheme will remain safe throughout its design life and that flood risk will not be increased elsewhere.

2.5.17. Additionally, the wider benefits of the Scheme are detailed in **Section 2.2** of **Chapter 2 The Scheme** of the ES **(Application Document Reference: TR010031/APP/6.1)**. This demonstrates that the Scheme benefits be considered to outweigh the flood risk to and from the proposed development.

2.5.18. The Scheme will result in an improved surface water drainage strategy, which will include improvements to the water quality and attenuation for climate change scenarios.

A Green Future: Our 25 Year Plan to Improve the Environment

2.5.19. This plan outlines the Governments plans that seek to ensure that new developments are flood resilient and do not increase flood risk, whilst achieving environmental net gains.

Flood and Water Management Act 2010

2.5.20. The Flood and Water Management Act 2010 created the role of the LLFA, in this case Gateshead Council, to take responsibility for leading the co-ordination of local flood risk management in their areas. In accordance with the Act the EA is responsible for the management of risks associated with main rivers, the sea and reservoirs. LLFAs are responsible for the management of risks associated with local sources of flooding such as ordinary watercourses, surface water and groundwater.

2.5.21. The Act is also guiding the role of the LLFA in the review and approval of surface water management systems.

Environmental Permitting (England and Wales) Regulations 2010

2.5.22. The Environmental Permitting (England and Wales) Regulations 2010 replaced the Water Resources Act 1991 as the key legislation for water pollution in the UK. Under the Environmental Permitting Regulations, it is an offence to cause or knowingly permit a water discharge activity, including the discharge of polluting materials to freshwater, coastal waters, relevant territorial waters or groundwater, unless complying with an exemption or an environmental permit. An environmental permit is obtained from the EA. The EA sets conditions which may control volumes and concentrations of particular substances or impose broader controls on the nature of the effluent, taking into account any relevant water quality standards from EC Directives. With regards to the water environment any works in, under or near a main river requires permission from the EA to ensure no detrimental impacts on the watercourse. Previously, this was a Flood Defence Consent; however, in April 2016 consent for flood risk activities was included under the Environmental Permitting Regulations.

Land Drainage Act 1991

2.5.23. Local Authorities and Internal Drainage Boards have additional duties and powers associated with the management of flood risk under the Land Drainage Act 1991. As Land Drainage Authorities, consent must be given for any permanent or temporary works that could affect the flow within an ordinary watercourse under their jurisdiction in order to ensure that local flood risk is not increased.

2.5.24. The Land Drainage Act specifies that the following works will require formal consent from the appropriate authority:

- Construction, raising or alteration of any mill dam, weir or other like obstructions to the flow of a watercourse.
- Construction of a new culvert
- Any alterations to an existing culvert that would affect the flow of water within a watercourse.

2.5.25. The Land Drainage Act also sets out the maintenance responsibilities riparian owners have in order to reduce local flood risks. Riparian owners, who are land owners with a watercourse either running through their land or adjacent to, have the responsibility to ensure that the free flow of water is not impeded by any obstruction or build-up of material within the watercourse.

LOCAL POLICY

2.5.26. Planning for the Future: Core Strategy and Urban Core Plan for Gateshead and Newcastle upon Tyne 2010-2030 (CSUCP)14 was adopted on 26th March 2015.

2.5.27. The relevant policies within the document in relation to the water environment are outlined below.

Policy CS17 refers to Flood Risk and Water Management and States that "*Development will avoid and manage flood risk from all sources, taking into account the impact of climate change over its lifetime. Development will:*

1. *Avoid and manage flood risk to people and property by:*

- Locating new development in areas with the lowest risk where appropriate by applying the sequential test;
- Managing flood risk from development to ensure that the risk is not increased on site and/or elsewhere, where appropriate by applying the Exception Test;
- Ensuring opportunities for development to contribute to the mitigation of flooding elsewhere are taken;
- Prioritise the use of Sustainable Drainage Systems (SuDS), given the multifunctional benefits to water quality, green space and habitat enhancement;
- Ensuring development is in accordance with the Council's Strategic Flood Risk Assessment; and
- Requiring a Flood Risk Assessment for sites over 0.5ha in Critical Drainage Areas as identified in the Council's Strategic Flood Risk Assessments.

2. *Ensure development is in accordance with the Council's Strategic Flood Risk Assessment;*

3. *Not adversely affect water quality and where possible seek to improve water quality;*

4. *Separate, minimise and control surface water runoff, discharging in order of priority to:*

- *Infiltration based Sustainable Drainage Systems;*
- *A watercourse*
- *A surface water sewer*
- *A combined sewer"*

2.5.28. Other relevant local policies are CS16 referring to Climate Change and CS18 Green Infrastructure and the Natural Environment.

2.5.29. In addition to the above, the Gateshead Council Level 1 Strategic Flood Risk Assessment (SFRA) (2017) has been reviewed.

2.6. CONSULTATION

2.6.1. The following stakeholders have been consulted:

- Environment Agency
- Gateshead Council as LLFA
- Highways England Safety SES team.

2.6.2. A meeting with the Highways England SES team was held on 15th February 2017 and the topics discussed included the available asset information, policy for discharges from third parties, surface water design principles including allowances for climate change and the approach for HAWRAT and the Allerdene Burn culvert extension. The Highways England Structures Team have also approved the Structures Options Report (SOR) and Agreements in Principal (AIP). The SOR is effectively a feasibility study that records details of the various structural options considered taking account site constraints and stakeholder requirements. The options are assessed and compared prior to a preferred option being recommended for development at detailed design and construction. The AIP has been prepared in accordance with BD2/12 Design of Highway Structures (**Ref 1.8**) and provides details of the proposed design philosophy to be referred to in the development of the detailed design of the preferred structural option. In relation to flood risk this consultation and resulting SOR and AIP primarily relate to the culverts and works to the piers that would be undertaken.

2.6.3. Two meetings (31/10/17 and 15/03/18) have taken place between WSP, Gateshead Council and the Environment Agency. Topics discussed have included flood risk, water quality, drainage and the linkages between this project and the River Team Flood Alleviation project (Lamesley Pastures), within which various interventions are being prepared by the Environment Agency. Gateshead Council also expressed a desire that the surface water flood risk is assessed at Bowes Railway Path (bridleway) which passes under the A1 to the east of junction 66 (Eighton Lodge). The Environment Agency's Risk of Flooding from Surface Water Map and Highways Agency Drainage Data Management System (HADDMS) indicate that the surface water flood risk appears to originate from the surrounding land rather than the Scheme.

2.6.4. Additional comments were also received from both the Environment Agency and Gateshead Council as part of the formal Scoping Response.

2.6.5. Consultation by other parts of the design team has been undertaken with key stakeholders as the design has progressed. These discussions have informed the water related aspects of the Scheme design.

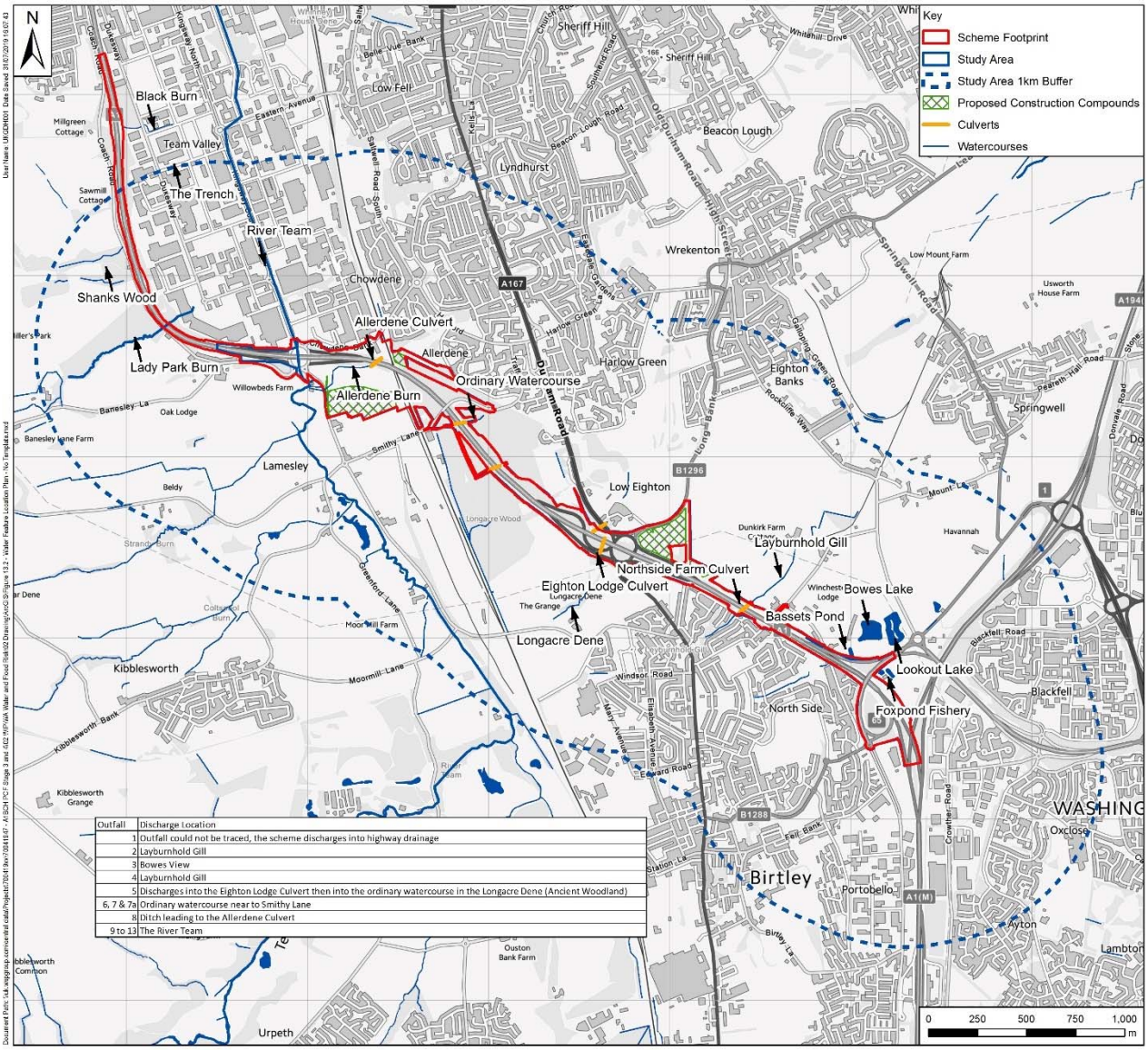
3. EXISTING SITE

3.1. WATERBODIES

3.1.1. The flood risk posed to and as a result of the Scheme has been assessed for the extent of works (i.e. junction 65 (Birtley) to junction 67 (Coal House)) as shown in **Figure 2** below and included in **Figure 13.2** of the ES (**Application Document Reference: TR010031/APP/6.2**). The section between junctions 67 and 68 has not been assessed as only signage changes are proposed for this section, which do not require an assessment of flood risk in accordance with Section 6.8 of HD45/09 (**Ref 1.1)** because the drainage and flooding characteristics of the environment will not be changed as a result in this location. Furthermore, the four watercourses in that location (see below) are outside the extents of work, separated from the Scheme by the River Team thus no hydrological links with the other parts of the Scheme are evident.

3.1.2. Numerous watercourses have been identified in the vicinity of the Scheme, as illustrated in **Figure 2** below (also enclosed in as **Figure B Appendix E**, Scheme Figures) and discussed in turn (moving north to south).

Figure 2 - Water feature location plan



Black Burn

3.1.3. The Black Burn (classified as an ordinary watercourse) is a tributary of the River Team which is culverted under Coach Road and the A1, before emerging from culvert to the east of the Scheme. To the east of the Scheme the Black Burn runs in sections of open channel and culvert under the Team Valley Trading Estate before discharging into the River Team.

3.1.4. The Environment Agency's River Team model demonstrates that the Scheme is in Flood Zone 1 at this point with localised areas of Flood Zones 2 and 3 downstream of the scheme.

3.1.5. Black Burn is not considered further in the assessment as it is located within the section where only signage changes are proposed.

The Trench/Drain

3.1.6. The Trench (Drain) is an ordinary watercourse which passes under the Scheme and the Team Valley Trading Estate in culvert, before it joins the River Team. This is not considered further in the assessment as it is located within the section where only signage changes are proposed.

Unnamed ordinary watercourses

3.1.7. There are two small unnamed ordinary watercourses to the west of the Scheme which run through Shanks Wood. The land surrounding these ordinary watercourses is classified as Flood Zone 1. This is not considered further in the assessment as it is located within the section where only signage changes are proposed.

Lady Park Burn

3.1.8. This is a small main watercourse which is culverted under the A1, any waters which exceed the capacity of the culvert and after reaching a critical level within the woodland would spill onto Coach Road, which runs parallel to the A1 at this location and would likely flow south on this road, due to the presence of kerbs separating the roads combined with the likely low velocities resulting from the slow spilling process. There are historical flood records from 2012 associated with this watercourse, therefore it is considered as a residual risk in the assessment as it is located within the section where only signage changes are proposed.

River Team

3.1.9. The River Team (classified as a main river and under the jurisdiction of the Environment Agency) flows beneath junction 67 (Coal House), under the Kingsway Viaduct which carries the main carriageway over the floodplain. The River Team flows from south to north and joins the Tyne Estuary approximately 4.5km downstream of junction 67 (Coal House). The Scheme crosses over the fluvial floodplain of the River Team, which is land designated as both Flood Zones 2 and 3. The soffit of the viaduct is at approximately 16m AOD which is 4.2m higher than the bank levels at 11.8m AOD. Flood risk associated with the River Team is assessed in **Section 4.3** of this report.

3.1.10. The Environment Agency have advised that their Flood Map for planning has yet to be updated to account for the findings of their latest modelling of the River Team. Therefore, the baseline flood extents from the 2016 River Team Model should be used. This has therefore been included in all figures and assessments instead of the published flood map for planning.

Allerdene Burn

3.1.11. The Allerdene Burn is an ordinary watercourse located just east of junction 67 (Coal House). The watercourse is culverted under the A1 before discharging into the River Team. The Burn is culverted in its headwaters around Harlow Green. Upstream of the railway it emerges into a short section of open channel that leads into a 1350mm culvert beneath the railway. After which it flows through an open channel before entering a 2400x1800mm rectangular culvert to convey it under the A1. It then flows in open channel through farmland and beneath

Lamesley Road to its confluence with the River Team. Flood risk associated with the Allerdene Burn is assessed in **Section 4.3** of this report.

Longacre Dene

3.1.12. The Longacre Dene is located to the south of junction 66 (Eighton Lodge); OS mapping shows the presence of an outfall into Longacre Dene where a small ordinary watercourse is shown. The presence of the Eighton Lodge Culvert through which the Scheme outfalls to the Longacre Dene has been confirmed through Highways England's Structures Management Information System (SMIS). Flood risk associated with the Allerdene Burn is assessed in **Section 4.5** of this report.

3.1.13. There are two small ponds located in Longacre Wood to the southwest of junction 66 (Eighton Lodge).

Existing Drainage Outfalls

3.1.14. The existing road is currently drained by a combination of gully and pipe connections, draining into various ditches, culverts and watercourses which run parallel to the existing highway boundary.

3.1.15. In the baseline condition, there are 14 outfalls, these have been identified through Closed-Circuit Television (CCTV) survey, with the major catchments contributing to the River Team, Allerdene Burn and Longacre Dene. Details of the existing outfall locations are described below and shown in Figure 2 above. These outfalls are summarised below:

- Junction 67 and the stretch of the A1 between junction 66 (Eighton Lodge) and junction 67 (Coal House) are drained west to the Coal House junction (junction 67). Surface water from the road discharges at junction 67 (Coal House) into the River Team through outfalls 9 – 13.
- Outfalls 7 and 6 drain the Scheme to the ordinary watercourse near Smithy Lane, whilst outfall 7a drains to a ditch which leads to the ordinary watercourse near Smithy Lane.
- From the east of the Scheme up to junction 66 (Eighton Lodge), the road drains west to junction 66 through outfall 5 which discharges into the Longacre Dene via Eighton Lodge Culvert. The ultimate discharge of this watercourse would be the River Team.
- Between junction 65 (Birtley) and junction 66 (Eighton Lodge), an unnamed drain and Leyburnhold Gill run from north-east to south-west before joining the River Team. According to OS mapping, these watercourses run culverted for much of their stretch and pass beneath the A1 in culvert. There are two outfalls into the Leyburnhold Gill (no. 2 and no.4), with these outfalls draining the Scheme between junction 65 (Birtley) and just south of junction 66.
- There are two outfalls in proximity to junction 65 (Birtley); outfall 3 which discharges at Bowes View, drains the southbound (A1231) off slip, whilst the northbound on-slip drains to outfall 1, for which the exact discharge location could not be traced and is assumed to be the Gateshead Council's (as the highways authority) drainage network.

- Between junction 66 (Eighton Lodge) and junction 67 (Coal House), there are several drains that flow in a culvert in parts of their reaches and discharge to the River Team upstream of junction 67 (Coal House). There are three locations where these watercourses are believed to pass under the A1. However, no changes to the culvert arrangement under the A1 at these locations is proposed, therefore there will be no alteration in flood risk and no further assessment is required.

3.1.16. No changes to culverts are proposed as a result of the Scheme, with the exception of the Allerdene Burn. Therefore, they are not considered further within this report.

3.2. GEOLOGY, HYDROGEOLOGY AND SOILS

3.2.1. The soils underlying the majority of the Scheme are considered to be slowly permeable seasonally wet slightly acid, but base-rich loamy and clayey soils. A small section of the Scheme centred on junction 66 (Eighton Lodge) is underlain by freely draining slightly acid loamy soils.

3.2.2. According to the British Geological Survey, the bedrock underlying the entirety of the Scheme is of the Pennine Middle Coal Measures Formation, containing Mudstone, Siltstone, Sandstone, Coal, Ironstone and Ferricrete.

3.2.3. Superficial deposits underlying the Scheme are mostly Till, Devensian – Diamicton, with localised areas of Alluvium (Clay, Silt, Sand and Gravel) and Glaciolacustrine deposits (Devensian Clay and Silt) underlying the Scheme between junction 66 (Eighton Lodge) and junction 67 (Coal House).

3.2.4. The Bedrock underlying the Scheme is classified as Secondary A aquifer. These are permeable strata capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers

3.2.5. The majority of superficial deposits underlying the Scheme have been classified as secondary (undifferentiated) aquifer, with the rest classified as unproductive strata.

3.2.6. Secondary undifferentiated aquifer is assigned to rocks where it is not possible to attribute either Secondary A or Secondary B to the rock type. Secondary B aquifers are predominantly lower permeability strata which may in part have the ability to store and yield limited amounts of groundwater by virtue of localised features such as fissures, thin permeable horizons and weathering.

3.2.7. This information will be considered further in **Section 4.6** which assesses the groundwater flood risk.

4. FLOOD RISK

4.1. HISTORICAL FLOODING

4.1.1. A review of the Environment Agency's Open Data 'Recorded Flood Outlines' and 'Historic Flood Map' (**Ref 1.4**) reveals a series of past flood events that have impacted the areas in which the Scheme is located, as detailed below:

- Fluvial flooding affecting the southbound off and northbound on slips at junction 67 (Coal House) and the land to the south of the junction during June 2012.
- Surface water flooding in the land bordering the Scheme at the Team Valley Retail Park during June 2012.
- Flooding of the River Team where the channel capacity was exceeded (no raised defences) during November 2000, impacting junction 67 (Coal House) and the land to the north and south of junction along the river. Fluvial flooding of an unknown cause along the River Team south of the Scheme extending south towards Lamesley during 1981.
- The Environment Agency have informally provided information on a flood event that occurred in 2012 on the Lady Park Burn. The Environment Agency detailed that they consider that this event was considered too extreme. In conjunction with the extreme volume of water a significant amount of debris was conveyed on to the trash screen on the culvert inlet causing a significant blockage. The volume of water led to overtopping which eventually spilled onto the A1.

4.2. FLUVIAL FLOOD RISK

4.2.1. As outlined above, several watercourses exist in close proximity to the Scheme, and a section of the Scheme in vicinity of junction 67 (Coal House) lies within the floodplain. This section outlines the current (baseline) level of flood risk associated with these watercourses before assessing how the Scheme could alter flood risk, and how this risk will be mitigated.

LADY PARK BURN

4.2.2. There is a residual risk of blockage which could cause flooding of the A1 in extreme events, i.e. those in which the volume of water exceeds the available upstream storage when the trash screen is 100% blocked before water weirs onto the A1. The Environment Agency consider that these events are beyond the 1 in 5 and 1 in 10 year design scenario required by Highways England in accordance with HD33/16 (**Ref 1.5**), which requires the surface water drainage network to be functioning, beyond this flooding of the highway is allowed.

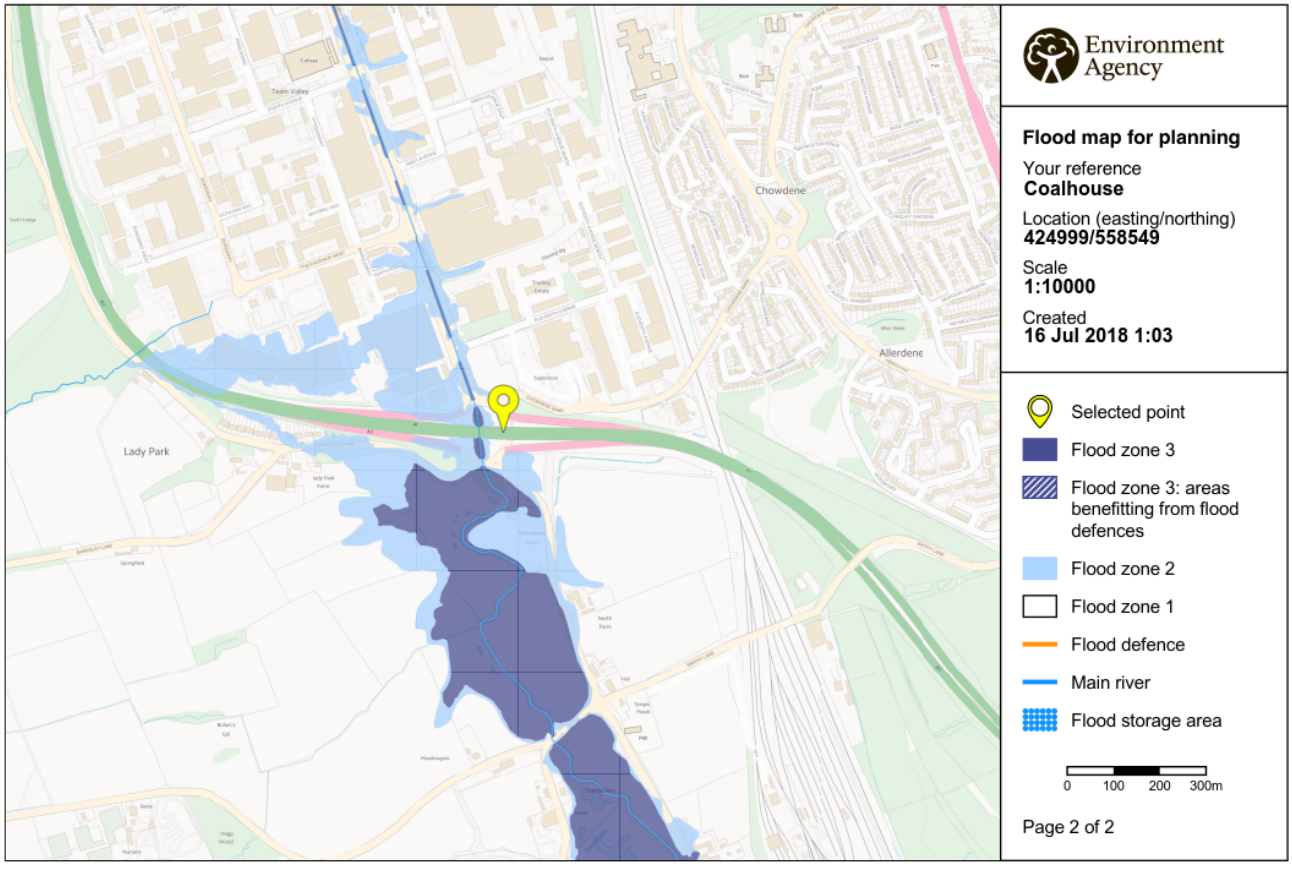
4.2.3. The mechanisms for managing the residual risk will be agreed between the Environment Agency and Highways England during detailed design, but are likely to include measures within the operating procedures for this section of the A1, with Highways England undertaking inspections of the trash screen adjacent to Coach Burn Road at pertinent times to assist the Environment Agency with understanding their maintenance requirements. In the most extreme circumstances part of the A1 may need to be closed.

RIVER TEAM

4.2.4. The River Team (classified as a main river and under the jurisdiction of the Environment Agency) flows beneath junction 67 (Coal House), under the Kingsway Viaduct. The Environment Agency's Flood Map for Planning shows the western half of junction 67 (Coal House) and part of the slip roads (to the west of the junction) to be within Flood Zone 2 (see **Figure 3**). Flood Zone 2 equates to an annual probability of fluvial flooding of between 1 in 1000 and 1 in 100 years (0.1%-1.0%).

4.2.5. The Flood Map for Planning (see **Figure 3**) shows that Flood Zone 3 extends up to the south of junction 67 (Coal House), with the main carriageway located upon Kingsway viaduct, substantially elevated above the floodplain. Flood Zone 3 equates to an annual probability of fluvial flooding of greater than 1 in 100 years (>1.0%).

Figure 3 - Flood map for planning at junction 67 (Coal House) (awaiting update in light of most recent model results)



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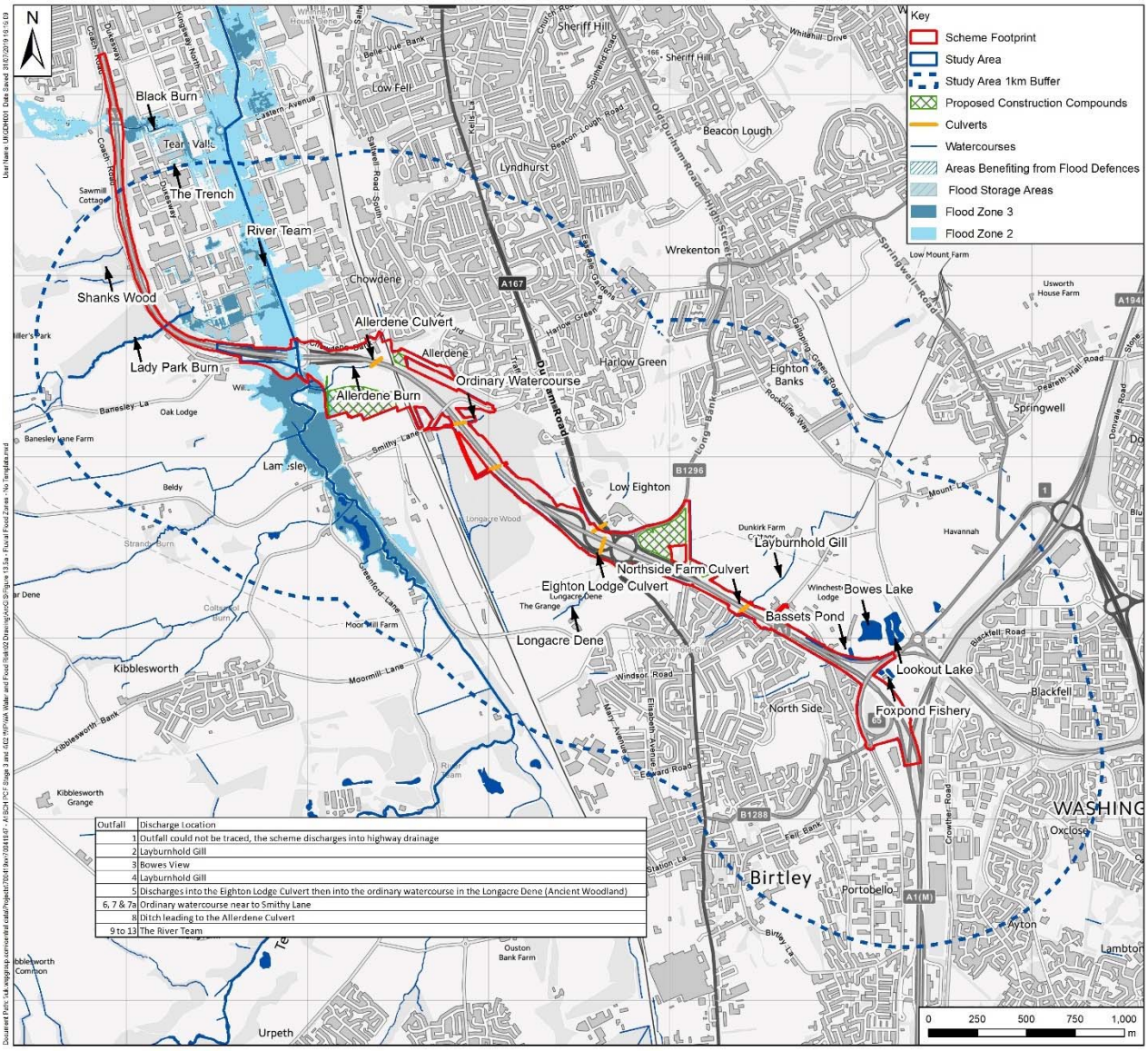
4.2.6. The Environment Agency provided their Infoworks ICM model for the River Team and informed us that they are currently updating their Flood Map for Planning with the flood outlines from this model, this demonstrates that the Scheme Extents are in Flood Zone 2, as shown in **Figure 4** below (also enclosed as **Figure C** in **Appendix E**, Scheme Figures). This

leaves the channel in current Flood Zone 3 and the piers and western on/off slips in Flood Zone 3, once the impacts of climate change are taken into account.

Figure 4 - Environment Agency revised Flood Zones



4.2.7. The Environment Agency's model has been re-run for the 1 in 100 year, 1 in 100 year plus climate change events (25% and 50%) along with the 1 in 1000 year event for both the baseline and the proposed scenarios. This model does not include the strategic flood alleviation projects that are to be implemented by the Environment Agency, are not present. When these Environment Agency projects are progressed they will result in a lower flood risk to the Scheme. Changes to the Kingsway Viaduct and associated piers have been incorporated into the model as detailed in **Appendix A**. The locations of the piers are also detailed in **Appendix A**.

4.2.8. Hydraulic modelling shows the proposed widening of the Kingsway Viaduct has negligible impact on flood risk. The model does not predict flooding from the River Team at junction 67 (Coal House) for the 1% AEP event. However, flooding occurs from the left bank in the 1% AEP plus 25% climate change event which causes flooding to the west side of junction 67 (Coal House) including the A1 northbound (entry) and southbound (exit) slip roads. Flood extents and depth increase for the 1% AEP plus 50% climate change and 0.1% AEP events.

4.2.9. The impact of the Scheme on flood risk is considered negligible for all events up to and including the 0.1% AEP. **Table 4-1** demonstrates that the impact on flood levels is within the model tolerance as the largest increase is 20mm, which occurs during the 0.1% AEP, whilst the largest model tolerance for the 1% AEP + climate change scenarios is 13mm. This model tolerance occurs within the roundabout, where there are no residential properties, downstream of which there are commercial properties and the Scheme has required only small changes to Environment Agency's model. Therefore, in this instance this degree of model tolerance is considered suitable. Furthermore, as the bridge pillars have a footprint of approximately $4m^2$ this level of impact is expected. **Figure 5** shows the location of the proposed bridge pillars (shown as orange points) and the flood extents for the 0.1% AEP event.

4.2.10. Given that the southbound slip road could flood to a depth of 1.035m in the 1 in 100 year plus 50% climate change event, mitigation measures are required to prevent access to this slip road. Likewise, the northbound slip road would also need to be included, given that it would provide access to the flooded gyratory. If at detailed design additional mitigation is required, consideration of the timing of the surface water runoff peaks from the highway and the wider catchment could be considered to determine whether further mitigation is required. This could include active management through CCTV observation linked to water level sensors which would enable operatives to implement slip road closures to reduce the risk to users during and following extreme heavy rainfall events.

Figure 5 – Post Scheme predicted flood risk depth for the 0.1% AEP flood event at the Kingsway Viaduct

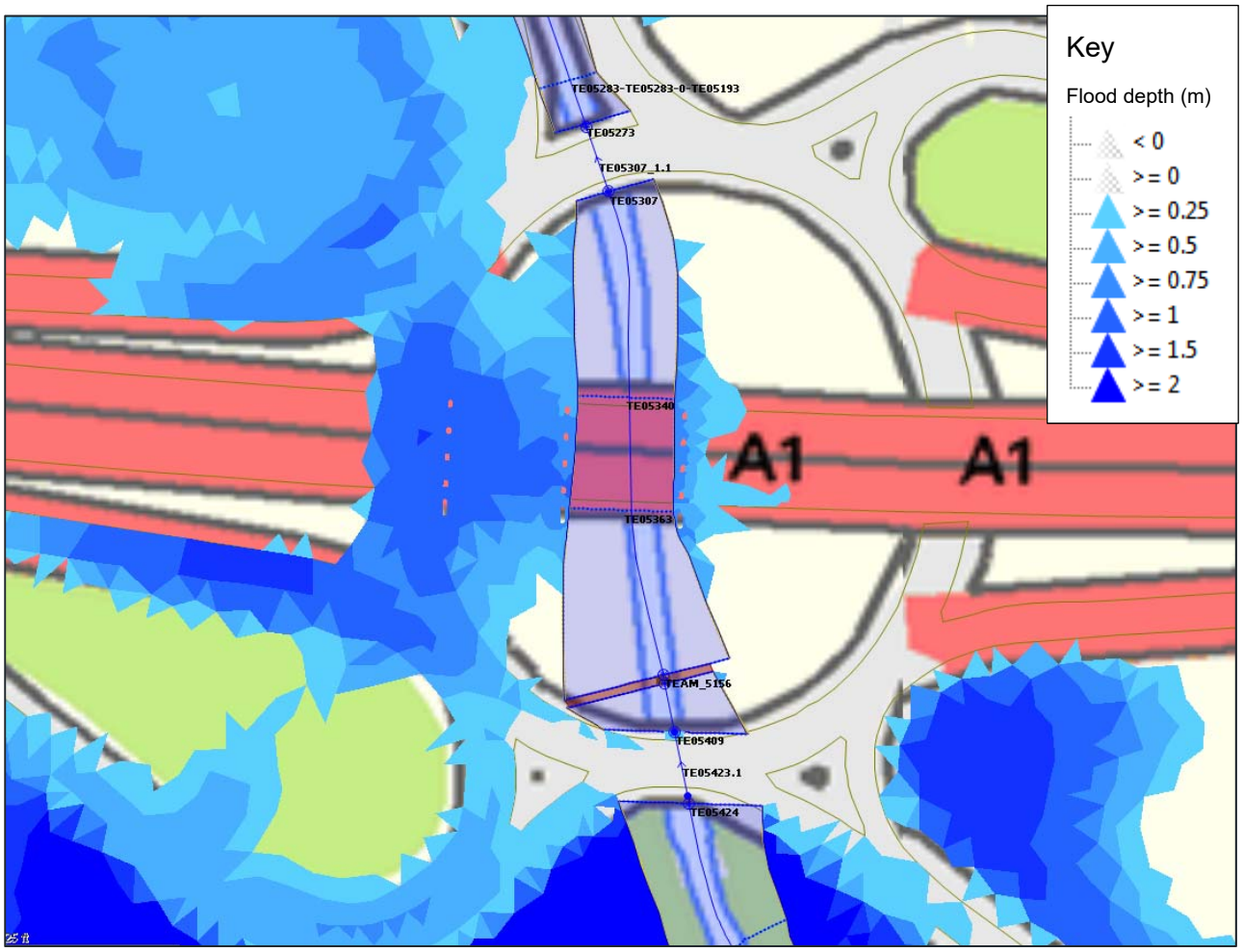


Table 4-1 - Maximum predicted flood depth adjacent to the proposed bridge pillars for the 0.1% AEP event (reported west to east)

Pillar	Flood depth (metres)				
	Pillar 5	Pillar 4	Pillar 3	Pillar 2	Pillar 1
Baseline	1.297	0.733	0.731	0	0
Proposed	1.315	0.753	0.727	0	0
Difference (mm)	18	20	-4	0	0

4.2.11. The Environment Agency and the LLFA have stated that the Team Valley Industrial Estate, which is located immediately downstream of the Scheme is very vulnerable and sensitive to flooding. Therefore, to ensure that the Scheme does not have an adverse impact on flood risk elsewhere flood plain compensation works are proposed.

4.2.12. Three of the proposed bridge piers are located within the extent of the 1 in 100 year + 50% climate change event and will remove existing flood storage area; compensation on a level for level, volume for volume approach is required to provide equivalent storage near the area of lost floodplain to ensure that there is no increase in flood risk downstream. This replacement storage has been designed for the 1 in 100 year plus 50% climate change event.

4.2.13. Each of the bridge piers are 3.02m^2 in area, and flood to between 0.65m and 1.2m for the design event (100yr + 50%CC). The total volume of water taken up by the proposed pillars in this event is 7.6m^3. An area has been found within the roundabout, adjacent to the bridge piers, to provide the compensatory storage. The area is within the flood extent of the design event and provides storage at the required depth bands and is sufficiently far from existing or proposed drainage infrastructure to avoid any clashes. **Figure 6** shows a strip 2.6m wide (width of a JCB excavator bucket) by 38m long that could be used for the compensation. Lowering this area by 130mm would provide the necessary required volume. As this area is approximately 170mm higher than the lowest levels close to the bridge piers an additional section of re-profiling is proposed to link to two areas to ensure that this compensation area can be used at the same point in the flood event as that being lost. This design will be optimised during detailed design. Further information is provided in the figure enclosed as Figure **D** in **Appendix E**, Scheme Figures/**Figure 13.7** of the ES.

Figure 6 - Location of proposed flood compensation

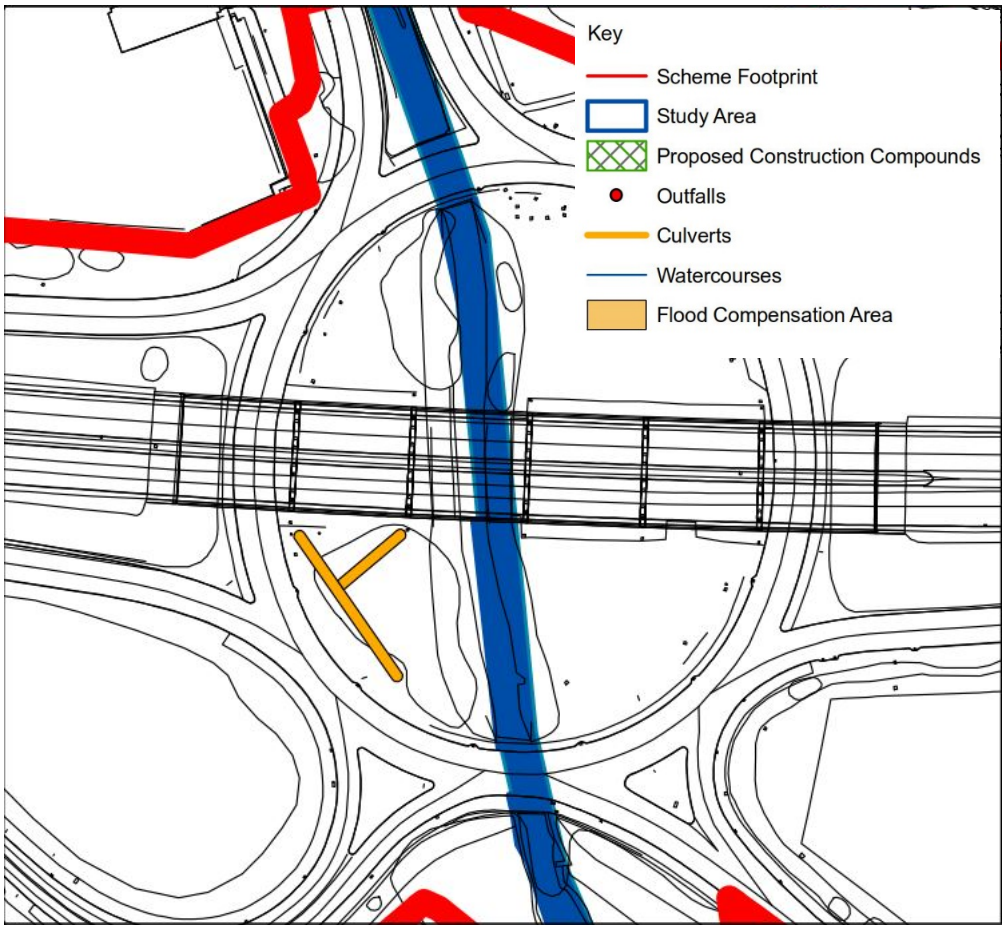


Table 4-2 - Flood compensation volumes for the 1 in 100 year plus 50% scenario

Depth bands (m AOD)	Required compensatory storage (m^3)	Storage provided (m^3) by 130mm excavation over proposed area
11 - 11.25	0.00	0.02
11.25 - 11.5	0.72	0.75
11.5 - 11.75	0.75	0.80
11.75 - 12	1.33	3.00
12 - 12.25	2.26	2.27

Depth bands (m AOD)	Required compensatory storage (m^3)	Storage provided (m^3) by 130mm excavation over proposed area
12.25 - 12.5	2.20	2.91
12.5 - 12.75	0.36	1.59
12.75 - 13	0.00	0.00
Total:	**7.63**	**11.34**

ALLERDENE BURN

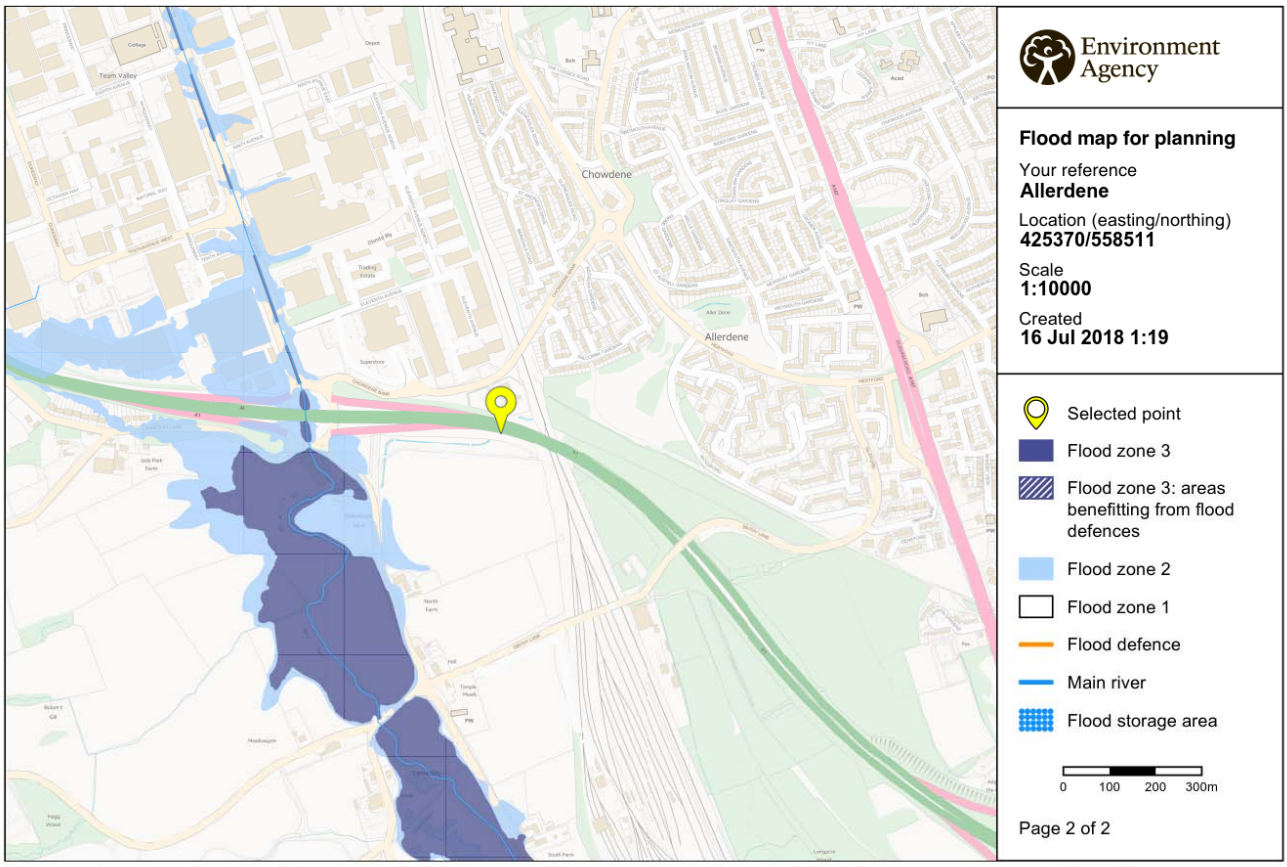
4.2.14. Allerdene Burn is located just east of junction 67 (Coal House) and the ordinary watercourse is culverted under the Scheme before discharging into the River Team (see Error! Reference source not found.). The land adjacent to the Allerdene Burn is shown to be in Flood Zone 1 on the Environment Agency's Flood Map for Planning, as shown in **Figure 7** (see the yellow marker).

4.2.15. Flood Zone 1 is associated with a low risk of flooding from fluvial sources, with an annual probability of less than 1 in 1000 (<0.1%).

4.2.16. The existing Allerdene Bridge crosses over the Allerdene Burn, as part of the Scheme, the bridge will be replaced with a wider structure with additional lanes to improve capacity and the culverted ordinary watercourse will therefore require modification to accommodate the bridge replacement. Two options (Allerdene embankment option and Allerdene viaduct option) have been proposed with respect to the bridge replacement, which will affect how the culverted ordinary watercourse is modified:

- Allerdene embankment option: This includes lengthening the culverted section of the watercourse (Allerdene Burn) and the realignment of approximately 300m of the open section of the watercourse downstream to run parallel to the new bridge.
- Allerdene viaduct option: This includes the replacement of the culverted section of the watercourse (Allerdene Burn) with an engineered open channel and the existing watercourse downstream will be realigned to accommodate the new viaduct. The proposed channel (new section and realignment) will be approximately 620m in length and will run under one of the bridge spans of the new structure.

Figure 7 – Environment Agency flood map for planning centred on the Allerdene Burn



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4.2.17. As detailed above the Scheme will require the replacement and extension of the existing Allerdene Burn and the replacement of the existing drainage channel. The potential effects of these changes have been modelled in InfoWorks ICM, with a detailed methodology provided in **Appendix A**.

4.2.18. Baseline modelling representing the existing site conditions has been undertaken in addition to modelling of the proposed replacement and lengthening of the culvert and realignment of the downstream channel to facilitate the relocation of the NGN premises, the proposed NGN site is covered by a separate FRA.

4.2.19. Hydraulic modelling of the proposed Allerdene Burn (i.e. the lengthening and realignment of the existing channel and installation of two 1200mm culverts, that runs parallel to the A1) indicates that peak flows for all events will remain unchanged, with no risk to the Scheme. This is due to the capacity of the existing channel being exceeded for these events and exceedance flows being contained within the adjacent flood plain, which is lower than the drainage channel bank tops. The proposed channels have larger capacities and therefore less flows are transferred to the flood plain; the channel capacities are detailed in **Table 4-3.** This demonstrates that with careful detailed design there will be no increase in flood risk elsewhere.

Table 4-3 - 100 year channel storage volumes (m^3)

	Baseline	Allerdene embankment option	Allerdene viaduct option
Channel storage	683	875	1475
Channel storage and the loss/gain of culvert storage	865	1001	1293

Note: The modelling demonstrates that the culvert provides the following storage volumes, baseline 182 m^3 and culvert extension 126m^3.

4.2.20. As the Scheme does not cross the fluvial floodplain in any other location, the Scheme is not expected to alter the fluvial flood risk aside from the extension of the Allerdene Culvert at junction 67 (Coal House). The rest of the Scheme is located in Flood Zone 1 (see **Figure 2**) and the fluvial flood risk to the rest of the Scheme is expected to remain low.

4.3. TIDAL FLOOD RISK

4.3.1. The lower reaches of the River Team are tidally influenced, with the Normal Tidal Limit at a weir downstream of the railway (located between the A184 and the B1426). This is over 3km from the Scheme at the Kingsway Viaduct. The Environment Agency's 2016 River Team model will have included this within the downstream boundary condition and thus it has been considered within the assessment of the Scheme.

4.4. SURFACE WATER FLOOD RISK

4.4.1. Surface water flooding happens as a result of overland flow that can follow a rainfall event before the runoff enters a watercourse or sewer. This form of flooding is usually associated with high intensity rainfall events but can also occur with lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or otherwise has a low permeability. The extents of this flooding are discussed below and shown on **Figure E** enclosed in **Appendix E**, Scheme Figures.

4.4.2. This flood risk relates to the conveyance of waters to the Scheme by overland flow from areas outside the Scheme; conveyance of water from areas within the Scheme itself; and the resulting ponding of these waters in depressions in the topography.

4.4.3. Cut off ditches are to be incorporated into the base of new embankments to minimise the runoff going onto third party land.

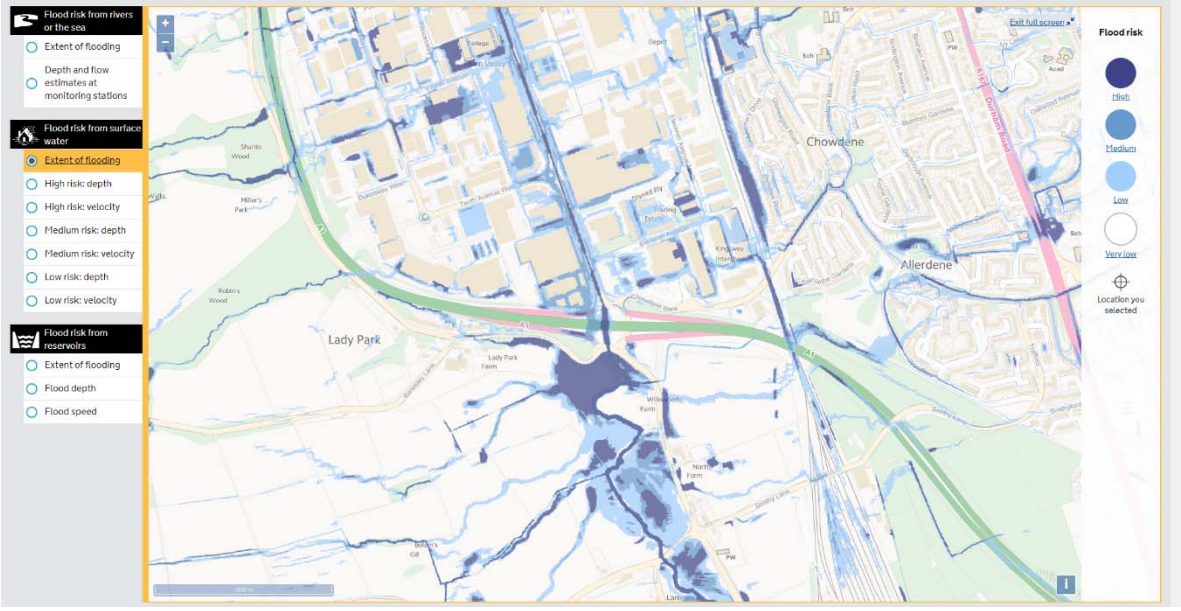
4.4.4. The surface water flood risks need to be considered in perspective with the Highways England standards for surface water design and the point at which the road surface can become flooded. The 1 in 5 year event is the standard for managing the surface water on the highway, in accordance with HD33/16 (**Ref 1.5**), which requires the surface water drainage network to be functioning, beyond this flooding of the highway is allowed. As the surface water risks are identified for greater events, flooding would technically be acceptable. However, if at detailed design additional mitigation is required consideration of the timing of the surface water runoff peaks from the highway and the wider catchment could be considered to determine whether further mitigation is required. If so, active management through CCTV observation measures linked to water level sensors, which would enable operatives to implement slip road closures to reduce the risk to users during/following the more extreme heavy rainfall events, could be implemented.

Junction 67 (Coal House)

4.4.5. The Environment Agency's Risk of Flooding from Surface Water Map (see **Figure 8**) shows areas at high risk of surface water flooding on the slip roads to the west of junction 67 (southbound off and northbound on), meaning that areas at risk are predicted to flood in a 1 in 30 year return period event, or greater (>3.3%).

4.4.6. The Environment Agency's mapping predicts flood depths in the 1 in 30 year event of below 300mm on the southbound slip road, and 300 to 900mm on the northbound slip road, for the 1 in 30 year event. This is not assessed further as outlines and flow direction/velocity indicate that this is associated with the River Team (i.e. the fluvial flood outlines) which have been assessed through detailed modelling, as outlined in the previous section 'Fluvial Flood Risk'.

Figure 8 - Environment Agency's risk of flooding from surface water map centred on junction 67



JUNCTION 67 TO 66

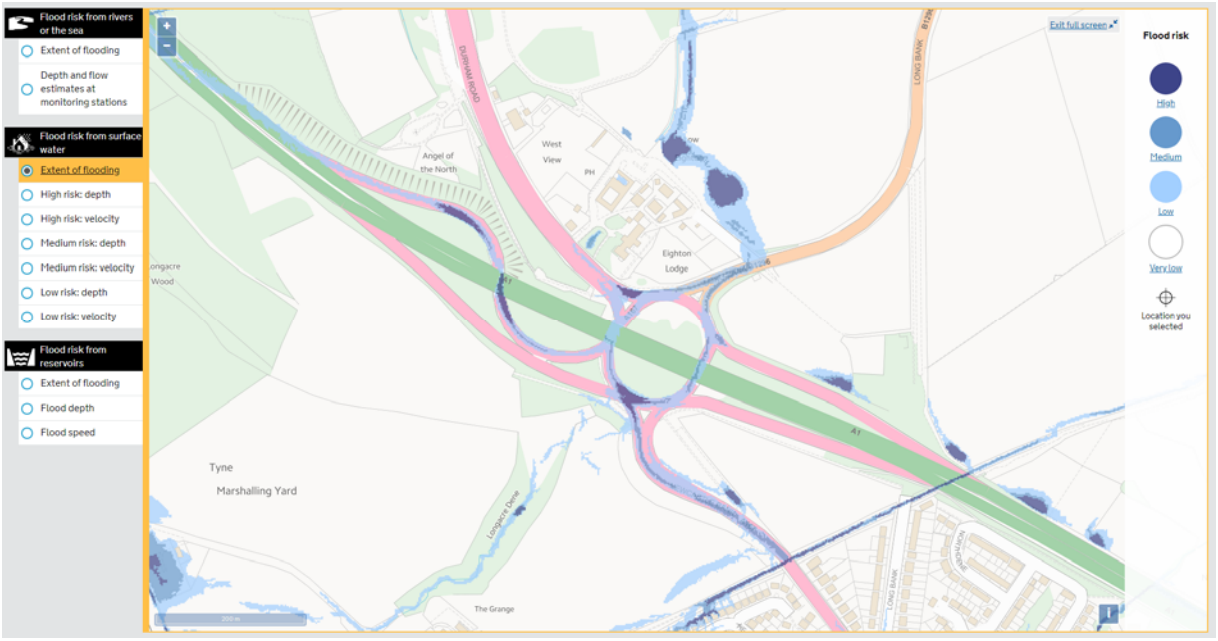
4.4.7. The Environment Agency's Risk of Flooding from Surface Water Map shows an area at high risk of surface water flooding on the northbound carriageway between Allerdene Railway Underbridge and Smithy Lane Overbridge, as can be seen in **Figure 8**. High risk equates to an annual probability of surface water flooding of greater than 1 in 30 (>3.3%).

4.4.8. This has been assessed as part of the Allerdene Burn hydraulic model (**Section 4.2**), which demonstrates that no flood waters would impact the A1 and therefore, no further consideration in this section is required.

JUNCTION 66 – LONGACRE DEAN

4.4.9. At junction 66 (Eighton Lodge), the Environment Agency's Risk of Flooding from Surface Water Map shows discrete areas of high risk (>3.3%) on the junction roundabout and on the southbound off slip road, as shown below in **Figure 9**.

Figure 9 - Environment Agency's risk of flooding from surface water map centred on junction 66



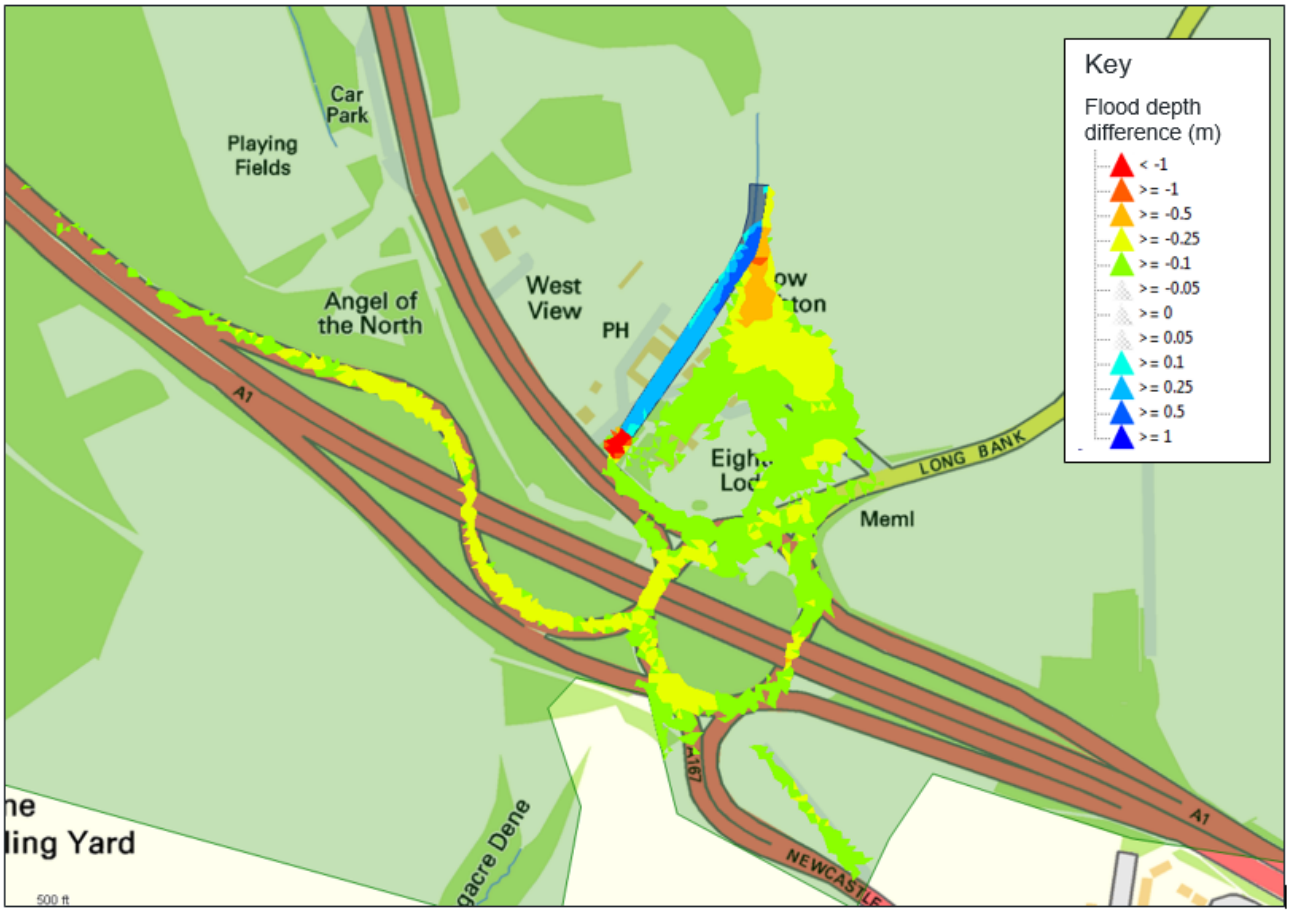
4.4.10. Hydraulic modelling of the surface water flood risk at this junction has been undertaken as the current surface water flood risk maps do not give an accurate representation as the existing culvert and drainage channel were not represented in the original surface water flood risk model. Full details are included in the hydraulic modelling report (see **Appendix A**) with a summary provided below.

4.4.11. The refined modelling undertaken included incorporating a channel for the watercourse and a culvert connecting the watercourse to the assumed outfall at Longacre Dene.

4.4.12. **Figure 10** shows the change in predicted surface water flood depths between the baseline model and the culvert model at junction 66 (Eighton Lodge) for the 1% AEP event. The inclusion of the culvert and channel for the watercourse reduces the flood depths at the junction 66 roundabout by between 0.1 and 0.5m, as flow from the watercourses is no longer routed to the roundabout.

4.4.13. Residual surface water flood risk at junction 66 (Eighton Lodge) can be managed by the proposed highway drainage infrastructure (see **Section 5**) and the CCTV network linked to water level sensors to give the operators the ability to close the southbound off-slip as required.

Figure 10 - Change in surface water flood depth for the 1% AEP event at junction 66



BOWES RAILWAY PATH

4.4.14. **Figure 9** also shows that there is a surface water flow route along the Bowes Railway path. A site visit was undertaken to assess the likely flow route, this confirmed that water will flow along the path from the north-east, under the A1 and continue in a south westerly direction. This is due to the topography and the path being in a slight depression, which means that once water flows onto the path it will remain on it. The land to the south adjacent to the A1

drops away to the south and will not contribute additional flows. However, the land to the north is likely to contribute overland flows, particularly as the field is ploughed down gradient (**Figure 11**). The extension of the underpass will require relocation (and enhanced so it is similar to that on the Lamesley Road underpass) of the cross drainage and creation of a flow mechanism from the elevated field, this would act to reduce the sediment within the underpass. The current and proposed cross drainage are shown in **Figure 12**.

Figure 11 - Down gradient ploughing on field to the north of the Bowes Railway Path

Figure 12 - Cross drainage (a, existing, b downstream at Lamesley Road underpass)

a **b**

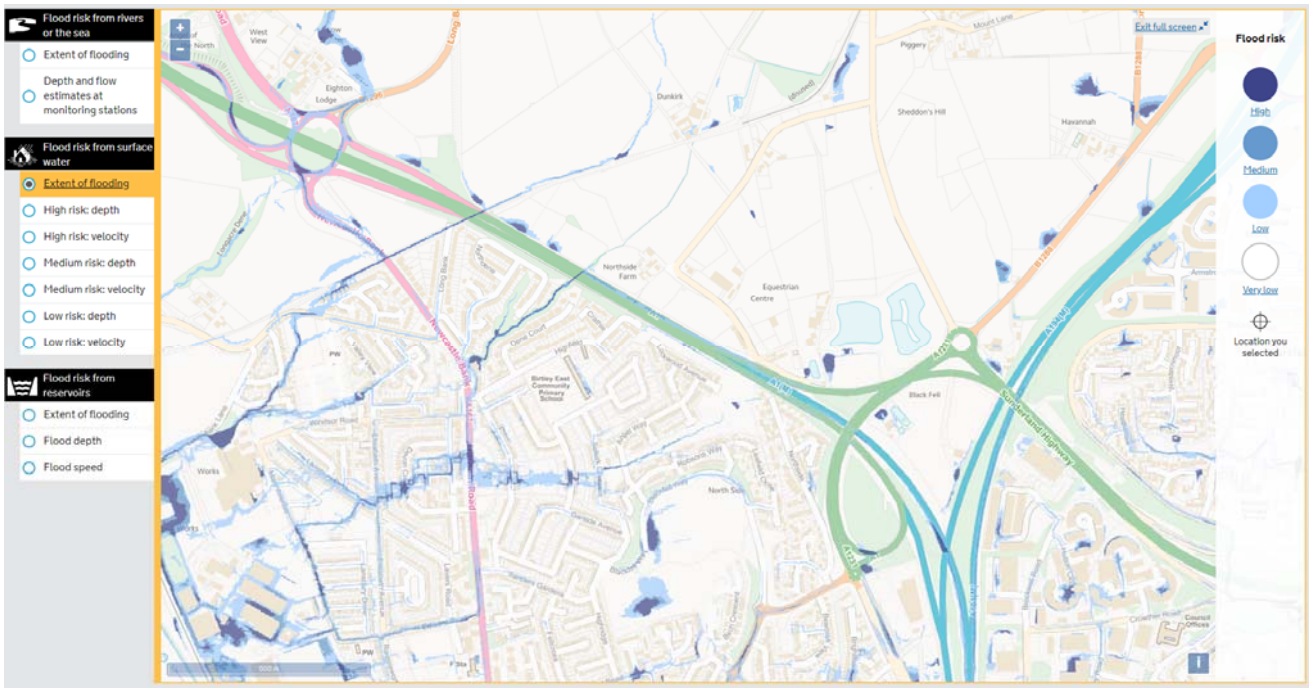
Junction 66 to 65

4.4.15. The Environment Agency's Risk of Flooding from Surface Water Map (**Figure 13**) shows the risk to the majority of the Scheme between junction 66 (Eighton Lodge) and junction 65 (Birtley) to be low (1-0.1%) to very low (<0.1%). However, the upstream surface water flood

map (see **Figure 9**) shows a flow path along the southbound carriageway in the 1 in 100 to 1 in 30 year event (medium risk) associated with shallow flood depths (below 300mm). The cause and impacts of this has been discussed in **Section 4.4.9**.

4.4.16. A small isolated area on the northbound on slip at junction 65 (Birtley) is shown to be at high risk (within the 1 in 30 year i.e. 3.3% AEP event), see **Figure 13**. Predicted flood depths for this area of ponding are 300 to 900mm which only marginally increases for the 1 in 1000 year event which infers that this is restricted to a localised depression. Within this area there is significant drainage infrastructure and the road is on a camber on a bend, therefore it is likely that these depths are towards the lower end of the range and no further mitigation is required.

Figure 13 - Environment Agency's risk of flooding from surface water map for junctions 66 to 65



4.5. GROUNDWATER FLOOD RISK

4.5.1. According to the SFRA, groundwater is not identified as being a significant source of flooding in the area.

4.5.2. The Bedrock underlying the Scheme is classified as Secondary A aquifer.

4.5.3. The majority of superficial deposits (as shown in **Figure F** enclosed in **Appendix F**, Scheme Figures) underlying the Scheme have been classified as secondary (undifferentiated) aquifer. This classification has been assigned to rocks where it was not possible to attribute either Secondary A or Secondary B to the rock type.

4.5.4. Secondary A Aquifers are permeable strata capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers

4.5.5. Secondary B Aquifers are predominantly lower permeability strata which may in part have the ability to store and yield limited amounts of groundwater by virtue of localised features such as fissures, thin permeable horizons and weathering.

4.5.6. The Scheme is located at grade or elevated in relation to the surrounding ground levels, in light of this, emergence of groundwater on the highway is considered unlikely. This is supported by the Environment Agency's and Coal Authority's screening toolkit for assessing the potential for groundwater flood risk to the scheme. The toolkit identifies that there is no risk of groundwater flooding and no further actions are required, further information is provided in **Appendix B**.

4.5.7. The scoping opinion identified that due consideration should be given to potential issues associated with possible cessation of large scale, coal mine legacy, dewatering occurring locally. In theory, should the Coal Authority cease, or significantly reduce, their local dewatering operation at Kibblesworth then the whole Study Area would be subject to major groundwater level rebound and an array of associated consequences could manifest including:

- Impacts on groundwater quantity (levels and flows).
- Impacts on groundwater quality (mobilisation/inundation of contaminants, inundation of mine audits/shafts/voids and other poor water quality zones).
- Quantity and quality breakout to the surface water environment.
- Impacts on drainage/flooding.
- Impacts on geotechnical properties/stability characteristics (through inundation, reduced pore pressures and possible hydrochemical attack) affecting natural/artificial ground conditions/properties and ground engineered infrastructure.
- Mobilisation and surface breakout of ground gases.

4.5.8. Although it is incumbent upon us to give due consideration to realistic changes to the baseline water environment when undertaking an ES, we do not believe the prospect of cessation, or significant reduction, in local dewatering operations by the Coal Authority is realistic and therefore we scope out a need to consider an additional baseline groundwater regime over and above the present baseline. Our reasoning for this is set out below.

4.5.9. Scoping out the need to consider an additional baseline groundwater regime dependent upon the cessation of major dewatering by the Coal Authority.

4.5.10. A meeting was held between WSP and the Coal Authority on 22 March 2018. This identified that the local groundwater regime is heavily influenced by major dewatering at Kibblesworth (~300l/s) and some of the consequences identified in **Section 13.4.9** could manifest if this operation were to be terminated. However, the meeting did not identify that this is a realistic prospect.

4.5.11. From the 1980s through to 2005 incremental closure of underground coal mining in the Durham Coalfield occurred along with commensurate cessation of coal mine dewatering operations. In the 1990s great environmental concern was expressed regarding impacts associated with groundwater level rebound and it was decided to abandon mine dewatering operations proximal to the coast and focus continued mine dewatering inland using both existing facilities (such as Kibblesworth) and newly constructed facilities elsewhere (**Ref. 13.6**.

4.5.12. Although pumping rates at Kibblesworth have remained little altered in recent decades (300+ l/s) corresponding pumped groundwater levels have risen from circa -70 to -25m OD over the period 1997 to 2004. This is thought to be due in part to a small reduction in pumping locally at Kibblesworth but also reflects Regional cessation/reduction in dewatering operations proximal to coastal areas (Reference A).

4.5.13. Over a corresponding period, groundwater level rises at the Environment Agency Birtley observation borehole (proximal to the Study Area) have risen from circa -33 to -22m AOD.

4.5.14. In 2005 the combined Lamesley (near Birtley) Water Treatment Scheme was commissioned. This entails a joint venture between Northumbrian Water, the Coal Authority and the Environment Agency and involves passive treatment (through a 5.6 ha wetland) combining treatment of two source waters including secondary treated water from Birtley WWTWs (~100 l/s) and mine water form Kibblesworth (~300 l/s) with onward discharge to the River Team post passive treatment.

4.5.15. Gateshead Council recognise the significance of the artificially maintained groundwater level regime in relation to groundwater mediated flood risk in their area. In their assessment no potential groundwater discharge breakouts are identified in the Scheme Study Area should mine dewatering at Kibblesworth be subject to cessation. They make reference to an earlier study by the National Rivers Authority that cessation of dewatering at Kibblesworth could lead to the following surface breakouts:

- Duston shaft, Dunston (though this breakout would likely be subdued as the mine shaft has been infilled).
- Norwood shaft, Dunston (though this breakout would likely be subdued as the mine shaft has been infilled).
- Swalwell Henry shaft, Swalwell (though this breakout would likely be subdued as the mine shaft has been infilled).
- Swalwell Henry adit, Swalwell (though this breakout would likely be subdued as the mine adit has been infilled).
- Addison Industrial Estate, Ryton (area identified as being subject to historical mine related flooding).
- Monkridge Garden, Dunston Hill (area identified as being subject to historical groundwater related flooding).

4.5.16. We infer from the above references that the Coal Authority may be prepared to allow very modest levels of further groundwater level recovery in the Kibblesworth Block affecting

areas such as Birtley and Gateshead. However, any further significant groundwater level recovery to anything approaching 'natural' regimes can be regarded as unthinkable and unacceptable. The modest levels of additional groundwater level recovery realistically envisaged will not significantly change the present groundwater baseline regime for the project or give rise to added design or environmental considerations for the Scheme.

4.5.17. Groundwater flooding to the Scheme is considered to be a low risk.

4.6. ARTIFICIAL SOURCES OF FLOODING

4.6.1. Non-natural or artificial sources of flooding can include reservoirs, lakes, canals etc.

Local Drainage

4.6.2. Drainage and infrastructure flooding occurs when sewerage systems are overwhelmed resulting in flooding which may occur alone or in combination with other flood sources (e.g. fluvial or surface water).

4.6.3. There are only highway drainage sewers running along the Scheme and these have been assessed as part of the drainage strategy, it is highly unlikely that any public sewers have manholes on the surface of the A1; however as discussed in **Section 3.1** there are a number of culverted watercourses. The risk of flooding associated with these culverted watercourses has been considered above in **Section 4.2**.

Reservoir

4.6.4. The Environment Agency's Risk of Flooding from Reservoirs Map shows junction 67 (Coal House) to be within the maximum flood extent should nearby reservoirs fail. Based on Northumbria Local Resilience Forums' 2015 Multi-Agency Generic Reservoir Flooding Off Site Plan (**Ref 1.7**), the reservoirs which could inundate the Scheme should they fail Scheme are, Whittle Dene, Airy Holme, Kielder Water Reservoir and Derwent Reservoir.

4.6.5. However, these reservoirs are a substantial distance from the Scheme, with the closest, Whittle Dene, located 18km away and the Environment Agency states that reservoir flooding is extremely unlikely to happen. Therefore, this risk is considered to be low.

Other Sources

A review of online mapping sources was undertaken to check for other possible sources of flood risk. The desk-based review and site visit did not show there to be any other significant sources of artificial flooding near to, and at higher elevation than the Scheme.

5. DRAINAGE STRATEGY

5.1. OVERVIEW

5.1.1. The surface water drainage strategy for this Scheme of works has been developed in consultation with Gateshead Council as LLFA and the Highways England SES team. The key aspects of the drainage strategy are provided below, with further context and information provided in **Appendix C**.

5.2. DESIGN PARAMETERS AGREED WITH HIGHWAYS ENGLAND DRAINAGE SES

5.2.1. The Highways England guidance for the Scheme (provided via their SES team) is that the climate change rainfall intensities are to be increased by 20%.

5.2.2. Where there is no increase to paved area, the additional runoff (generated by application of the 20% increase to rainfall intensities for climate change) is to be attenuated, so that the proposed discharge rate does not exceed the existing.

5.2.3. Where it is proposed to increase the paved areas (e.g. nearside widening/hardening of the central reserve), the discharge rate can be increased above the existing by an amount equal to the Greenfield runoff rate for the additional paved area. Allowance for climate change is also to be applied for the entire catchment area inclusive of the new paved areas. Flows exceeding the revised discharge rate are to be attenuated and released at a rate which is identical to the existing.

5.3. THE PROPOSED DESIGN

5.3.1. It is proposed that the Scheme will be drained by a combination of the following collection systems:

- Combined kerb and drainage unit (CKDU)
- Gullies
- Filter drains
- Combined surface and sub-surface drainage
- Surface water channels
- Slotted linear drainage channel

5.3.2. All collection systems will connect into a carrier drain network and utilise the existing outfalls. The proposed drainage layouts are shown on Drawing Nos HE551462-WSP-HDG-ZZ-DR-CH-05001 to 05004 (**Appendix D**).

5.4. ATTENUATION

5.4.1. Attenuation is to be provided using oversized pipes, geo-cellular storage and balancing ponds which are designed to surcharge during storm events with control orifices included in manholes to control the discharge rates.

5.4.2. The drainage design for the Scheme incorporates an attenuation pond at a proposed location of the redundant A1 carriageway. The attenuation pond will capture all the water drained from the majority of the catchment (i.e. Outfalls 7, 7A and 8). This would reduce the rate of the surface water run-off which would have flowed freely ultimately into the River Team. The pond would do this by storing surface water run-off during peak flow (i.e. heavy rainfall) and slowly releasing the water after the peak flow has passed.

5.4.3. A secondary effect of the attenuation ponds would be to treat the water. Sediment and pollutants would settle to the bottom of the attenuation ponds and not enter the Allerdene Burn or the River Team. Additionally, vegetation associated with the ponds would uptake nutrients, which would reduce the nutrient concentration in the water.

5.4.4. The drainage design would also provide protection against spillage events and subsequent contamination of the River Team. The attenuation pond and other storage facilities would be designed with overflow and isolation systems in order to retain contaminated water before it would flow into the drainage system or watercourses. This would allow contaminated water to be treated before being discharged and is integral to the incident management routine.

5.4.5. **Table 5-1** below outlines the proposed attenuation requirements and provisions required to ensure the surface water run-off do not exceed the agreed rates. This is shown graphically in **Appendix D**, with the location of the outfalls shown in **Figure G** in **Appendix E**, Scheme Figures

Table 5-1 - Attenuation and flow control schedule

Outfall No.	Attenuation Type	Volume (m^3)	Storage Dimensions	Flow Control Device
1	Geo-cellular structure	108	1m depth to invert	Orifice
2	Pipe	172	1200mm dia. x 152m length	Orifice
3	Pipe	15	1050mm dia. x 17.43m length	Orifice
4	Pipe	111	1200mm dia. x 98m length	Orifice
5	Pipe	207	1200mm dia. x 183m length	Orifice
5	Pipe	38	750mm dia. x 85m length	Orifice
5	Pipe	2	500mm dia. x 11m length	Orifice

Outfall No.	Attenuation Type	Volume (m^3)	Storage Dimensions	Flow Control Device
6	Pipe	4	525mm dia. x 20m length	Orifice x 2
7a, 7 & 8	Pond	662	2m depth to invert	Weir
9	Pipe	66	800mm dia. x 130m length	Vortex flow control
11	Geo-cellular structure	240	1.2m depth to invert	Vortex flow control
12	Pipe	6	375mm dia. x 50m length	Orifice
13	Geo-cellular structure	1100	2.4m depth to invert	Vortex flow control

5.4.6. Outfalls 7a, 7 and 8 is a linked network where each catchment discharges to individual outfalls. The model contains loops which would allow the overflow flows carried to the adjacent network i.e. Outfall 7a to 7, Outfall 7 to 8.

OIL INTERCEPTORS AND SILT CONTROL

5.4.7. The CCTV survey only identified two locations where the surface water is treated by an oil interceptor prior to discharge. These oil interceptors are located adjacent to the Outfalls 4 and 11. These existing interceptors will be replaced with new interceptors and the remaining 10 outfalls that are to be utilised as a part of the drainage Scheme will all be equipped with oil interceptors as a primary treatment prior to discharge.

5.4.8. Bypass oil interceptors has been specified to capture and control flows for the majority of storm events. Initial discussions with the Managing Agent Contractor (MAC) Asset Led Highways England have requested that the interceptors are alarmed and able to inform the Highways England Regional Control Centre. Excessive oil accumulation will not allow the separator to work effectively and the emptying of the tank shall be inclusive to the maintenance requirements.

5.4.9. In addition, silt control vortex separators will be incorporated into the outfalls to Longacre Dene to minimise sediment issues, with detailed design to consider the potential for these to be installed at all outfalls. It should also be noted that catchpits have been specified in-lieu of manholes throughout the network, these assist with sediment reduction due to the sump at the base.

TEMPORARY DRAINAGE STRATEGY

5.4.10. The temporary drainage strategy would utilise the existing edge of carriageway collection systems where possible. The additional paved areas and collection system is to be constructed simultaneously with the new drainage provisions. The construction sequence should be thoroughly planned to allow for utilising the existing network and outfalls from inception.

5.4.11. All pre-earthworks drainage for cuttings and embankments should be constructed prior to and retained as the permanent feature. The attenuation tanks have been proposed as a provision to reduce discharge and impact as a cause of additional paved area and climate change allowance. As the current network has no flow control or attenuation features, the occurrence of a high intensity storm event during construction will not exacerbate any flooding issues.

5.4.12. The temporary drainage strategy will be developed for the construction area during detailed design to ensure that any areas of temporary hard standing do not lead to increased runoff and sediments / contaminants from the construction works are appropriately managed.

6. CONCLUSIONS

6.1.1. This FRA has been produced to support the Scheme. This FRA includes an assessment of flood risk from all potential sources and demonstrates that there will be no significant changes to flood risk either onsite or offsite as a result of the Scheme. The Scheme is largely located in Flood Zone 1, which represents a low risk of flooding from rivers or the sea, with an annual probability of less than 1 in 1000 (0.1%).

6.1.2. Where the Scheme crosses the floodplain of the River Team, there are sections of the Scheme within Flood Zone 2 (medium risk (0.1%-1.0%AEP), as detailed by the Environment Agency's River Team model. The river channel is in Flood Zone 3, with the piers and western on/off slips in Flood Zone 3 once climate change is considered. The main carriageway is raised above the floodplain on the Kingsway Viaduct, and the proposed changes to the viaduct as a part of this Scheme have been modelled to show that flood risk will not be increased.

6.1.3. Hydraulic modelling shows the proposed widening of the Kingsway Viaduct has negligible impact on flood risk, with the model not predicting flooding from the River Team at junction 67 (Coal House) for the 1% AEP event. However, flooding occurs from the left bank in the 1% AEP plus 25% climate change event which causes flooding to the west side of junction 67 (Coal House) including the A1 northbound (entry) and southbound (exit) slip roads. Flood extents and depth are predicted to increase for the 1% AEP plus 50% climate change and 0.1% AEP events, however these increases are expected to be minimal. This means that the flood depths on the southbound slip could reach 1.035m in the 1 in 100 year plus 50% climate change event, mitigation measures are required to prevent access to this slip road. It is recommended that suitable signage is installed along with CCTV which is linked to water level sensors to give the operators the ability to close the southbound off-slip as required.

6.1.4. Additionally, the piers will remove a small proportion of the flood plain (the piers have a footprint of approximately $4m^2$). This is to be compensated through a 130mm reduction in levels across a strip 2.6m wide and 38m long to provide $8.72m^3$ of compensatory storage.

6.1.5. The Scheme also involves extending the Allerdene Culvert and realigning the existing drainage channel, just to the east of junction 67 (Coal House). At this location Flood Zones 2 and 3 bordering the Scheme. This section of Scheme adjacent to the Allerdene watercourse is currently shown to be in Flood Zone 1, and where the Allerdene joins the River the Team there is an area of Flood Zone 2. Hydraulic modelling of the baseline and proposed changes to the Allerdene Burn and drainage channel have been undertaken to demonstrate that the Scheme will not increase flood risk in this area, when suitable mitigation is installed.

6.1.6. Hydraulic modelling of the proposed Allerdene culvert (i.e. the lengthening and realignment of the existing channel and installation of two 1200mm culverts, that runs parallel to the A1) indicates that peak flows for all events will remain unchanged, with no risk to the Scheme.

The is due to the capacity of the existing channel being exceeded for these events and exceedance flows being contained within the adjacent flood plain, which is lower than the drainage channel bank tops. The proposed channels have larger capacities and therefore less flows are transferred to the flood plain, as detailed in **Section 4.**

6.1.7. The site is at very low risk of flooding from artificial sources or infrastructure, with the groundwater flood risk at the site assessed to be low.

6.1.8. According to the Environment Agency's Risk of Flooding from Surface Water map, the majority of the Scheme is shown to be at low risk of surface water flooding, however as outlined in **Section 3.6** there are localised areas which are deemed to be at medium to high risk.

6.1.9. One of the areas shown to be at high risk of surface water flooding (>3.3% AEP) on the Environment Agency's Surface Water Flood Map is junction 66 (Eighton Lodge). Hydraulic modelling undertaken by WSP (see **Section 3.6** and **Appendix A**) has demonstrated that the risk of surface water flooding at this location is less severe than as shown in the EA's map, as the mapping did not take accurately represent the existing culvert and drainage channel in this location. The residual surface water flood risk at this location can be managed through the proposed highway drainage infrastructure outlined in the drainage strategy in **Section 6** combined with the CCTV network linked to water level sensors to give the operators the ability to close the southbound off-slip as required.

6.1.10. The proposed drainage strategy (see **Section 6**) outlines how the Scheme will deal with surface water via combined kerb and drainage units (CKDU), Gullies, filter drains, combined surface and sub-surface drainage, surface water channels and slotted linear drainage channels. An attenuation pond will be provided at a proposed location of the redundant A1 carriageway, just east of where the existing Allerdene railway underbridge is located. The attenuation pond will capture all the water drained from the majority of the catchment (i.e. Outfalls 7, 7A and 8). This would reduce the rate of the surface water run-off which would have flowed freely ultimately into the River Team. The pond would do this by storing surface water run-off during peak flow (i.e. heavy rainfall) and slowly releasing the water after the peak flow has passed.

6.1.11. Furthermore, this FRA is considered to meet the requirements of the NPS NN as it meets the requirements detailed in **paragraphs 5.90 to 5.115**, particularly as:

- Surface water discharge is managed so that the volumes and peak flow rates of surface water leaving the site are no greater than the rates prior to the proposed project as required for the new and existing surfaces.
- Opportunities have been sought to lower flood risk by improving flow routes, flood storage capacity and using SuDS.

REFERENCES

Ref 1.1 Design Manual for Roads and Bridges (2009). Volume 11 Environmental Assessment, Section 3 Environmental Assessment Techniques Part 10 HD 45/09. Road Drainage and the Water Environment. Available at: www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/hd4509.pdf

Ref 1.2 HM Government. Flood risk assessments: climate change allowance. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Ref 1.3 HM Government. Flood risk and coastal change. Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change

Ref 1.4 Environment Agency. Available at: http://www.geostore.com/environment-agency/ds/catalogue/#/catalogue

Ref 1.5 Design Manual for Roads and Bridges (2016). Volume 4 Geotechnics and Drainage, Section 2 Drainage. Part 3. HD 33/16. Design of highway drainage systems. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol4/section2/hd3316.pdf

Ref 1.6 Northumbria Local Resilience Forum (2015). Multi-Agency Generic Reservoir Flooding Off Site Plan.

Ref 1.7 Environment Agency. Available at: https://environment.data.gov.uk/catchment-planning

Ref 1.8 Design Manual for Roads and Bridges (2012). Volume 1 Highway Structures: Approval Procedures and General Design, Section 1 Approval Procedures Available at:

http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol1/section1/bd212.pdf

Appendix A

HYDRAULIC MODELLING REPORT

Highways England

A1 BIRTLEY TO COAL HOUSE STAGE 3

Appendix 13.1a Hydraulic Modelling Report

HE551462-WSP-EWE-ZZ-RP-LE-00017
AUGUST 2019

CONFIDENTIAL

Highways England

A1 BIRTLEY TO COAL HOUSE STAGE 3

Flood Risk Appendix 13.1a Hydraulic Modelling Report

CONFIDENTIAL

PROJECT NO. 70041947

OUR REF. NO. HE551462-WSP-EWE-ZZ-RP-LE-00017

DATE: AUGUST 2019

QUALITY CONTROL

Issue / revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	First issue	Updated in response to client comments	Updated in response to client comments	
Date	December 2019	April 2019	July 2019	
Prepared by	Chris Parker	Chris Parker	Chris Parker	
Signature				
Checked by	Sarah Hamilton	Andy Smith	Andy Smith	
Signature				
Authorised by	Andy Smith	Andy Smith	Andy Smith	
Signature				
Project number	70041947	70041947	70041947	
Report number	HE551462-WSP-EWE-ZZ-RP-LE-00017 P01	HE551462-WSP-EWE-ZZ-RP-LE-00017 P02	HE551462-WSP-EWE-ZZ-RP-LE-00017 P02	
File reference	\\uk.wspgroup.com\central data\Projects\700419xx\70041947 - A1BCH PCF Stage 3 and 4\02 WIP\WA Water and Flood Risk\03 Document\FRA\Supporting Documents\Hydraulic modelling report	\\uk.wspgroup.com\central data\Projects\700419xx\70041947 - A1BCH PCF Stage 3 and 4\02 WIP\EI EIA\Third ES draft 2019\Vol 6.3 Appendices\Word documents	\\uk.wspgroup.com\central data\Projects\700419xx\70041947 - A1BCH PCF Stage 3 and 4\02 WIP\EI EIA\Third ES draft 2019\Vol 6.3 Appendices\Word documents	

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1. INTRODUCTION

1.1. BACKGROUND

1.1.1. WSP UK Ltd (WSP) have been commissioned by Highways England (the Applicant) to produce a Flood Risk Assessment (FRA) for the A1 Birtley to Coal House Scheme (the Scheme).

1.1.2. To inform the FRA hydraulic modelling has been undertaken to assess the impact of the proposed road improvement Scheme.

1.1.3. This report summarises the modelling undertaken, including modelling limitations and assumptions, and presents the modelling results.

1.1.4. The report also discusses potential mitigation requirements for the design of the Allerdene channel realignment.

1.1.5. The report contains extracts of figures that are contained in **Appendix 6.2** of the Environmental Statement **(Application Document Reference: TR010031/APP/6.2)**. The figures contain Ordnance Survey data © Crown copyright and database right 2019.

1.1.6. From the Stage 2 FRA three areas were identified for further modelling and these are listed below:

- Hydraulic modelling to the River Team at junction 67 to assess the impact of the extension of the Kingsway Viaduct. This modelling utilises an existing Environment Agency (EA) hydraulic model of the River Team constructed by JBA in 2014. The EA are currently using the information from this model to update the Flood Map for planning.
- Hydraulic modelling of the Allerdene Burn to understand the impact of the A1 realignment which will require either:
  - The extension of the existing Allerdene culvert and replacement of the existing section of the Burn
  - Or daylighting of the existing culvert and replacement and realignment of the existing burn to accommodate a new viaduct over the existing railway line.
- Hydraulic modelling of the surface water flood risk at junction 66 (Eighton Lodge). The current surface water flood risk maps are considered not to give an accurate representation of the surface water flood risk as the existing culvert and drainage channel is not represented in the original surface water flood risk modelling.

1.2. AREAS OF INTEREST

1.2.1. Error! Reference source not found.**Table 1-1** gives details of the site locations and an overview of the contributing catchments. **Figure 1.1** shows the locations of the Kingsway Viaduct and Allerdene Burn and **Figure 1.2** shows the surface water flood risk at junction 66 (Eighton Lodge).

Table 1-1 - Site and catchment details

Site National Grid Reference:	Kingsway Viaduct: NZ 24944 58551 Allerdene Burn: NZ 25359 58530 A1 junction 66 (Eighton Lodge): NZ 26754 57562
Existing waterbodies:	The River Team is a medium sized watercourse that flows from south to north through the Team Valley Trading Estate before discharging at the confluence with the River Tyne. The catchment area is approximately 65km^2 and is a mixture of rural and urban land uses. Allerdene Burn is a small ordinary watercourse with a predominantly urban catchment. The watercourse flows from east to west and is culverted until the it reaches the railway line just north of the A1. Flow is conveyed via a small section of open channel north of the A1 and then flows south west through a culvert underneath the A1. On the south side of the A1 a canalised channel conveys flow to a confluence with the River Team south of Junction 67.
Existing flood defences:	None in the areas of interest.

Figure 1-1 - Site plan showing the location of the Kingsway Viaduct (point 13) and Allerdene Culvert

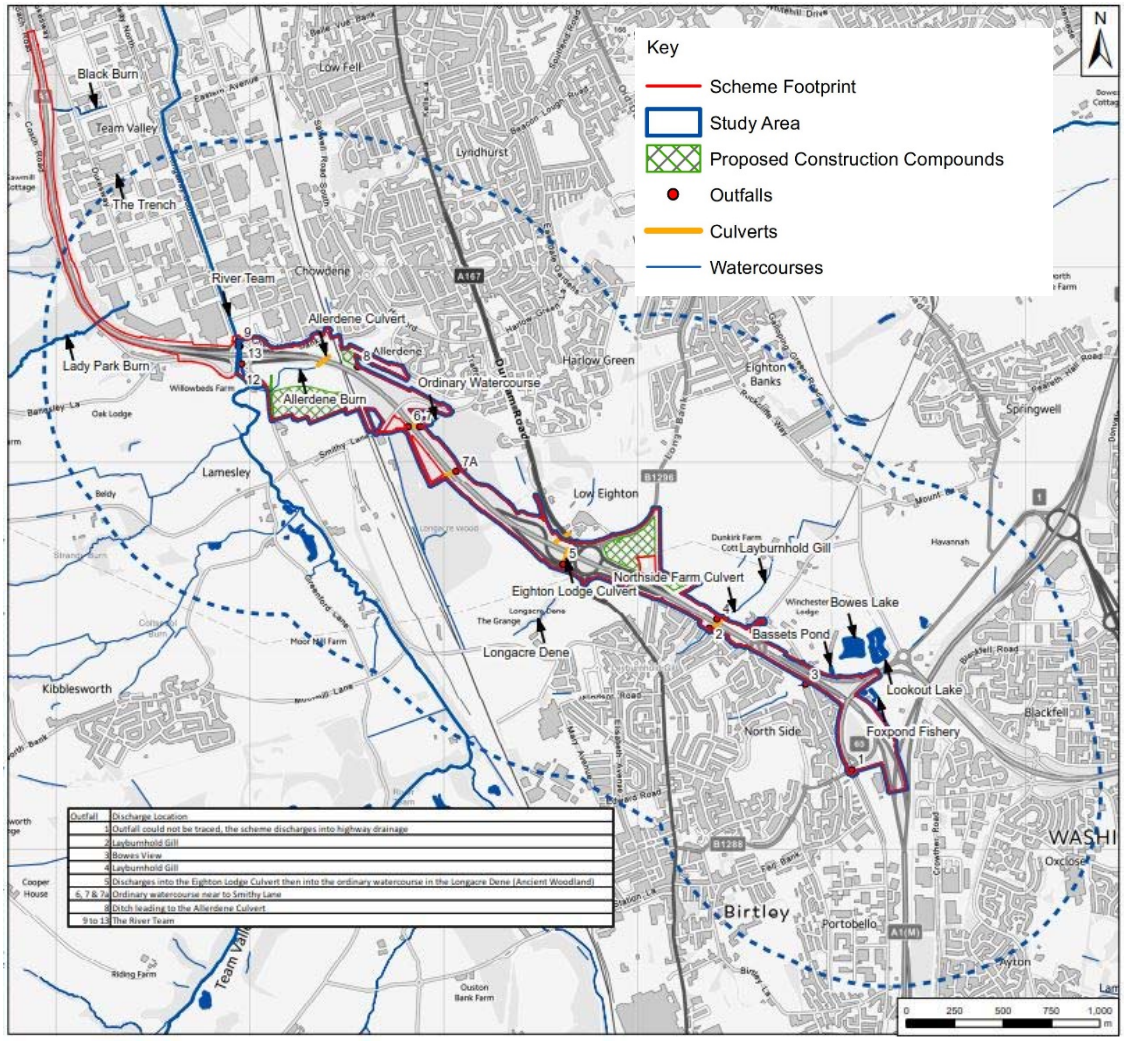
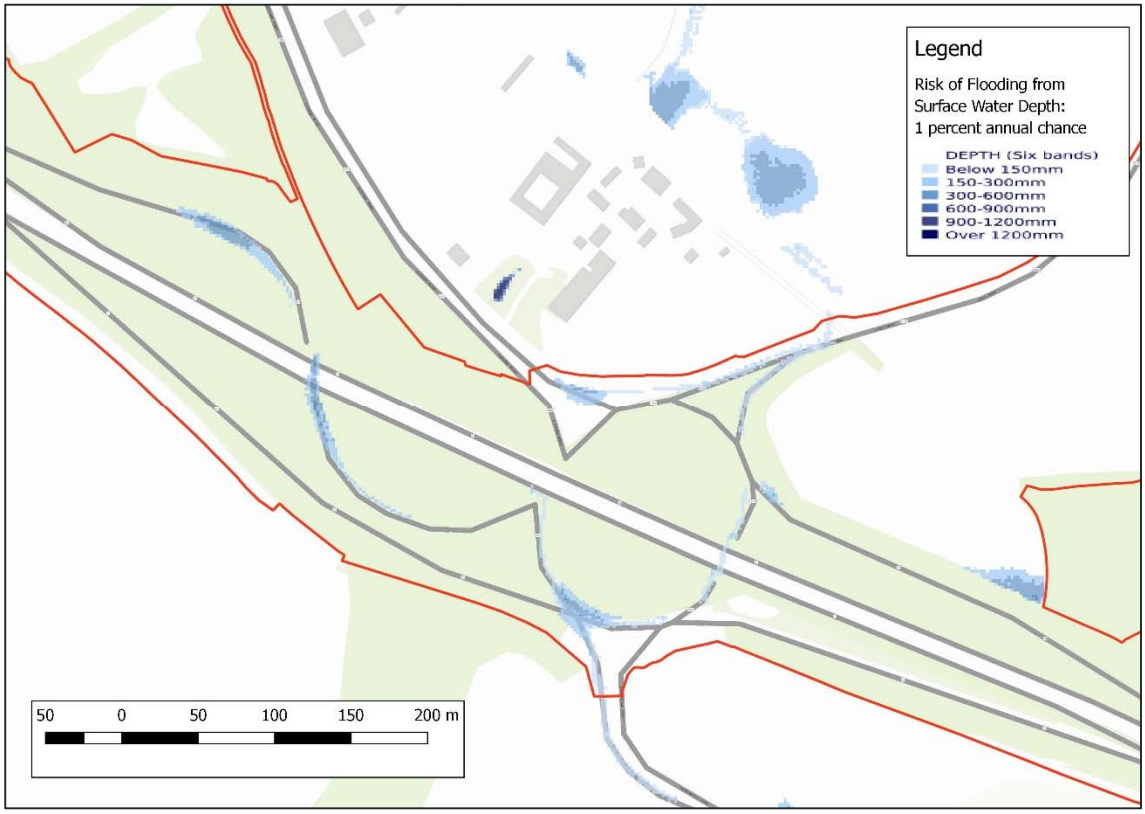


Figure 1-2 - Surface water flood risk at junction 66 (Eighton Lodge)



1.3. PROJECT LIMITATIONS

1.3.1. WSP hydraulic modelling is based on the latest available EA hydraulic model, best practice and guidance current at the time of undertaking the project.

1.3.2. The modelling undertaken assesses the existing hydrologic and hydraulic conditions of the River Team at the Kingsway Bridge and Allerdene Burn.

1.3.3. The modelling undertaken is based on the interpretation and assessment of data provided by third parties. WSP cannot be held responsible for the accuracy of the third-party data and the conclusions and findings of this report may change if the data is amended or updated after the date of consultation.

1.3.4. The conclusions of the modelling report are based on the data gathered for the purpose of the project and therefore are limited in their accuracy in proportion to the validity of the dataset.

2. DATA SOURCES

2.1.1. Error! Reference source not found.**Table 2-1** provides a list of all of the data used in the hydraulic models. The data quality has been assessed in accordance with the data scoring assessment within the Multi-Coloured Manual where:

- 1= best possible;
- 2= data with known deficiencies;
- 3= gross assumptions; and,
- 4= heroic assumptions.

2.1.2. There were no changes to made to the EA Team Valley model other than the changes described in **Section 3.3**.

Table 2-1 - Model input data

Data Type	Model	Source	Quality	Comment
Hydrology	Kingsway Viaduct	EA Team Valley Model utilising the ReFH rainfall runoff model	1-2	No changes made to the hydrology in the existing EA River Team model as the hydrology for the model has been approved by the EA.
	Allerdene Burn	ReFH2	1-2	ReFH2 used
	Junction 66 surface water	ReFH Rainfall*	1-2	Rainfall
2D Domain	Kingsway Viaduct Allerdene Burn Junction 66 surface water model	Digital Terrain Model (DTM) provided by the EA	2	The ground model provided is a composite of Lidar and SAR data
		Topographic Survey	1	Topographic survey of the A1 and adjacent areas defined by the red line boundary.

Data Type	Model	Source	Quality	Comment
		NextMap 5m DTM	3	This covers an area to north east of the A1 which has partial or no Lidar coverage.
1D Domain	Kingsway Viaduct	EA model	1-2	No updates have been made
	Alledene Culvert	Channel and culvert survey	1	Channel survey for Alledene Culvert was undertaken by Longdin and Browning in March 2018.
	Junction 66 surface water model	n/a	n/a	No 1D domain

* The ReFH rainfall (FEH99 rainfall model) has been used as it generates a greater rainfall depth, for this location, than ReFH2 (FEH13 rainfall model), this is considered a conservative approach as the highest rainfall and highest flow estimates have been utilised.

3. METHODOLOGY AND IMPLEMENTATION

3.1. DMRB GUIDANCE

3.1.1. This hydraulic modelling has been undertaken within Integrated Catchment Modelling (ICM), in accordance with Methods E and F of HD45/09. However, as this guidance was produced prior to the publication of the EA's Risk of Flooding of Surface Water map and the change in best practise for such mapping to be undertaken to support schemes, the is no direct methodology for this aspect. The surface water flood mapping has been undertaken in broad accordance with the prescribe methods, where relevant and in accordance with the accepted best practise.

3.2. HYDROLOGICAL ANALYSIS

3.2.1. This section briefly describes the hydrology used in the Allerdene Burn model and the junction 66 surface water model. The hydrology within the River Team model has not been altered from that provided within the EA model thus it is not described here.

3.2.2. **Table 3.1** below provides a summary of the hydrological inputs used in Allerdene Burn model and the junction 66 surface water models.

3.2.3. Allerdene Burn receives flow from the A1 drainage network. This has been represented in the model as an impermeable subcatchment with a runoff co-efficient of 0.9. ReFH rainfall has been used within ICM as an input to this subcatchment.

Table 3-1 - Model hydrology summary for the Allerdene Burn and junction 66 surface water models

Summary of hydrological analysis required	Design flow hydrographs for inflow points in the Alleredene hydraulic model
Number and location of flood estimation points	Inflow applied to the culvert upstream of the railway at manhole MH01.
Peak flows, hydrographs or hyetographs?	Hydrograph inflow for the Allerdene Burn model. Hyetograph derived using ReFH model in ICM for the section of the A1 surface water drainage catchment that contributes to the Allerdene Burn and the Junction J67 surface water model. The ReFH rainfall (FEH99 rainfall model) has been used as it generates a greater rainfall depth, for this location, than ReFH2 (FEH13 rainfall model).

Return periods:	1 in 100 and 1 in 1000 year / 1% and 0.1% Annual Exceedance Probability (AEP)
Climate change estimation?	Flows: 1 in 100 year plus 25%, and 50% Rainfall: 1 in 100 year plus 20% and 40%
Choice of approach?	ReFH2 has been used for the Allerdene Burn model using the urbanised flows as the catchment has a high URBEXT value. As the catchment is very urbanised the summer rainfall profile has been used as it give the highest peak flows.
Comparison against other approaches undertaken?	A comparison against ReFH within ICM was undertaken and the ReFH2 peak flows were found to be approximately 25% larger.
How incorporated into the hydraulic model?	Imported into ICM as inflow files.

3.3. KEY CATCHMENT CHARACTERISTICS

3.3.1. The Allerdene catchment is highly urbanised and the watercourse itself is culverted in a until the crossing point between the railway and the A1. The culvert size underneath the railway is 1350mm as a comparison the existing A1 culvert is 2400x1800mm rectangular culvert.

3.3.2. **Table 3.2** provides details of the catchment characteristics for the Allerdene Burn catchment. Catchment delineation using the DTM shows that the catchment is significantly larger (1.64km2) than the FEH default catchment (0.91km2). The EA River Team model report contains sewer maps for this catchment and indicates that they are almost similar to the one used within this study, with the catchment drainage being predominantly combined with some partially separate highway drainage. The FEH and delineated catchment for the Allerdene Burn are shown in **Figure 3.1** and the Peak ReFH inflows for the Allerdene Burn model are shown in **Table 3-3**.

Table 3-2 - Allerdene Burn catchment characteristics

Catchment	Allerdene Burn Catchment
AREA: (WSP delineation)	0.9075 (1.64)
FARL:	1
PROPWET:	0.32
BFIHOST:	0.682
DPLBAR (km):	1.65
DPSBAR (m/km):	82
SAAR (mm):	663
SPRHOST:	12.12
$URBEXT_{2000}$:	0.3747
FPEXT:	0.0331
Pumped watercourse?	No
Any unusual catchment features? In particular is BFIHOST>0.65, SPRHOST<0.20, URBEXT>0.125, FARL<0.90 or high FPEXT?	Soil maps indicate the catchment crosses the boundary between freely draining and impeded drainage soils. BFIHOST is high and SPRHOST is low. ReFH2 is considered to be more suitable for permeable catchments than ReFH1. FARL was reviewed against OS mapping and deemed to be appropriate.

Figure 3-1 - Allerdene Burn catchment plan

3.3.3. Given the recent development and approval by the EA of their model no alterations or changes to this have been made unless detailed below. The Team Valley Model uses ReFH subcatchments within ICM using ReFH rainfall as the input. This means that when applying climate change the uplift must be applied to the rainfall instead of the inflows (a hydrograph boundary condition). The peak combined modelled inflows for the ReFH subcatchments upstream of the Kingsway Viaduct, are shown in **Table 3-3Error! Reference source not found.**. For the climate change scenarios, a 20% and 40% uplift has been applied to the rainfall which generates a combined inflow of plus 25% and plus 54% for the 1% AEP plus 25% and 50% climate change scenarios allowance respectively. Altering the rainfall input for the 1% AEP plus 50% climate change event to generate an exact inflow match of 50% allowance was considered unnecessary as 54% increase is conservative.

Table 3-3 - Combined modelled peak inflows from the ReFH subcatchment upstream of the Kingsway Viaduct (Percentage increase in flow for climate change is show in brackets) and ReFH2 inflows for Allerdene Burn

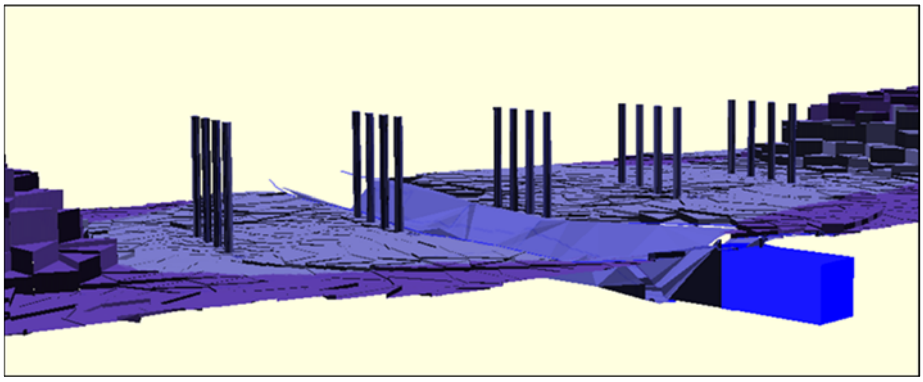
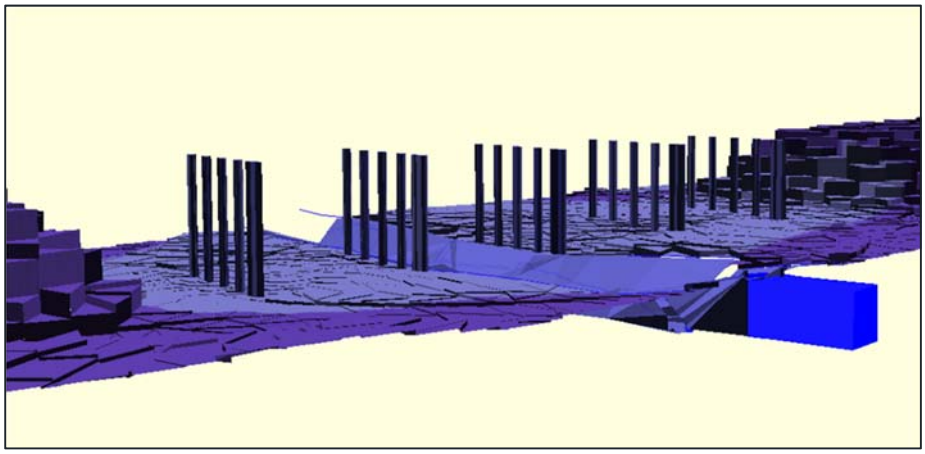
Inflow Location	Flood Peaks (m^3/s)			
	1 in 100 year (1% AEP)	1 in 100 year (1% AEP+25%)	1 in 100 year (1% AEP +50%)	1 in 1000 year (0.1% AEP)
Combined inflow from ReFH subcatchment upstream of the Kingsway Viaduct	44.7	55.8 (25%)	68.7 (54%)	76.1
Allerdene Burn	2.0	2.39	2.99	3.58

3.4. BASELINE HYDRAULIC MODELLING

3.4.1. This section describes the hydraulic modelling that has been undertaken.

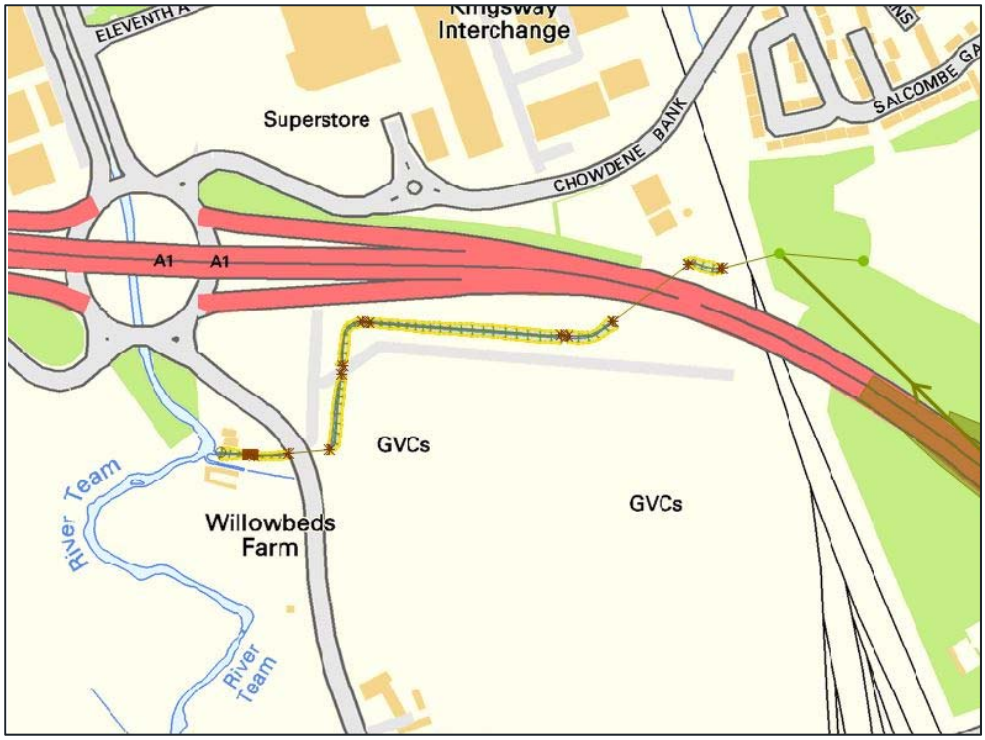
Table 3-4 - River Team Kingsway Viaduct Modelling Summary

Model extent	The River Team model extends from the upper reaches near Beamish to the confluence with the River Tyne.
What existing modelling exists?	The River Team hydraulic model was constructed on behalf of the E A by JBA in 2015.
What modelling has been undertaken and why was that approach chosen?	Modelling changes are confined to the A1 junction 67 roundabout 424950, 558550 and included the modelling of the existing Kingsway Viaduct and the proposed widening of the viaduct to include an additional pillar.
What software version(s) have been used?	InfoWorks ICM version 6.5

Model extent	**The River Team model extends from the upper reaches near Beamish to the confluence with the River Tyne.**
What has been updated from the previous model?	The model has been refined in the immediate vicinity of the Scheme (i.e. the A1 junction 67 roundabout) to convert it from a 1D only model to a joint 1D/2D model. The 2D modelling of the Kingsway Viaduct has developed from a 1D river section and 1D structure, in the original model, through cutting down the 1D river sections, to the top of banks, with the bridge pillars represented in the 2D as mesh zones. The local ground model has been updated to include the A1 topographic survey. This is shown in the images below: Existing Viaduct with four pillars (Baseline).   Proposed Viaduct extended viaduct with additional pillar (Proposed).
How have watercourse channels and structures been represented?	No changes other than those described above.

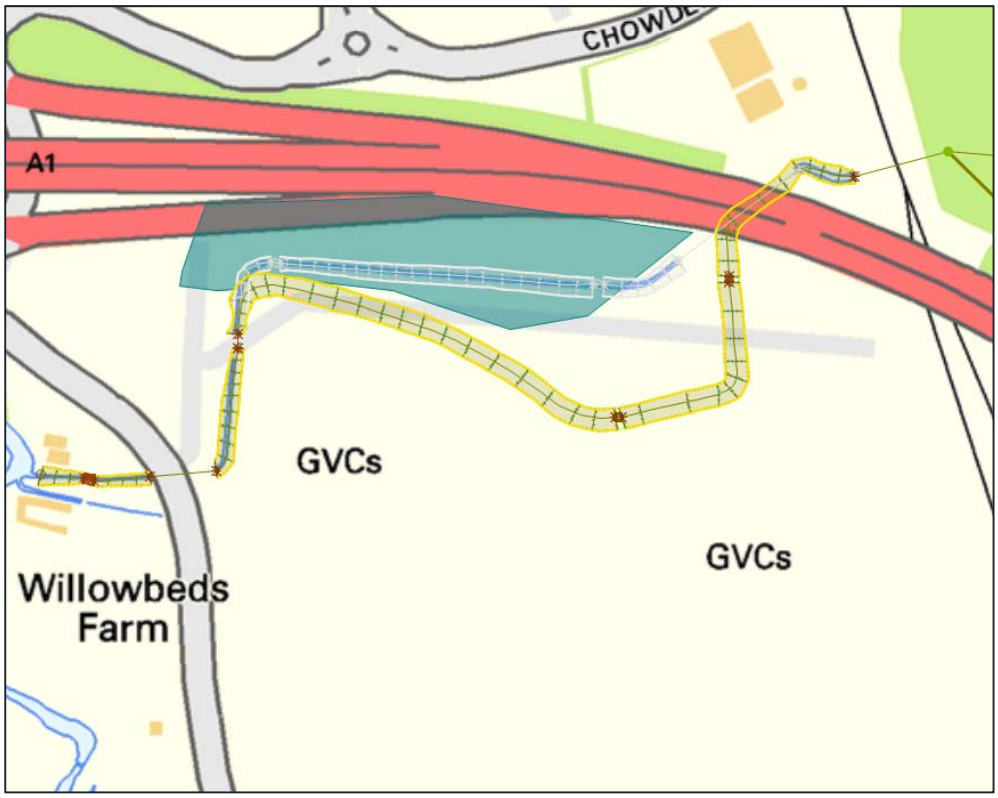
Model extent	**The River Team model extends from the upper reaches near Beamish to the confluence with the River Tyne.**
How have sewer networks been represented?	Sewer network modelling is unchanged from the original model.
How has the floodplain/ground surface been represented?	As the exiting model with the exception of the changes described above.
How have the 1D and 2D model been linked?	Defined as the top of bank through the junction 67 roundabout. Flow can transfer freely between the 1D and 2D model domains. The model bank lines have been updated to reflect the updated ground model. Discharge coefficient and modular limit set to 1 and 0.9 respectively.
Have any adjustments to the raw DTM been made?	The original DTM has been updated to include the A1 topographic survey.
How have flood defences been represented?	No formal flood defences have been identified or included in the model at the location of the A67 viaduct.
What boundary conditions have been used?	ReFH rainfall for the inflows using ReFH subcatchments in ICM and River Tyne as per the original River Team model.
Scenario	The baseline scenario model represents the existing site conditions. The proposed scenario includes the propose widening of the Kingsway Viaduct with 5 additional pillars included in the 2D domain.

Table 3-5 - Allerdene Burn Modelling Summary

Model extent	The model extends from the culverted watercourse to the north of the A1 and east of the railway to the confluence with the River Team just south of the Junction 67 roundabout. Visual extracts from the model are provided below: *Existing model* 

Allerdene embankment option - Extension of the Allerdene culvert and realignment of the burn

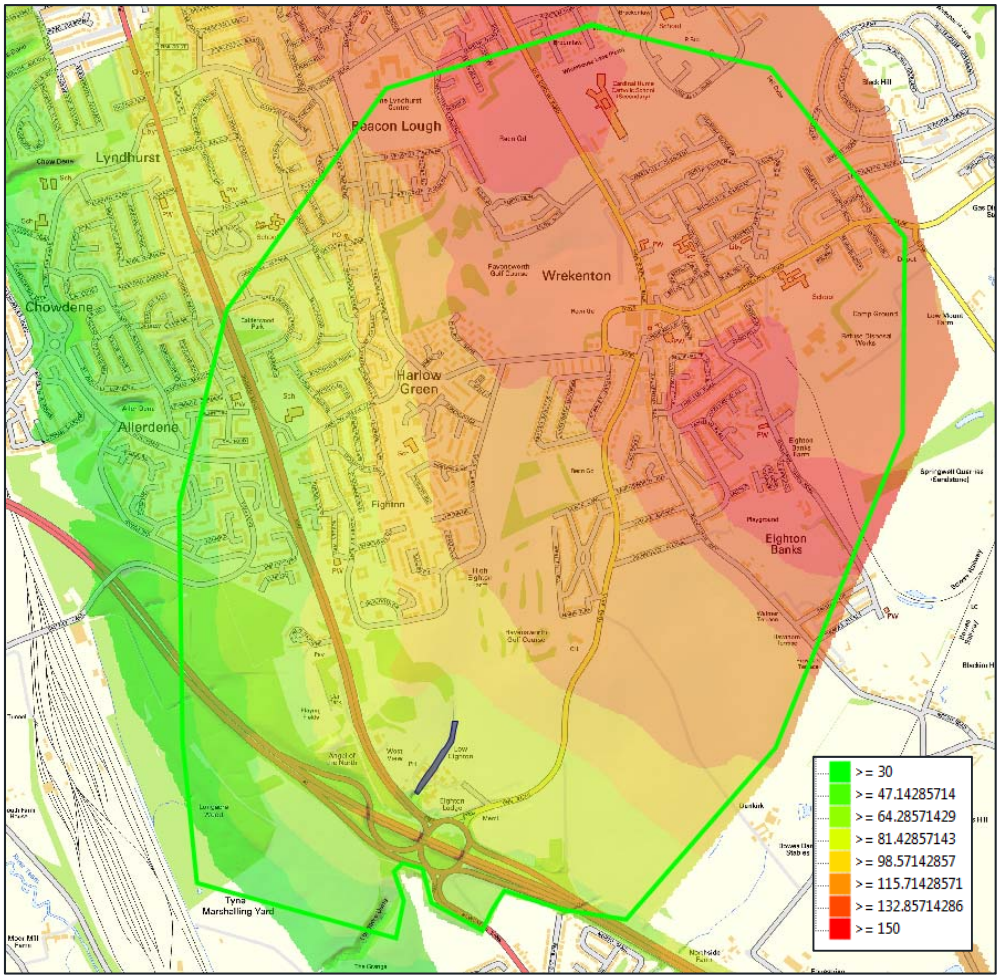
Allerdene viaduct option – Daylighting of Allerdene Burn and replacement and realignment of the drainage channel to accommodate a new viaduct over the adjacent railway line



What existing modelling exists?	None for this watercourse.
What modelling has been undertaken and why was that approach chosen?	Linked 1D-2D ICM model of the open channel sections of the Allerdene watercourse adjacent to the A1.
What software version(s) have been used?	InfoWorks ICM version 8.
What has been updated from the previous model?	No previous model available.
How have watercourse channels and structures been represented?	Channels, structures and culverts have been modelled as a 1D network. The model includes 6 structures, 5 have been modelled as culverts and 1 as a bridge.
How have sewer networks been represented?	A small section of culvert has been modelled based on an As Built drawing upstream of the open channel section to the north of the A1.
How has the floodplain/ground surface been represented?	The flood plain has been represented as a 2D zone.
How have the 1D and 2D model been linked?	The 1D and 2D models are linked at the top of banks within ICM and flow can transfer freely between the two models. The model bank lines have been updated to reflect the updated ground model. Discharge coefficient and modular limit set to 1 and 0.9 respectively.
Have any adjustments to the raw DTM been made?	The DTM has been updated with site specific topographic survey information.

How have flood defences been represented?	No formal flood defences are present.
What boundary conditions have been used?	ReFH2 inflow applied at the upstream extents of the model applied to MH01. The downstream model boundary has been generated from the EA River Team model for the Allerdene Burn critical duration event which is 3 hours 30 minutes. This has been applied as a time varying level.
Scenario	Baseline: The baseline scenario model represents the existing site conditions. Allerdene embankment option: requires the extension of the existing Allerdene culvert and realignment of the drainage channel. The proposed drainage channel includes two 1200mm culverts, one at the downstream end of the channel and one at the midpoint along the channel. This is designed to mimic the existing channel structure, which has three 1350mm culverts, to attenuate peak flows and maximises the available channel storage. Allerdene viaduct option: Requires the daylighting and replacement of Allerdene culvert with a new section of open channel and realignment of the existing channel to accommodate the construction of a new viaduct over the adjacent railway line. Similar to Allerdene embankment option the new drainage channel includes three 1300mm diameter culverts to attenuate peak flows. An existing 1350mm dimeter culvert remains in place where the new channel ties into the existing channel at the downstream extent.

Table 3-6 - Junction 66 (Eighton Lodge) surface water model summary

Model extent	The model extents are shown in the plan below. This has been defined from the ground model. The catchment is steep and the ground falls from an elevation of 155m in the north to 30m in the south near Longacre Dene. 
What existing modelling exists?	None, however, results from the EA surface water flood risk mapping are available.
What modelling has been undertaken and why was that approach chosen?	Construction of a simple 1D/2D surface water flood risk model using direct rainfall runoff. This is to demonstrate the surface water flood risk at the A1 junction 66 (Eighton Lodge) is partly caused by incorrect assumption in the original nationwide strategic flood risk mapping as it did not include localised drainage. The revised modelling includes a channel for the watercourse and a culvert connecting the watercourse to the assumed outfall at Longacre Dene. The channel orientation,

	culvert size and associated dimensions have been assumed based on mapping data and aerial photography.
What software version(s) have been used?	InfoWorks ICM version 8
What has been updated from the previous model?	No previous model available.
How have watercourse channels and structures been represented?	The watercourse has been represented in the model by lowering the mesh at the approximate channel location. This is a conservative approach through the existing hamlet as in practice a piped connection exists that would throttle the flows and lead to localised flooding in the depression upstream of the hamlet (image below). In large exceedance events, this may lead to overland flows across the hotel as alternative flow paths are sought. Due to the resolution of the ground model the channel is not represented in the DTM. A 1350mm culvert has been included in the model to transfer flows to Longacre Dene (image of watercourse below).

Photograph of the depression upstream of the hamlet:

	Photograph of the watercourse downstream of the hamlet and upstream of the A1 
How has the floodplain/ground surface been represented?	The flood plain has been represented as a 2D zone sampled from the revised ground model.
Have any adjustments to the raw DTM been made?	The DTM has been updated with topographic survey information for the A1 and NextMap 5m resolution ground model for the area to the north east of the A1 as no LIDAR data is available.
What boundary conditions have been used?	ReFH rainfall is used as the input to the 2D model with rainfall directly applied to the 2D mesh. No downstream boundary has been applied as the catchment is very steep and a downstream level is unlikely to have an impact on the surface water flow within the model.
Scenario	Baseline: The baseline scenario model attempts to recreate the results of the surface water flood risk mapping. Culvert Model: This scenario includes a channel for the watercourse and a culvert connecting the watercourse to Longacre Dene.

4. MODEL RESULTS

4.1. KINGSWAY VIADUCT

4.1.1. Hydraulic modelling shows the proposed widening of the Kingsway Viaduct has negligible impact on flood risk. The model does not predict flooding from the River Team at Junction 67 for the 1% AEP event. However, flooding occurs from the left bank in the 1% AEP plus 25% climate change event which causes flooding to the west side of Junction 67 including the A1 northbound (entry) and southbound (exit) slip roads. Flood extents and depth are predicted to increase for the 1% AEP plus 50% climate change and 0.1% AEP events for the existing scenario.

4.1.2. The impact of the Scheme on the flood risk is considered negligible for all events up to and including the 0.1% AEP. **Table 4-1**Error! Reference source not found. demonstrates that the impact on flood levels is within an acceptable degree of model tolerance as the largest increase is 20mm, which occurs during the 0.1% AEP, whilst the largest model tolerance for the 1% AEP + climate change scenarios is 13mm. This model tolerance occurs within the roundabout, where there are no residential properties, downstream of which there are commercial properties and the Scheme has required only small changes to EA's model. Therefore, in this instance this degree of model tolerance is considered suitable. Furthermore, as the bridge pillars have a foot print of approximately $4m^2$ this level of impact is expected. **Figure 4.1** shows the location of the proposed bridge pillars and the flood extents for the 0.1% AEP event.

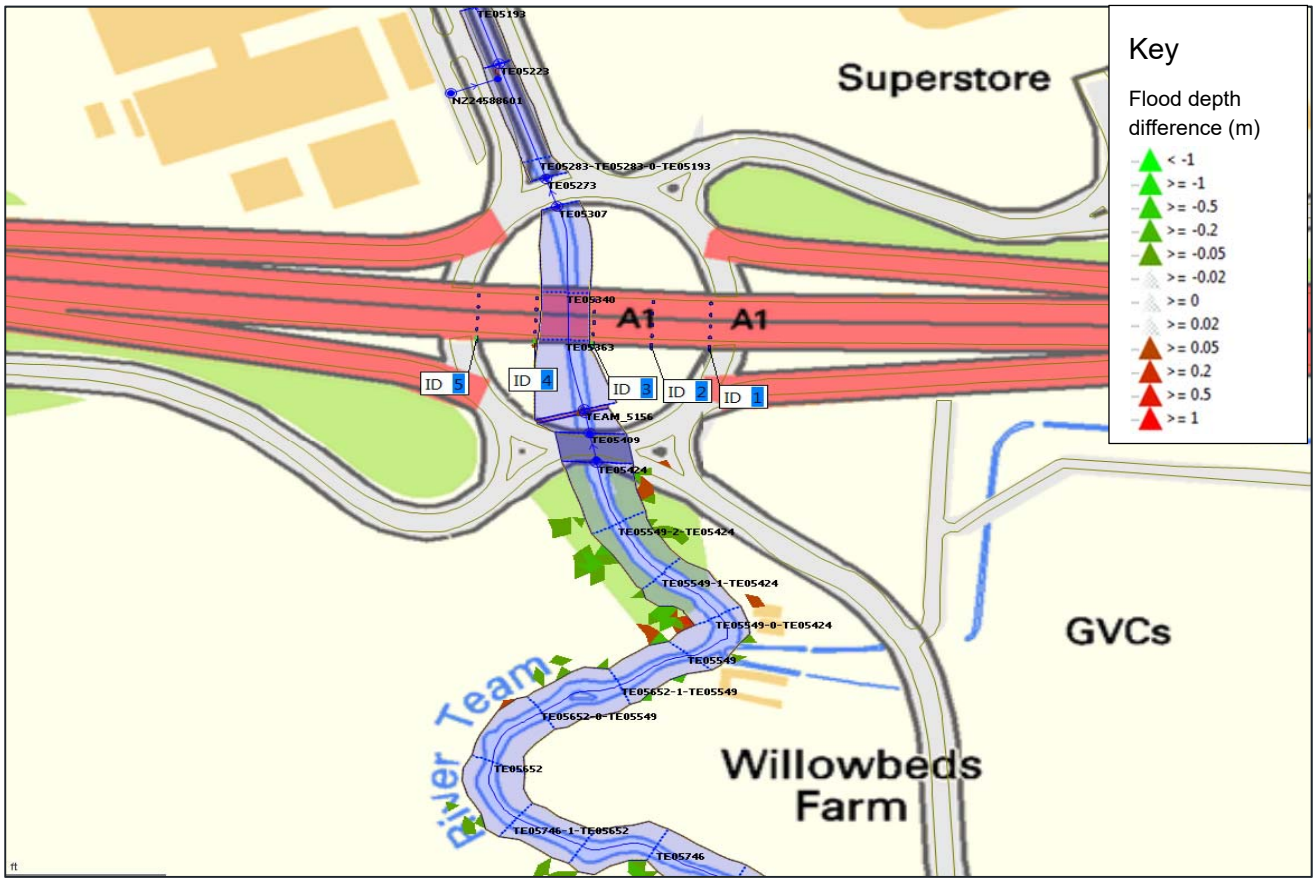
4.1.3. If required compensation storage can be provided in the Junction 67 roundabout. For the 0.1% AEP approximately $12m^3$ of compensation storage would be required to offset the area taken by the bridge pillars.

Table 4-1 - Maximum predicted flood depth adjacent to the proposed bridge pillars for the 0.1% AEP event (reported west to east)

Scenario	AEP (Return period)	Flood depth (m)				
		Pillar 5	Pillar 4	Pillar 3	Pillar 2	Pillar 1
Baseline	1% 1 in100 year)	0	0	0	0	0
Proposed		0	0	0	0	0
Difference (mm)		0	0	0	0	0
Baseline	1% + 25% CC	0.788	0.211	0.166	0	0
Proposed		0.789	0.224	0.167	0	0

Scenario	AEP (Return period)	Flood depth (m)				
		Pillar 5	Pillar 4	Pillar 3	Pillar 2	Pillar 1
Difference (mm)	(1 in 100 year +25% CC)	1	13	1	0	0
Baseline	1% +50% CC (1 in 100 year +50% CC)	1.219	0.662	0.648	0	0
Proposed		1.223	0.656	0.656	0	0
Difference (mm)		4	-6	8	0	0
Baseline	0.1% (1 in 1000 year)	1.297	0.733	0.731	0	0
Proposed		1.315	0.753	0.727	0	0
Difference (mm)		18	20	-4	0	0

Figure 4-1 - Predicted flood difference between the existing and proposed scenarios for the 0.1% AEP event and the location of the proposed bridge pillars numbered 1 to 5 from east to west



4.2. ALLERDENE BURN

4.2.1. Hydraulic modelling of the two proposed options for Allerdene Burn indicate that peak flows for all events will remain unchanged and present no risk to the proposed A1 Scheme. Error! Reference source not found.**Table 4.3** shows the predicted peak flows in the model at river reach ST02 DS.1 which is directly downstream of the proposed channel realignment.

4.2.2. The proposed channels, for both the Allerdene embankment option and the Allerdene viaduct option, have a larger capacity compared to the Existing Scenario and therefore provide additional in channel storage, as detailed in **Table 4-2**Error! Reference source not found.. In addition, the Allerdene viaduct option utilises some of the space beneath the viaduct to provide additional flood plain storage.

Table 4-2 - 100 year channel storage volumes (m^3)

	Baseline	Allerdene embankment option	Allerdene viaduct option
Channel storage	683	875	1475
Channel storage and the loss/gain of culvert storage	865	1001	1293

Note: The modelling demonstrates that the culvert provides the following storage volumes, baseline 182 m^3 and culvert extension 126m^3.

4.2.3. In a similar manner to the existing flow scenario, flow control culverts in the channels in both Allerdene embankment option and Allerdene viaduct option control the peak flow and maximise attenuation. The flow control culverts also act to transfer flow from the channel to the flood plain in events equal to and greater than the 1 in 100 year plus 25% climate change. This is the same mechanism that occurs in the existing scenario however, as in channel attenuation is larger in the Option models flow to the flood plain is marginally reduced (**Table 4-3**Error! Reference source not found.). The minor differences in flood plain are shown in **Figure 4.2** and **Figure 4.3**. This design (i.e. channel size and throttles) will be optimised at detailed design (once the design and construction approach is finalised) to ensure that the floodplain is, as a minimum, maintained, the feasibility of which is shown in **Figure 4.3**.

4.2.4. **Figure 4.4** shows the flow hydrographs for the modelled events and show the post Scheme attenuation compared to the Existing Scenario.

Table 4-3 - Predicted peak flows at the river reach ST02 DS.1 for the existing scenario and Allerdene embankment option and the Allerdene viaduct option

Scenario	Flood Peaks (m^3/s)			
	1 in 100 year (1% AEP)	1 in 100 year (1% AEP+25%)	1 in 100 year (1% AEP +50%)	1 in 1000 year (0.1% AEP)
Existing	2.16	2.53	2.68	2.85
Allerdene embankment option	2.10	2.51	2.65	2.83
Allerdene viaduct option	2.14	2.53	2.70	2.82

Figure 4-2 - Allerdene embankment option pre and post- Scheme flood extents

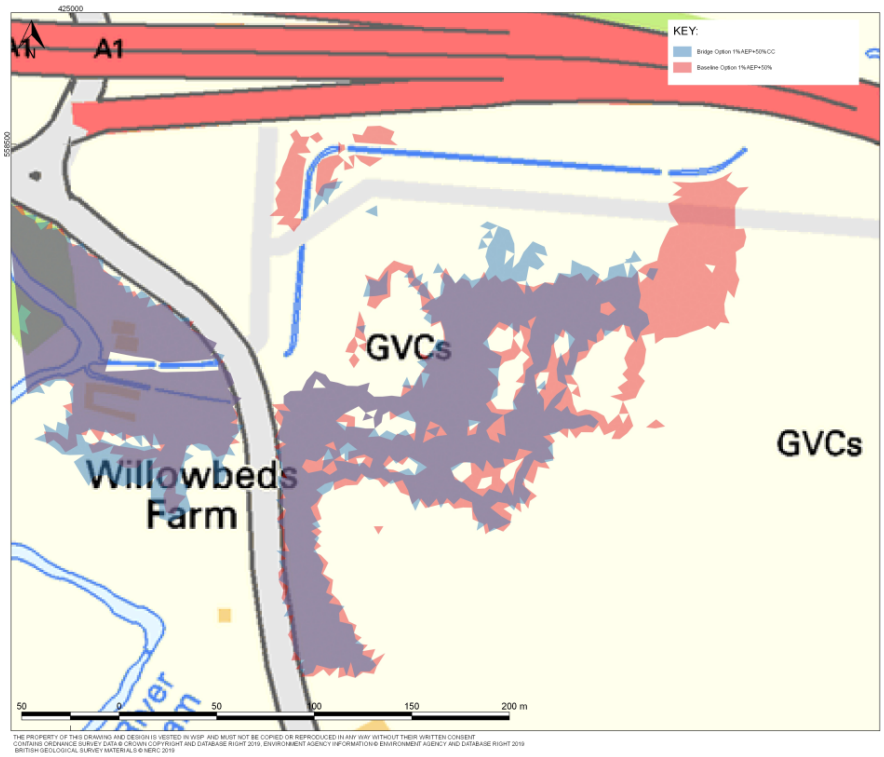


Figure 4-3 - Allerdene viaduct option pre and post- Scheme flood extents

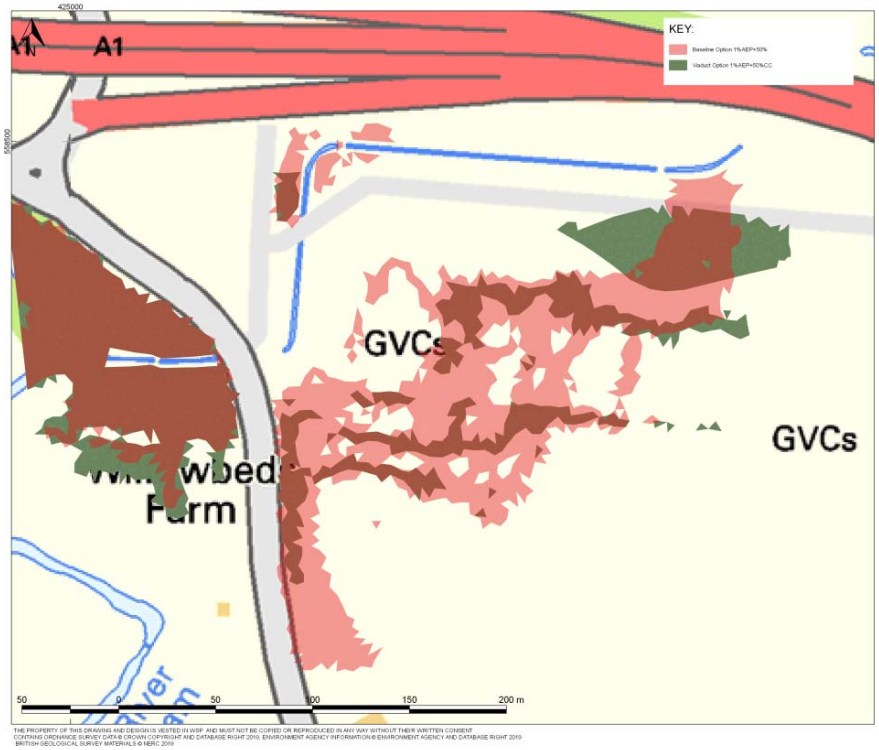
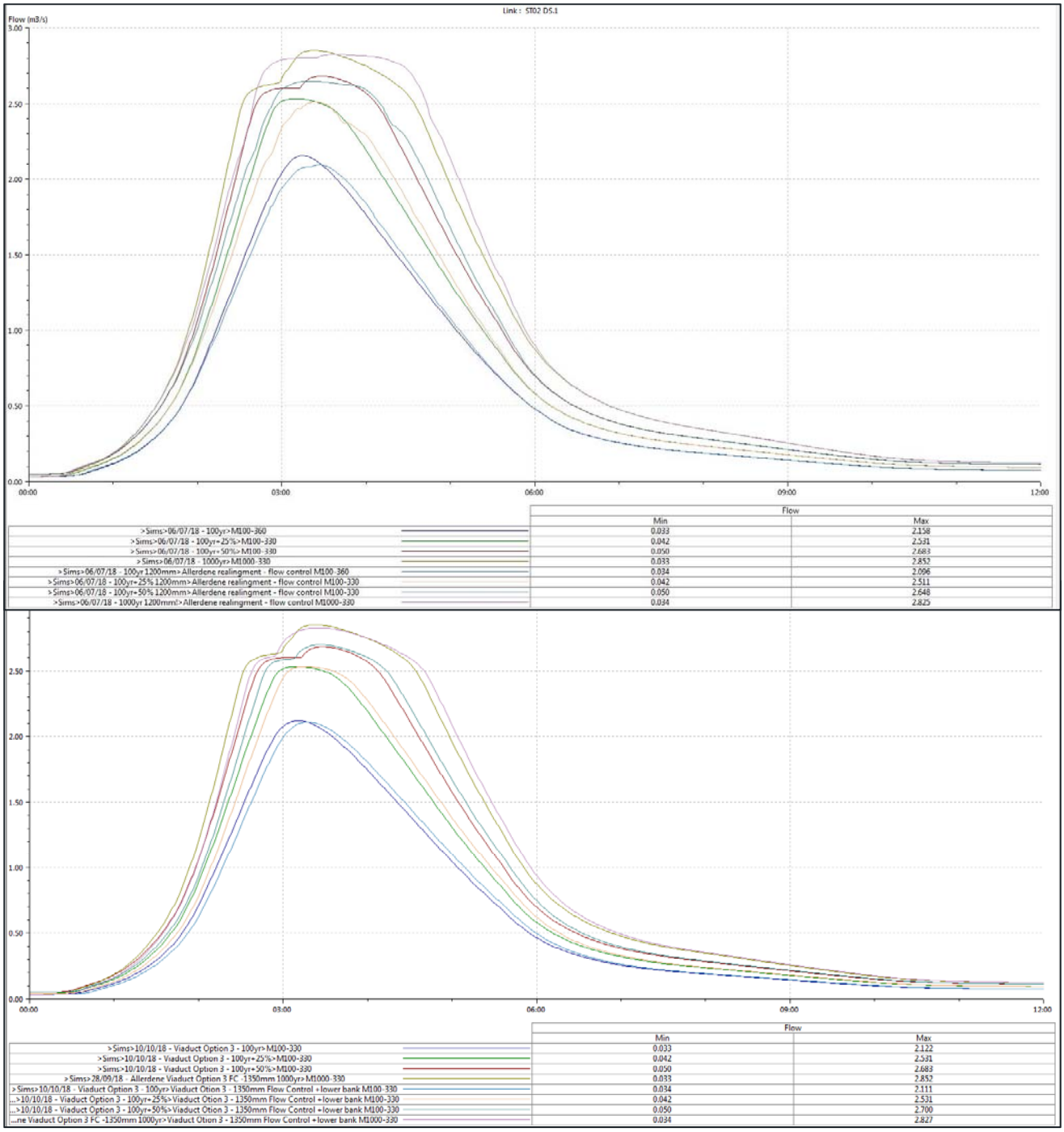


Figure 4-4 - Hydrographs for the Allerdene embankment option (top) and Allerdene viaduct option (bottom) compared to the existing scenario



4.3. JUNCTION 66 SURFACE WATER FLOOD RISK

4.3.1. **Figure 4.5** shows the change in predicted surface water flood depths between the baseline model and the culvert model at junction 66 (Eighton Lodge) and the predicted flood depths for the 1% AEP event. The refined model which, includes the culvert and watercourse, reduces the flood risk at the junction 66 roundabout by between 0.1 and 0.5m as flow from

the watercourse is no longer routed to the roundabout. However, the model still predicts surface water flood depths of between 0.1 and 0.5m on the roundabout and A1 slip roads. The slip roads at this point on a substantial camber (**Figure 4.6**) and water would likely lead to water ponding only on the off slip close to the roundabout, at which point the vehicle speed will have substantially reduced.

Figure 4-5 - Change in surface water flood depth (top) and predicted flood depths (bottom) for the 1% AEP event

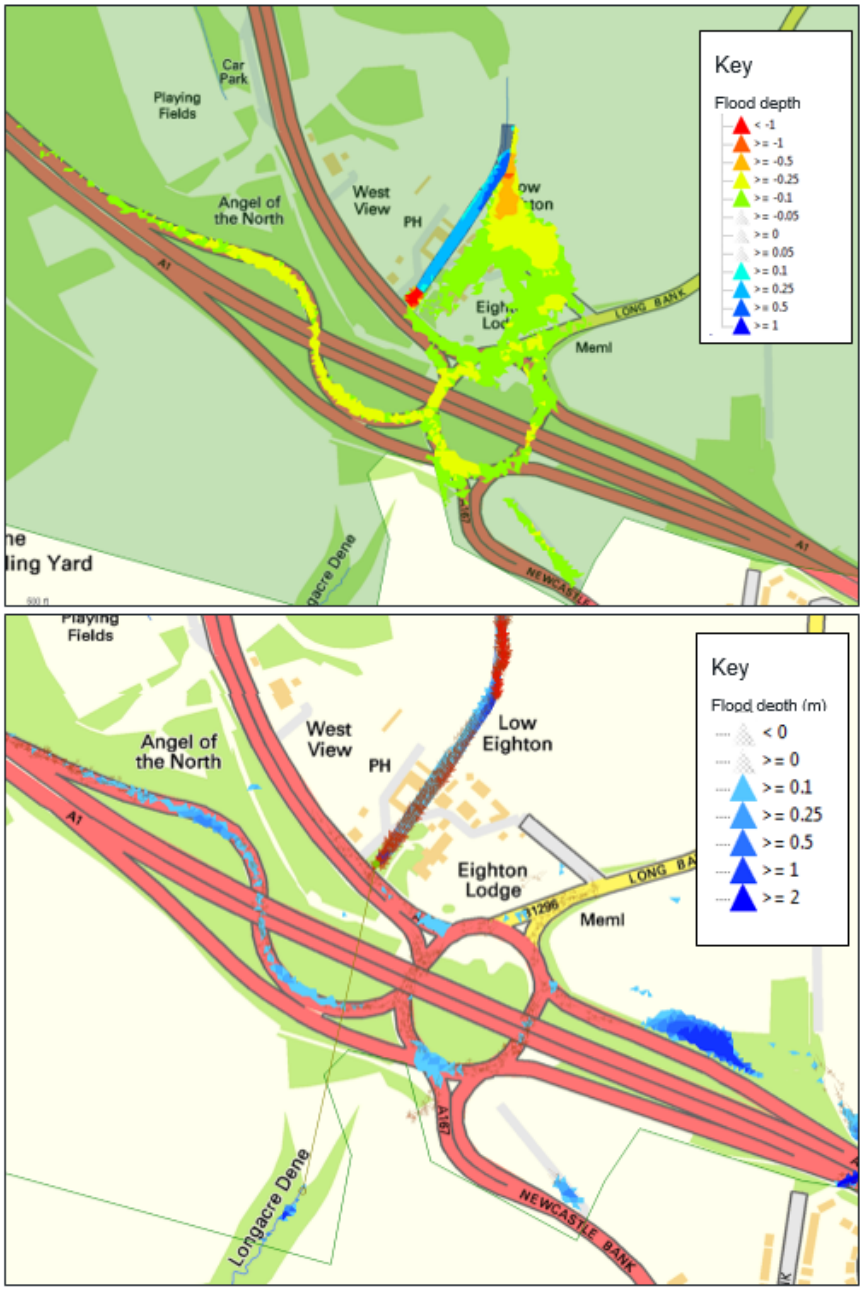


Figure 4-6 - Camber on the on/off slip

5. CONCLUSIONS

5.1. TEAM VALLEY

5.1.1. The proposed extension of the Kingsway Viaduct has negligible impact on the flood risk with only minor increases in flood levels (< 20mm) at the location of the proposed bridge pillars, this is considered to be within the model tolerance.

5.1.2. If required, compensation storage can be provided in the junction 67 roundabout with approximately 12m^3 of storage require for the 0.1% AEP event.

5.2. ALLERDENE BURN

5.2.1. Hydraulic modelling of the two proposed options for Allerdene Burn indicate that peak flows for all events will remain unchanged and present no risk to the proposed A1 Scheme.

5.2.2. The proposed channels, for both Allerdene embankment option and the Allerdene viaduct option, have a larger capacity compared to the existing channel and therefore provide additional in channel storage.

5.3. JUNCTION 66 SURFACE WATER FLOOD RISK

5.3.1. The refinements to the surface water flood maps through the inclusion of a section of open channel and a culvert to link the Longacre Dene water course in the surface water flood risk model reduces the flood risk at junction 66 (Eighton Lodge). However, the model still predicts depths of up to 0.5m on the A1 slip roads and junction 66 roundabout.

Appendix B

GROUNDWATER TOOLKIT

GROUNDWATER FLOOD RISK

We have used the Environment Agency's and Coal Authority's screening toolkit for assessing the potential for groundwater flood risk to the Scheme. This identifies that there is no risk of groundwater flooding and no further actions are required for the reasons outlined below:

SCOPE

The Coal Authority and the Environment Agency have published guidance via an online screening tool to identify specific mining and groundwater related constraints particularly around whether there are any additional considerations that need to be given to the design of the proposed drainage and infiltration measures so that sustainable development and sustainable drainage systems (SuDS) may be appropriately designed and implemented.

COAL AUTHORITY ZONES

The toolkit shows that the site falls within three different constraint zones; these can be summarised as:

- Birtley to Smithy Lane **– Category B "**no shallow mine workings, no nearby controlling outflow or shallow mine water present"
- Smithy Lane **– Category C1 "**shallow mining and/or controlling outflow present"
- River Team Valley **– Category C2** "shallow mine water present"

CONSTRAINTS

Birtley to Smithy Lane – Category B ***"no shallow mine workings, no nearby controlling outflow or shallow mine water present"***

The guidance for this section states:

> **"*Your project is a major development, but you are not proposing drainage boreholes deeper than 30 metres***
>
> *If your site is a major development but you are not proposing drainage boreholes over 30 metres deep there is no specific consultation required. However, the impacts of the proposal and suitability of the subsurface coalfield environment should be considered. Follow CIRIA's SuDS manual (C753) for assessing pollution and flood risk on controlled waters, including groundwater, to provide a fully justified risk assessment to support sustainable development."*

Compliance

To comply with the guidance the following elements have been completed:

- No infiltration based SuDS are proposed, all surface water discharges are to surface waters, to continue the current regime.
- A surface water drainage strategy in accordance with the Construction Industry Research and Information Association (CIRIA) SuDS manual (C753) has been developed and is contained within the site specific Flood Risk Assessment (FRA).
- No further consultation on groundwater flood risk is required for this section.

<u>Smithy Lane</u> – Category C1 ***"****shallow mining and/or controlling outflow present"*

The guidance for this section states:

> ***"Your project is a major development or you are proposing drainage boreholes deeper than 30 metres***
>
> *If your project is a major development or you are proposing drainage boreholes deeper than 30 metres SuDS that change the current infiltration rate, volume or location may impact on Coal Authority mine workings or other infrastructure.*
>
> *Infiltration rates of the development should be assessed and compared to greenfield or pre-development rates. Consider the impacts of the development and suitability of the subsurface coalfield environment in terms of quantity, routing of water and the pollution risk.*
>
> *Developers must undertake pre-application consultation with Coal Authority and site specific flood and drainage assessments. The assessments need to consider the current and future mine water and groundwater data, as rising mine waters may reduce the infiltration rate and efficiency of the infiltration SuDS over the design life of the drainage scheme."*

Compliance

To comply with the guidance the following elements have been completed:

- Only a small section of the Scheme falls into this category (approximately 600m), most of which is at grade, a small section is in a minor cutting.
- No infiltration based SuDS are proposed, all surface water discharges are to surface waters, to continue the current regime.
- A surface water drainage strategy in accordance with CIRIA's SuDS manual (C753) has been developed and is contained within the site specific FRA.
- No further consultation on groundwater flood risk is required for this section.

<u>River Team Valley</u> – Category C2 "*shallow mine water present"*

The guidance for this section states:

> *"If there is no hydraulic connection to the mine workings, for example a mine entry, pathway or borehole, including site investigation works, no specific consultation is required.*
>
> *However, impacts of the proposal and suitability of the subsurface coalfield environment should be considered.*
>
> *Follow CIRIA's SuDS manual (C753) for assessing pollution and flood risk on controlled waters, including groundwater, to provide a fully justified risk assessment to support sustainable development.*

If there is hydraulic connection to the mine workings, for example a mine entry, pathway or borehole, including site investigation works, infiltration SuDS may not work either now, or in the future. All SuDS could be impacted by mine water.

The developer should suggest alternative methodologies and must undertake pre-application consultation with the Coal Authority and pre-consultation with Lead Local Flood Authority for drainage proposals, other than drainage to the network."

Compliance

To comply with the guidance the following elements have been completed:

- This section is centred on the Kingsway Viaduct and includes Allerdene Bridge
- No infiltration based SuDS are proposed, all surface water discharges are to surface waters, to continue the current regime.
- A surface water drainage strategy in accordance with CIRIA's SuDS manual (C753) has been developed and is contained within this site specific FRA.
- Consultation has been undertaken with the Coal Authority and it is understood that any changes associated with rising mine waters will not impact the above ground features of the Scheme.
- Initial consultation has been undertaken with the Lead Local Flood Authority in terms of the surface water drainage proposals.
- The toolkit identifies that no further consultation on groundwater flood risk is required for this section at this stage as no infiltration SUDS are proposed.
- As the construction method for the Allerdene Viaduct Option (should this be the preferred option) and the Kingsway Viaduct pier widening will involve piling further consultation is recommended with the Coal Authority during the detailed design stage.

Appendix C

SURFACE WATER DRAINAGE STRATEGY

Highways England

A1 BIRTLEY TO COAL HOUSE SCHEME

Appendix 13.1 Surface Water Drainage Strategy

HE551462-WSP-EWE-ZZ-RP-LE-0000
AUGUST 2019

PUBLIC

Highways England

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TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70041947

OUR REF. NO. HE551462-WSP-EWE-ZZ-RP-LE-0000

DATE: AUGUST 2019

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QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks				
Date				
Prepared by				
Signature				
Checked by				
Signature				
Authorised by				
Signature				
Project number				
Report number				
File reference				

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TABLES

1. SURFACE WATER DRAINAGE STRATEGY

1.1. OVERVIEW

1.1.1. The surface water drainage strategy for this scheme of works has been developed in consultation with Gateshead Council acting as Lead Local Flood Authority (LLFA) and the Highways England (HE) Safety, Engineering & Standards (SES) team.

DESIGN PARAMETERS AGREED WITH HIGHWAYS ENGLAND DRAINAGE SES

1.1.2. The Highways England guidance for the Scheme (provided via their SES team) is that the climate change rainfall intensities are to be increased by 20% to allow for climate change.

1.1.3. In instances where there is no increase to paved area, the additional runoff (generated by application of the 20% increase to rainfall intensities for climate change) is to be attenuated, so that the proposed discharge rate does not exceed the existing.

1.1.4. Where it is proposed to increase the paved areas (e.g. nearside widening / hardening of the central reserve), the discharge rate can be increased above the existing by an amount equal to the Greenfield runoff rate for the additional paved area. Allowance for climate change is also to be applied for the entire catchment area inclusive of the new paved areas. Flows exceeding the revised discharge rate are to be attenuated and released at a rate which is identical as the existing.

1.2. EXISTING SITUATION

1.2.1. The existing A1 Birtley to Coal House is currently drained by a combination of gully and pipe connections and filter drains. The pipe network drains into a number of ditches, culverts and watercourses which run parallel with the existing highway boundary.

1.2.2. An extensive drainage survey was undertaken which identified a total of 14 outfalls. It was evident that the majority of the catchment conveyed surface water to the receiving watercourses at the River Team, Allerdene Burn and the Longacre Dene. The CCTV survey or HE records did not provide any evidence of flow control devices or storage attenuation within the existing system.

1.2.3. The table below corresponds to each discharge location for each outfall:

Table 1-1 - Outfall discharge locations

Outfall No.	Discharge Location
1	Unknown (possible connection to Gateshead Council highway drains)
2	Leyburnhold Gill
3	Bowes View

Outfall No.	Discharge Location
4	Leyburnhold Gill
5	Longacre Dene via Eighton Lodge Culvert
6	Ordinary watercourse near Smithy Lane
7a	Ditch leading to ordinary watercourse near Smithy Lane
7	Ordinary watercourse near Smithy Lane
8	Culvert leading to Allerdene Burn
9	The River Team
10	The River Team
11	The River Team
12	The River Team
13	The River Team

1.3. THE PROPOSED DESIGN

1.3.1. It is proposed that the new layout for this section of the A1 Birtley to Coal House will be drained by a combination of the following collection systems:

- Combined kerb and drainage unit (CKDU)
- Gullies
- Filter drains
- Combined surface and sub-surface drainage
- Surface water channels
- Slotted linear drainage channel

DESIGN BASIS

1.3.2. The key environmental issue considered in developing the drainage design is the need to improve protection of the local watercourse and water bodies, relative to the existing drainage of the A1.

DRAINAGE COLLECTION SYSTEM

1.3.3. All collection systems will connect into a carrier drain network and utilise the existing outfalls. The proposed drainage layouts are shown on Drawing Nos HE551462-WSP-HDG-ZZ-DR-CH-05001 to 05004 (Appendix C of the Flood Risk Assessment).

1.3.4. The highway cross section will consist of an urban category through the northbound and southbound carriageway (the extent from the start of scheme is at junction 67 Coal House to Smithy Lane Bridge for southbound section only). In accordance with Figure 4.1 HD

33/161 (Geotechnics and Drainage) and Figure 4-4a TD 27/052 (Road Geometry - Links), kerbs on verge sides has been selected for the purpose of surface water collection and urban cross-section.

1.3.5. Combined Kerb Drainage Units (CKDU) has been proposed at locations to meet the parameters from para. 1.3.4 and where spacing of gullies are inadequate due to cost and construction i.e. less than 5m intervals. Where outlets of surface water channels are required at closely spaced intervals, a CKDU system has been proposed as the substitute to this verge-side edge drainage.

1.3.6. Traditional kerb and gully drainage has been selected and the hydraulic parameters based on the following:

- Grating type = R
- Flow width = 0.5m

1.3.7. The flow width has been determined to limit surcharge of surface water into the wheel track zone.

1.3.8. All filter drains have been designed to contain surface water runoff from embankment fill and cuttings. Where land outside the highway boundary falls towards the highway, filter drains intercepts these flows into the highway drainage network. Filter drains have been selected for their sediment filtering properties which will be evident for overland catchments.

1.3.9. A section of the rural southbound carriageway is built upon cutting slopes and a combined surface and sub-surface drainage system has been selected for this purpose. Similar to the filter drains, sediment will be filtered combined with conveying the carriageway surface drainage. Due to the nature of the sub-surface connection to the highway filter drain, surcharge within the filter media has been limited to be contained below the flexible pavement construction.

1.3.10. In accordance with Figure 4.1 HD 33/16, the selection of surface water channel has been proposed for instances where a rural cross section exists on embankment without verge restrictions. The channels have been designed as 1 metre triangular symmetrical sections with side slopes at a gradient of 1 in 5. The invert of the channels will be 100mm below the carriageway and to contain the flows within a 1 in 1 year return period. The channels will surcharge encouraging the hard strip during a 1 in 5 year return period.

1.3.11. The Scheme further north from J68 at Lobley Hill had recently been upgraded with additional lanes and concrete central reserve barrier. Similarly, the proposal for a slotted linear drain has been selected based on a paved central reserve, restricted widths and continuity. The slotted drains will be a proprietary manufactured design without any

[1] http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol4/section2/hd3316.pdf

[2] http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol6/section1/td2705.pdf

permitted flow width or surcharge encroachment. The continuity of the drainage system from the scheme upstream will assist with future on-going maintenance regimes.

DRAINAGE NETWORK

1.3.12. The sub-surface pavement drainage is proposed to be drained via narrow fin drains, which also connect into the proposed carrier drain network.

1.3.13. The networks are designed to suit the new carriageway layout and replace the current drainage consisting predominantly of gullies connecting directly into carrier drains. The proposed system has utilised the existing carrier drains where possible with the connection of the CKDU at the outlets.

1.3.14. The proposed solution ensures that the new drainage will not cause any detrimental impact on capacity on the existing drainage and the receiving watercourse.

1.3.15. The existing highway within the limit of works was analysed to determine the existing peak run-off rates for the following storm return periods. 1 year, 5 year, 30 year and 100 year. The catchment contributing to each outfall was determined by the topography of the surrounding area, location of pipe and type of collection system. There was no evidence of flow control devices (as noted in paragraph 1.2.2) and the existing flow rates have been calculated as a free discharge.

1.3.16. As the highway contributing area is increased due to larger extent of the road surfacing and reduced Greenfield areas, the proposed drainage network is designed to maintain or provide betterment on the existing run-off rates during the various storm events.

1.3.17. The existing and proposed contributing areas have been allocated in accordance to their characteristic i.e. level of permeability. The following permeability factors have been applied to each catchment type:

Table 1-2 - Permeability factors

Type of surface	Permeability Factor (%)
Carriageway	100
Verge (grassed or paved)	100
Central reserve (grassed or paved)	100
Road embankment & cuttings	30
Overland flow	10

1.3.18. All verges and central reserves have been calculated as impermeable areas for both existing and proposed catchment definitions.

1.3.19. Overland flow is defined as catchment from land adjacent to the highway irrespective of permeability and assuming grassland. A 10% factor of the area is applicable for a total catchment extent of 100 metres.

ATTENUATION

1.3.20. Attenuation is to be provided using oversized pipes, geo-cellular storage and balancing ponds which are designed to surcharge during storm events. Control orifices are introduced in manholes to control discharge. The drainage design for the proposed A1 Birtley to Coal House scheme incorporates an attenuation pond at a proposed location of the redundant A1 carriageway.

1.3.21. The attenuation pond will capture the water drained from the highway catchment (i.e. Outfalls 7, 7A and 8). This would reduce the rate of the surface water run-off which would have flowed freely ultimately into the River Team. The pond would do this by storing surface water run-off during peak flow (i.e. heavy rainfall) and slowly releasing the water after the peak flow has passed.

1.3.22. A secondary effect of the attenuation ponds would be to treat the water. Sediment and pollutants would settle to the bottom of the attenuation ponds and not enter the Allerdene Burn or the River Team. Additionally, vegetation associated with the ponds would uptake nutrients, which would reduce the nutrient concentration in the water.

1.3.23. The drainage design would also provide protection against spillage events and subsequent contamination of the River Team. The attenuation pond and other storage facilities would be designed with overflow and isolation systems in order to retain contaminated water before it would flow into the drainage system or watercourses. This would allow contaminated water to be treated before being discharged and is integral to the incident management routine.

1.3.24. **Table 1-3** below outlines the proposed attenuation requirements and provisions required to ensure the surface water run-off do not exceed the rates as quantified from **Tables 1-4** to **1-17**. There is scope to evaluate alternative storage facilities provided the flow/head relationship is consistent to the drainage model simulation.

Table 1-3 - Attenuation and flow control schedule

Outfall No.	Attenuation Type	Volume (m^3)	Storage Dimensions	Flow Control Device
1	Geo-cellular structure	108	1m depth to invert	Orifice
2	Pipe	172	1200mm dia. x 152m length	Orifice

Outfall No.	Attenuation Type	Volume (m^3)	Storage Dimensions	Flow Control Device
3	Pipe	15	1050mm dia. x 17.43m length	Orifice
4	Pipe	111	1200mm dia. x 98m length	Orifice
5	Pipe	207	1200mm dia. x 183m length	Orifice
5	Pipe	38	750mm dia. x 85m length	Orifice
5	Pipe	2	500mm dia. x 11m length	Orifice
6	Pipe	4	525mm dia. x 20m length	Orifice x 2
7a, 7 & 8	Pond	662	2m depth to invert	Weir
9	Pipe	66	800mm dia. x 130m length	Vortex flow control
11	Geo-cellular structure	240	1.2m depth to invert	Vortex flow control
12	Pipe	6	375mm dia. x 50m length	Orifice
13	Geo-cellular structure	1100	2.4m depth to invert	Vortex flow control

1.3.25. Outfalls 7a, 7 and 8 is a linked network where each catchment discharges to individual outfalls. The model contains loops which would allow the overflow flows carried to the adjacent network i.e. Outfall 7a to 7, Outfall 7 to 8.

OIL INTERCEPTORS AND SILT CONTROL

1.3.26. The CCTV survey only identified two locations where the surface water is treated by an oil interceptor prior to discharge. These oil interceptors are located adjacent to the Outfalls 4 and 11. These existing interceptors will be replaced with new interceptors and the remaining 10 outfalls that are to be utilised as a part of the drainage scheme will all be equipped with oil interceptors as a primary treatment prior to discharge.

1.3.27. Bypass oil interceptors have been specified to capture and control flows for the majority of storm events. Initial discussions with the Asset Support Contractor (ASC – Highways England) have requested that the interceptors are alarmed and able to inform the Highways England Regional Control Centre. Excessive oil accumulation will not allow the separator to work effectively and the emptying of the tank shall be inclusive to the maintenance requirements.

1.3.28. In addition, silt control vortex separators will be incorporated into the outfalls to Longacre Dene to minimise sediment issues. Detailed design will give consideration to the inclusion of additional vortex separators at all the outfalls where appropriate, whilst giving due consideration to the current specification of catchpits instead of manholes, to help prevent the conveyance of sediment.

OUTFALLS, CULVERTS AND HEADWALLS

1.3.29. All collection systems will connect into a carrier drain network and utilise the existing outfalls. The proposed drainage layouts are shown on Drawing Nos HE551462-WSP-HDG-ZZ-DR-CH-05001 to 05004.

1.3.30. There are no new outfalls proposed and the design has been based on keeping existing outfalls in-situ. Any alterations to outfalls exceeding 300mm diameter will require an Environmental Permit issued from the Environment Agency for the main rivers or Ordinary Watercourse Consent from the LLFA.

1.3.31. The design of culvert extensions shall be undertaken by structural engineering specialists and to maintain the hydraulic properties which imitate the existing flow capacities, velocity and environment conditions. Allerdene culvert is constructed from corrugated steel and shall be designed in accordance with BD 12 and Series 2500 Special Structures of the SHW.

1.3.32. Headwalls which are proposed new or altered are designed by structural engineering specialists and scour prevention measures designed in accordance with HA 107/04.

1.4. EXISTING AND PROPOSED FLOW RATES

1.4.1. **Tables 1-4** to **1-17** below outline the existing and proposed drainage run-off rates.

1.4.2. The existing and proposed run-off rates from Networks 6, 7A, 7 & 8 and Networks 9-13 are ultimately received at the same watercourse to the River Team. The proposed run-off rates may show to exceed existing rates below however the cumulative of the immediate confluence has been retained lower than the existing.

Table 1-4 - Network 1 (Unknown Watercourse) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates (L/s)	Proposed Run-off Rates (L/s)
1 in 1 year	83.9	83.9

Return Period	Existing Run-off Rates (L/s)	Proposed Run-off Rates (L/s)
1 in 5 year	114.3	111.6
1 in 30 year	136.2	125.2
1 in 100 year	148.6	134.2

Table 1-5 - Network 2 (Leyburn Gill Outfall) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates (L/s)	Proposed Run-off Rates (L/s)
1 in 1 year	308.5	204.6
1 in 5 year	403.6	285.8
1 in 30 year	451.1	394.3
1 in 100 year	458.7	413.5

Table 1-6 - Network 3 (Bowes View) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates (L/s)	Proposed Run-off Rates (L/s)
1 in 1 year	94.4	81.0
1 in 5 year	155.6	122.2
1 in 30 year	244.7	136.9
1 in 100 year	315.4	141.6

Table 1-7 - Network 4 (Leyburn Gill Outfall) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	155.6	155.3
1 in 5 year	260.7	217.5
1 in 30 year	394.5	322.6
1 in 100 year	457.2	389.3

Table 1-8 - Network 5 (Longacre Dene via Eighton Lodge Culvert Outfall) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	199.3	185.4
1 in 5 year	267.6	267.5
1 in 30 year	332.9	319.2
1 in 100 year	353.6	339.0

Table 1-9 - Network 6 (Ordinary Watercourse near Smithy Lane Outfall 1) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	64.7	104.8
1 in 5 year	101.1	128.2
1 in 30 year	136.8	136.8
1 in 100 year	158.2	142.3

Table 1-10 - Network 7A (Ditch leading to the ordinary Watercourse near Smithy Lane Outfall 2) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	395.1	337.1
1 in 5 year	527.0	484.9
1 in 30 year	568.2	560.6
1 in 100 year	589.7	573.6

Table 1-11 - Network 7 (Ordinary Watercourse near Smithy Lane Outfall 3) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	84.8	25.0
1 in 5 year	111.7	41.8
1 in 30 year	123.9	60.8
1 in 100 year	127.0	66.8

Table 1-12 - Network 8 (Culvert leading to Allerdene Burn Outfall 4) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	176.8	171.9
1 in 5 year	265.3	295.5
1 in 30 year	374.1	383.6
1 in 100 year	413.2	416.1

Table 1-13 - Network 9 (The River Team Outfall 1) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	67.1	138.2
1 in 5 year	104.3	205.0
1 in 30 year	148.2	254.8
1 in 100 year	179.9	303.1

Table 1-14 - Network 10 (The River Team Outfall 2) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	11.7	Outfall removed
1 in 5 year	19.6	Outfall removed
1 in 30 year	34.1	Outfall removed
1 in 100 year	44.0	Outfall removed

Table 1-15 - Network 11 (The River Team Outfall 3) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	0.0	6.0
1 in 5 year	23.5	6.0
1 in 30 year	70.1	6.0
1 in 100 year	98.2	7.3

Table 1-16 - Network 12 (The River Team Outfall 4) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	76.0	129.5
1 in 5 year	114.9	188.7
1 in 30 year	149.5	239.4
1 in 100 year	179.6	273.3

Table 1-17 - Network 13 (Coal House Outfall 5) - Existing and proposed run-off rates

Return Period	Existing Run-off Rates	Proposed Run-off Rates
1 in 1 year	161.7	27.1
1 in 5 year	191.1	27.4
1 in 30 year	200.4	27.4
1 in 100 year	207.7	27.4

1.5. DESIGN CRITERIA AND ASSUMPTIONS

1.5.1.1. The drainage design is to be designed and simulated using Windes Microdrainage with the following design criteria consistent through all outfalls in the network:

Table 1-18 - Windes Microdrainage Design Criteria

Design Criteria	Input Value
FSR Rainfall	
Return Period (years)	1
Region	England and Wales

Design Criteria	Input Value
M5-60 (mm)	18.600
Ration R	0.350
Global Time of Entry (mins)	2.00
Max. Rainfall (mm/hr)	50
Max. Time of Conc. (mins)	30
Foul Sewage per hectare (l/s)	0.000
PIMP (%)	100
Volumetric Run-off Coeff.	0.750

1.6. ASSUMPTIONS

1.6.1. The highway drainage design is subject to the following assumptions:

- The combined kerb and drainage units shall be designed to the specific capacity requirements of a proprietary product available at the duration of the design.
- Where there is no increase to paved area, the additional runoff (generated by application of the 20% increase to rainfall intensities for climate change) is to be attenuated, so that the proposed discharge rate does not exceed the existing.
- Where it is proposed to increase the paved areas (e.g. nearside widening/hardening of the central reserve), the discharge rate can be increased above the existing by an amount equal to the Greenfield runoff rate for the additional paved area. Allowance for climate change is also to be applied to additional paved areas. Flows exceeding the revised discharge rate are to be attenuated.
- The condition of the existing drainage network has been evaluated as reported by the Carnell Group from the CCTV survey during July 2017. All defect remediation works are associated with this survey report.

Appendix D

SURFACE WATER DRAINAGE STRATEGY FIGURES

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KEY

- PROPOSED CATCHPIT
- EXISTING MANHOLES
- PROPOSED PIPE
- EXISTING PIPE
- LINEAR SLOTTED DRAIN
- COMBINED KERB AND DRAINAGE UNIT
- SURFACE WATER CHANNEL

PIPE DIRECTION — O2-1.000 300 (C/FD) — PIPE REFERENCE
PROPOSED PIPE DIMENSIONS (mm) — PROPOSED CARRIER/ FILTER DRAIN
300 (C) — EXISTING PIPE DIMENSIONS (mm) — EXISTING CARRIER/ FILTER DRAIN

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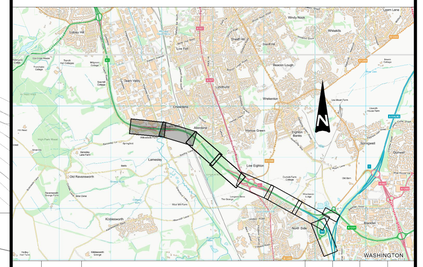
STATUTORY UNDERTAKERS
1. REFER TO DRAWING NO. HE551462-WSP-VUT-BCH-DR-D-00001 TO 00003 FOR DETAILS OF STATUTORY UNDERTAKERS.

DRAINAGE
1. ALL CROSS CARRIAGEWAY PIPES TO BE TRENCH AND BEDDING DETAIL TYPE Z, HCD DRAWING F1.
2. LOCATIONS OF OIL INTERCEPTIONS PROVIDED IN DRAWING.
3. REFER TO PIPE SCHEDULES FOR LENGTHS DEPTHS OF DRAINS.



Rev.	Date	Description	By	Eng' Ch'k	Disc' Ch'k	App'd
P01	25/04/18	FIT FOR COORDINATION	AW	AH	PG	---
P02	23/08/18	Design Revised	AW	AH	AH	---

Suitability: Suitable for Information — Status: S2

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Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title: DRAINAGE PRELIMINARY DESIGN SHEET 1 OF 4

Scale	Drawn	Eng. Check	Approved	Authorised
1:1000	A.Wallace	a.hussain	a.hussain	---
Original Size	**Date**	**Date**	**Date**	**Date**
A1	23/08/18	14/12/18	14/12/18	---

Drawing Number: HE PIN HE551462 | Originator WSP | Volume HDG | Section S2 | Type X | ID DR | Direction CD | Role 05000 | Number

Revision:

PW Stage Code: 3

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WSP Project Number: 70041947

HE551462-WSP-HDG-S2_X-DR-CD-05000

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SMITHY LANE OVERBRIDGE; STRUCTURE KEY 16439.

SMITHY LANE

A1 SB

A1 NB

OUTLINE B

OUTLINE C

OIL INTERCEPTOR

2ND. ORIFICE PLATE FLOW CONTROLS

A167 DURHAM ROAD

ANGEL OF THE NORTH

EIGHTON LODGE SLIP ROAD UNDERBRIDGE; STRUCTURE KEY 16441.

Longacre Wood

KEY

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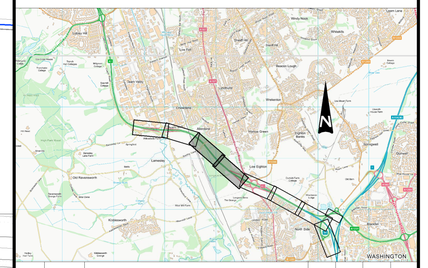

Rev.	Date	Description	By	Eng' Ch'k	Disc' Ch'k	App'd
P01	27/04/18	FIR FOR COORDINATION	AW	AH	PG	---
P02	23/08/18	Design Revised	AW	AH	AH	---

Suitability: Suitable for Information — Status: S2

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A1	23/08/18	14/12/18	14/12/18	---

Drawing Number: HE PIN HE551462 | Originator WSP | Volume HDG | Section S3 | Type | ID | Direction X | Type DR | Role CD | Number 05001

Revision:

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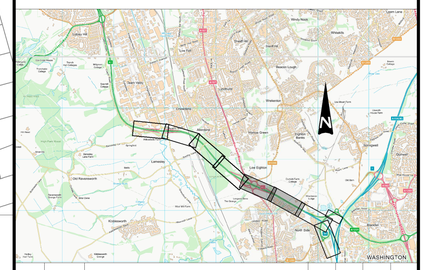
1. REFER TO DRAWING NO. HE551462-WSP-GEN-ZZ-DR-CH-0001 TO 0018 FOR DETAILS OF SITE SITE CLEARANCE INCLUDING REDUNDANT PIPES AND MANHOLE REMOVALS.

STATUTORY UNDERTAKERS

1. REFER TO DRAWING NO. HE551462-WSP-VUT-BCH-DR-D-00001 TO 00003 FOR DETAILS OF STATUTORY UNDERTAKERS.

DRAINAGE

1. ALL CROSS CARRIAGEWAY PIPES TO BE TRENCH AND BEDDING DETAIL TYPE Z, HCD DRAWING F1.
2. LOCATIONS OF OIL INTERCEPTIONS PROVIDED IN DRAWING.
3. REFER TO PIPE SCHEDULES FOR LENGTHS DEPTHS OF DRAINS.



Rev.	Date	Description	By	Eng' Ch'k	Disc' Ch'k	App'd
P01	27/04/18	FIT FOR COORDINATION	AW	AH	PG	---
P02	23/08/18	Design Revised	AW	AH	AH	---

Suitability: Suitable for Information

Status: S2

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Client: highways england

Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title: DRAINAGE PRELIMINARY DESIGN SHEET 3 OF 4

Scale	Drawn	Eng. Check	Approved	Authorised
1:1000	A.Wallace	a.hussain	a.hussain	---
Original Size	**Date**	**Date**	**Date**	**Date**
A1	24/08/18	14/12/18	14/12/18	---

Drawing Number: HE PW HE551462 | Originator: WSP | Volume: HDG | Revision

S3 | Section | X | Direction | DR | Type | CD | Role | 05002 | Number

PW Stage Code: 3

Confidential

WSP Project Number: 70041947

HE551462-WSP-HDG-S3_X-DR-CD-05002

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KEY

- PROPOSED CATCHPIT
- EXISTING MANHOLES
- PROPOSED PIPE
- EXISTING PIPE
- LINEAR SLOTTED DRAIN
- COMBINED KERB AND DRAINAGE UNIT
- SURFACE WATER CHANNEL

PIPE DIRECTION — PIPE REFERENCE — O2-1.000 300 (C)/FD) — PROPOSED PIPE DIMENSIONS (mm) — PROPOSED CARRIER/ FILTER DRAIN

300 (C) — EXISTING PIPE DIMENSIONS (mm) — EXISTING CARRIER/ FILTER DRAIN

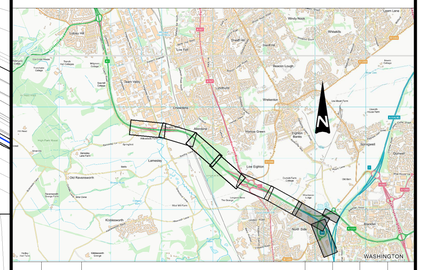
NOTES:

GENERAL
1. THIS DRAWING SHOULD ONLY BE READ IN RELATION TO THE SUBJECT OF THE TITLE. OTHER INFORMATION SHOWN ON THE DRAWING IS TO BE CONSIDERED INDICATIVE ONLY. REFERENCE SHOULD BE MADE TO THE APPROPRIATE DRAWING SERIES FOR OTHER INFORMATION.
2. ALL DIMENSIONS IN METRES UNLESS STATED OTHERWISE.

SITE CLEARANCE
1. REFER TO DRAWING NO. HE551462-WSP-GEN-ZZ-DR-CH-0001 TO 0018 FOR DETAILS OF SITE SITE CLEARANCE INCLUDING REDUNDANT PIPES AND MANHOLE REMOVALS.

STATUTORY UNDERTAKERS
1. REFER TO DRAWING NO. HE551462-WSP-VUT-BCH-DR-D-00001 TO 00003 FOR DETAILS OF STATUTORY UNDERTAKERS.

DRAINAGE
1. ALL CROSS CARRIAGEWAY PIPES TO BE TRENCH AND BEDDING DETAIL TYPE Z, HCD DRAWING F1.
2. LOCATIONS OF OIL INTERCEPTIONS PROVIDED IN DRAWING.
3. REFER TO PIPE SCHEDULES FOR LENGTHS DEPTHS OF DRAINS.



Rev.	Date	Description	By	Eng' Ch'k	Disc' Ch'k	App'd
P01	27/04/18	FIT FOR COORDINATION	AW	AH	PG	---
P02	23/08/18	Design Revised	AW	AH	AH	---

Suitability: Suitable for Information — Status: S2

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Client: highways england

Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title: DRAINAGE PRELIMINARY DESIGN SHEET 4 OF 4

Scale	Drawn	Eng. Check	Approved	Authorised
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Original Size	**Date**	**Date**	**Date**	**Date**
A1	23/08/18	14/12/18	14/12/18	---

Drawing Number: HE PIN HE551462 | Originator WSP | Volume HDG | Revision

S4 (Section) | Type | ID | X (Direction) | DR (Type) | CD (Role) | 05003 (Number) | PW Stage Code 3

Confidential

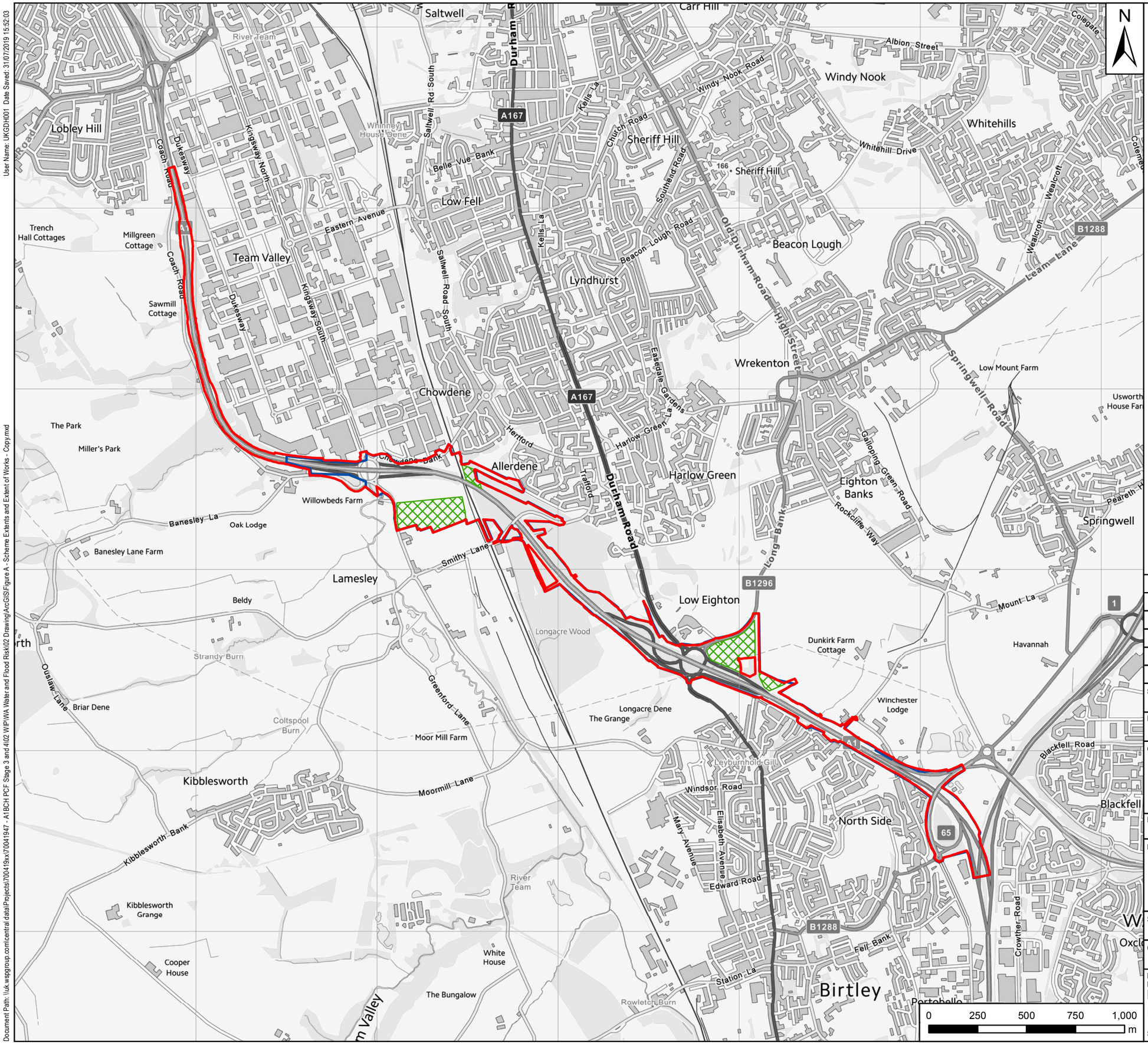
WSP Project Number: 70041947

HE551462-WSP-HDG-S4_X-DR-CD-05003

Appendix E

SCHEME FIGURES

Public



Rev	Date	Description	By	Chk'd	App'd
P04	31/07/19	Fourth Issue	GH	SS	AS
P04	24/04/19	Third Issue	EHC	SS	AS
P03	28/02/19	Second Issue	EHC	SS	AS
P02	12/12/18	First Issue	EHC	SS	AS
P01	29/11/18	First Issue	EHC	SS	AS

Suitability: Suitable for Information

Status: S2

PINS Reference Number: TR010031

Client: highways england

Project Title: A1 Birtley to Coal House Scheme

Drawing Title: Figure A Scheme Extents and Extent of Works Regulation 5 (2) (a)

Scale	Drawn	Checked	Approved	Authorised
1:20,000	EHC	SS	AS	NJA
Original Size	**Date**	**Date**	**Date**	**Date**
A3	29/11/18	04/12/18	06/12/18	12/12/18

Drawing Number: HE PIN HE551462 B2CH

Originator: WSP

Volume:

Revision: P05

PW Stage Code:

Section | Type | ID | Direction | Type | Role | Number

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Document Path: \\uk.wsgroup.com\central data\Projects\700419xx\70041947 - A1BCH PCF Stage 3 and 4\02 WIP\WA Water and Flood Risk\02 Drawing\ArcGIS\Figure A - Scheme Extents and Extent of Works - Copy.mxd

User Name: UKGDH001 Date Saved: 01/08/2019 14:24:02

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N

Key

- Scheme Footprint
- Study Area
- Study Area 1km Buffer
- Proposed Construction Compounds
- Culverts
- Watercourses

P05	31/07/19	Fourth Issue	GH	SS	AS
P04	24/04/19	Third Issue	EHC	SS	AS
P03	28/02/19	Second Issue	EHC	SS	AS
P02	12/12/18	First Issue	EHC	SS	AS
P01	29/11/18	First Issue	EHC	SS	AS
Rev	Date	Description	By	Chk'd	App'd

Suitability: Suitable for Information

Status: S2

PINS Reference Number: TR010031

Client: highways england

Project Title: A1 Birtley to Coal House Scheme

Drawing Title: Figure B Water Feature Location Plan
Regulation 5 (2) (a)

Scale	Drawn	Checked	Approved	Authorised
1:20,000	EHC	SS	AS	NJA
Original Size	**Date**	**Date**	**Date**	**Date**
A3	29/11/18	04/12/18	06/12/18	12/12/18

Drawing Number
HE PIN
HE551462
B2CH

Originator: WSP

Volume:

Revision: P05

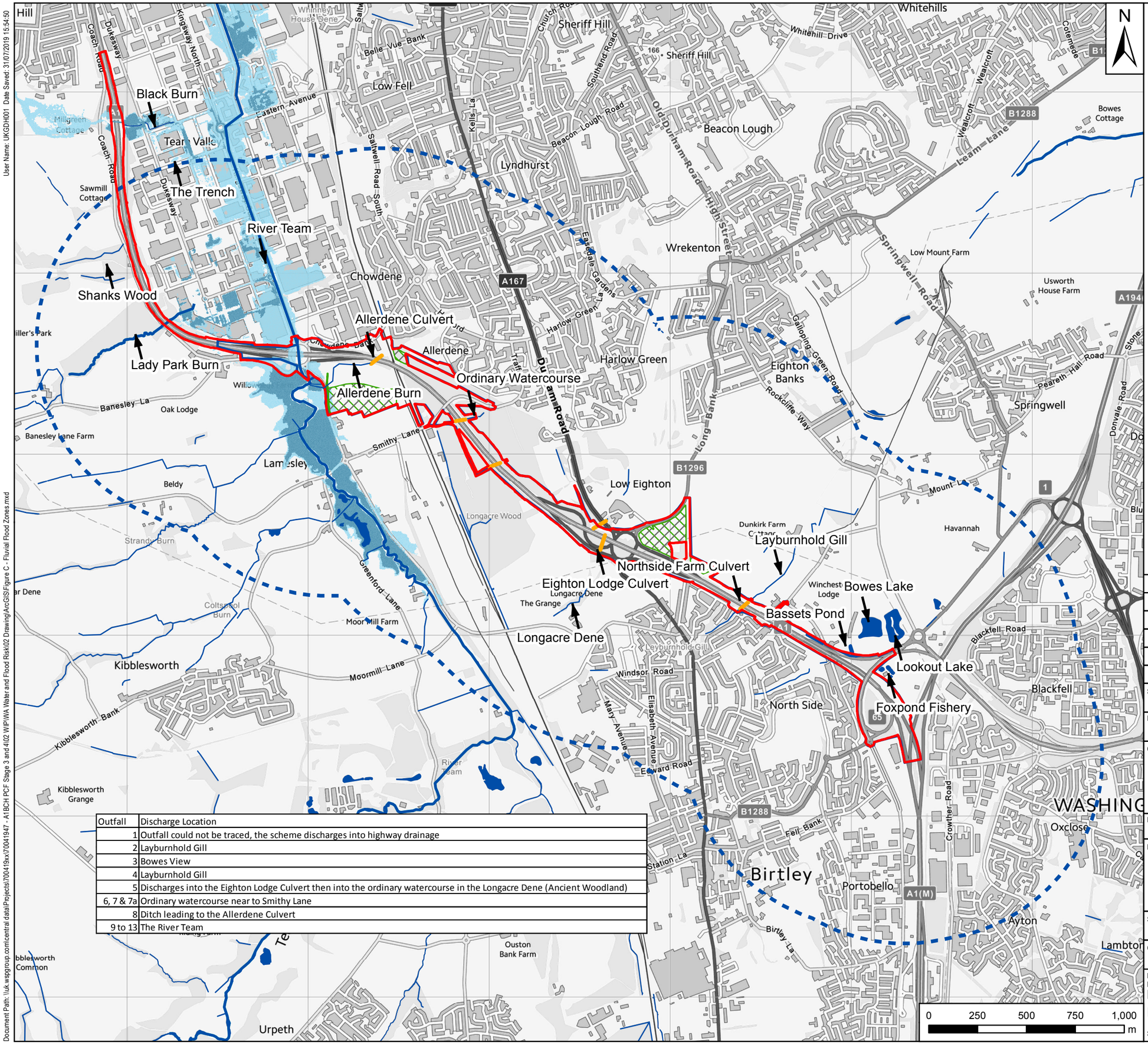
PW Stage Code:

Section | Type | ID | Direction | Type | Role | Number

0 250 500 750 1,000 m

User Name: UKGDH001 Date Saved: 31/07/2019 15:54:50

Document Path: \\uk.wspgroup.com\central data\Projects\700419xx\70041947 - A1BCH PCF Stage 3 and 4\02 WIP\WA Water and Flood Risk\02 Drawing\ArcGIS\Figure C - Fluvial Flood Zones.mxd



Outfall	Discharge Location
1	Outfall could not be traced, the scheme discharges into highway drainage
2	Layburnhold Gill
3	Bowes View
4	Layburnhold Gill
5	Discharges into the Eighton Lodge Culvert then into the ordinary watercourse in the Longacre Dene (Ancient Woodland)
6, 7 & 7a	Ordinary watercourse near to Smithy Lane
8	Ditch leading to the Allerdene Culvert
9 to 13	The River Team

P05	31/07/19	Fourth Issue	GH	SS	AS
P04	24/04/19	Third Issue	EHC	SS	AS
P03	28/02/19	Second Issue	EHC	SS	AS
P02	12/12/18	First Issue	EHC	SS	AS
P01	29/11/18	First Issue	EHC	SS	AS
Rev	Date	Description	By	Chk'd	App'd

Suitability: Suitable for Information
Status: S2

PINS Reference Number: TR010031

Client: highways england

Project Title: A1 Birtley to Coal House Scheme

Drawing Title: Figure C Fluvial Flood Zones
Regulation 5 (2) (a)

Scale	Drawn	Checked	Approved	Authorised
1:20,000	EHC	SS	AS	NJA
Original Size	**Date**	**Date**	**Date**	**Date**
A3	29/11/18	04/12/18	06/12/18	12/12/18

Drawing Number
HE PIN
HE551462
B2CH

Originator: WSP
Volume:
Revision: P05
PW Stage Code:

Section | Type | ID | Direction | Type | Role | Number

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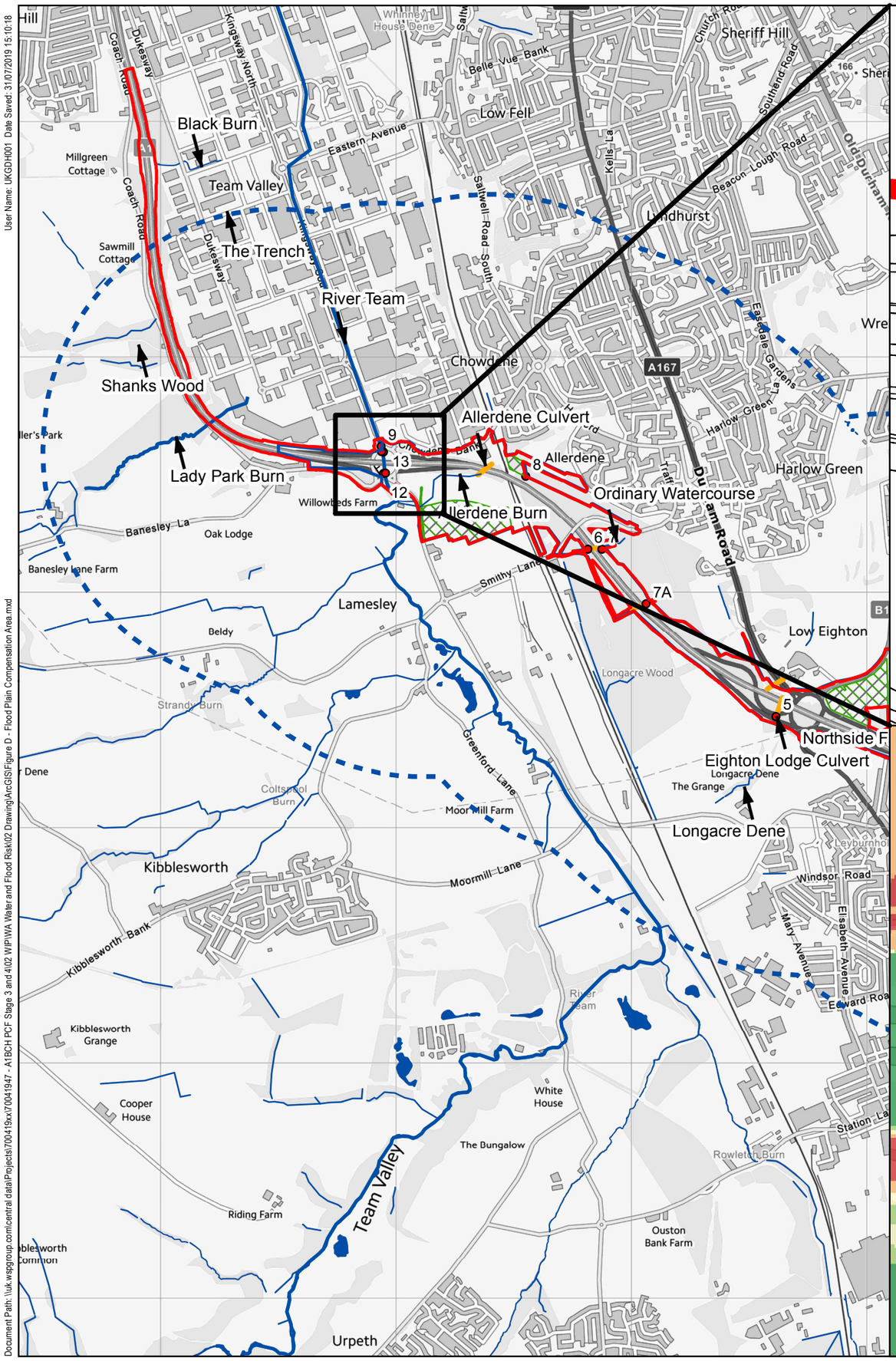
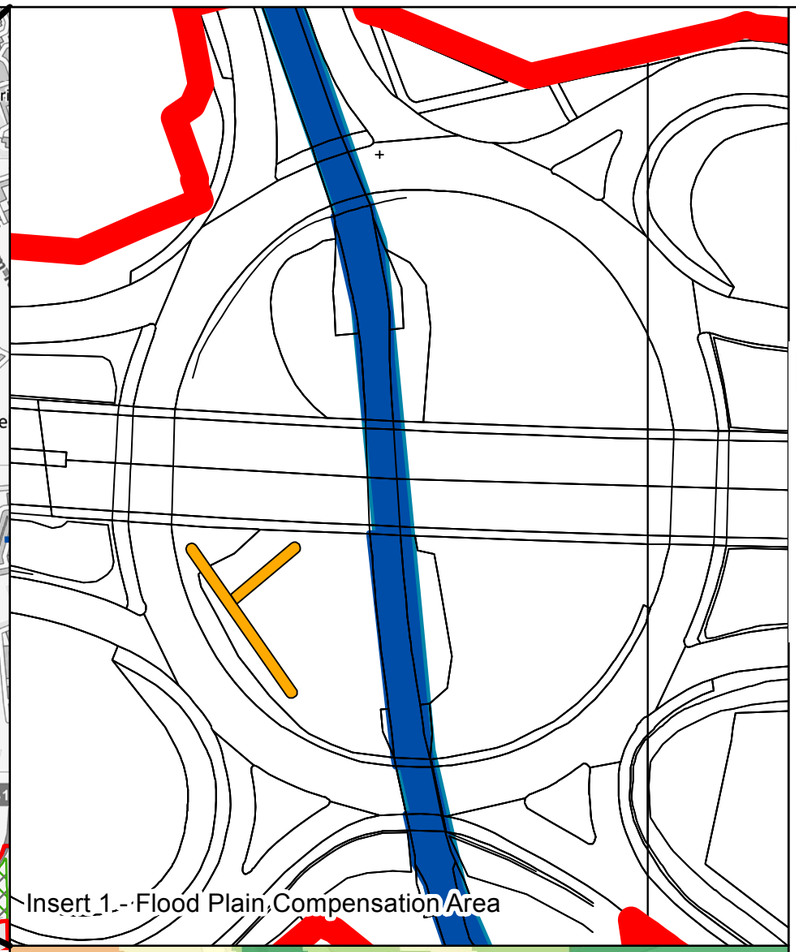
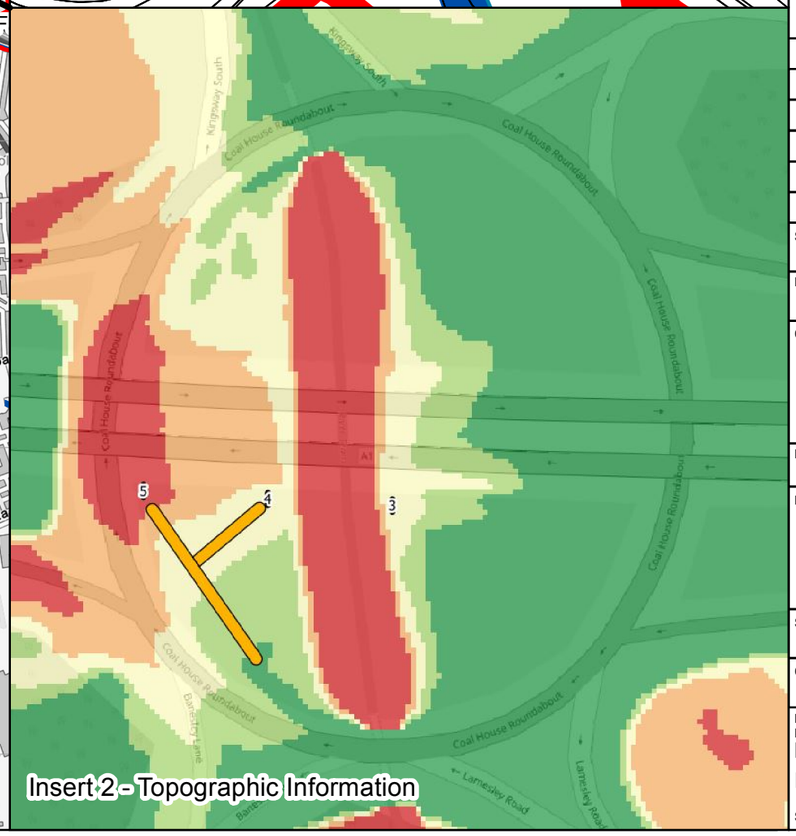
Document Path: \\uk.wspgroup.com\central data\Projects\70041947 - A1BCH PCF Stage 3 and 4\02 WIP\WA Water and Flood Risk\02 Drawing\ArcGIS\Figure D - Flood Plain Compensation Area.mxd







Key

- Scheme Footprint
- Study Area
- Study Area 1km Buffer
- Proposed Construction Compounds
- Outfalls
- Culverts
- Watercourses
- Flood Compensation Area
- Proposed Bridge Pillars 5-3

Terrain Height mAOD

- <= 11.4
- 11.4 - 11.8
- 11.8 - 12.2
- 12.2 - 12.6
- > 12.6

The flood plain compensation area is to be a strip 2.6m wide (i.e. the width of a JCB excavator bucket) by 38m long and 130mm deep to provide the replacement floodplain volume.

Rev	Date	Description	By	Chk'd	App'd
P05	31/07/19	Fourth Issue	GH	SS	AS
P04	24/04/19	Third Issue	EHC	SS	AS
P03	28/02/19	Second Issue	EHC	SS	AS
P02	12/12/18	First Issue	EHC	SS	AS
P01	29/11/18	First Issue	EHC	SS	AS

Suitability: Suitable for Information

Status: S2

PINS Reference Number: TR010031

Client: highways england

Project Title: A1 Birtley to Coal House Scheme

Drawing Title: Figure D Flood Plain Compensation Area Regulation 5 (2) (a)

Scale	Drawn	Checked	Approved	Authorised
1:20,000	EHC	SS	AS	NJA
Original Size	**Date**	**Date**	**Date**	**Date**
A3	29/11/18	04/12/18	06/12/18	12/12/18

Drawing Number: HE PIN HE551462 B2CH

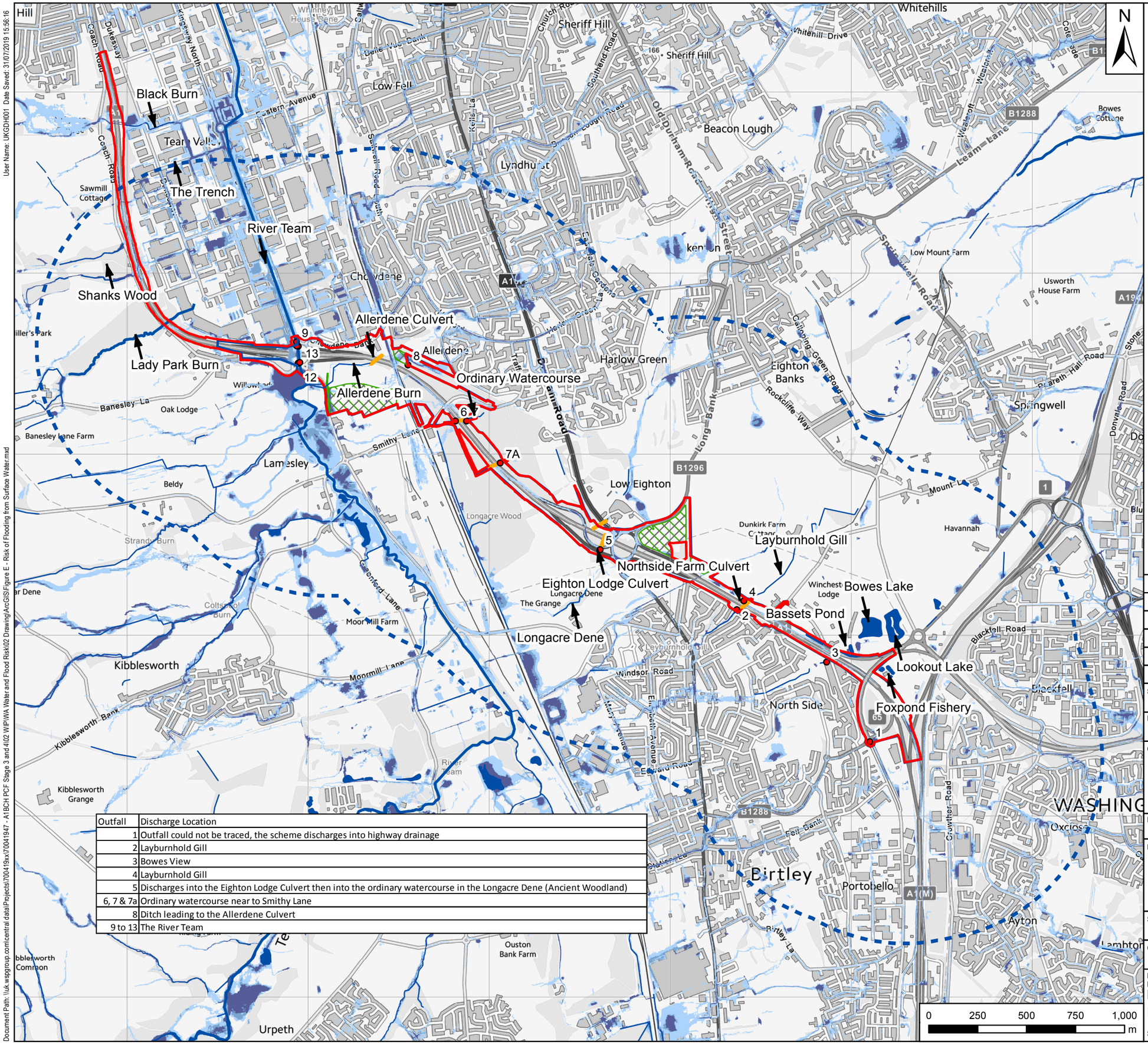
Originator: WSP

Volume:

Revision: P05

PW Stage Code:

Section | Type | ID | Direction | Type | Role | Number



Outfall	Discharge Location
1	Outfall could not be traced, the scheme discharges into highway drainage
2	Layburnhold Gill
3	Bowes View
4	Layburnhold Gill
5	Discharges into the Eighton Lodge Culvert then into the ordinary watercourse in the Longacre Dene (Ancient Woodland)
6, 7 & 7a	Ordinary watercourse near to Smithy Lane
8	Ditch leading to the Allerdene Culvert
9 to 13	The River Team

Rev	Date	Description	By	Chk'd	App'd
P05	31/07/19	Fourth Issue	GH	SS	AS
P04	24/04/19	Third Issue	EHC	SS	AS
P03	28/02/19	Second Issue	EHC	SS	AS
P02	12/12/18	First Issue	EHC	SS	AS
P01	29/11/18	First Issue	EHC	SS	AS

Suitability: Suitable for Information
Status: S2

PINS Reference Number: TR010031

Client: highways england

Project Title: A1 Birtley to Coal House Scheme

Drawing Title: Figure E Risk of Flooding from Surface Water Regulation 5 (2) (a)

Scale	Drawn	Checked	Approved	Authorised
1:20,000	EHC	SS	AS	NJA
Original Size	Date	Date	Date	Date
A3	29/11/18	04/12/18	06/12/18	12/12/18

Drawing Number: HE551462 B2CH
Originator: WSP
Volume:
Revision: P05
PW Stage Code:
Section | Type | ID | Direction | Type | Role | Number

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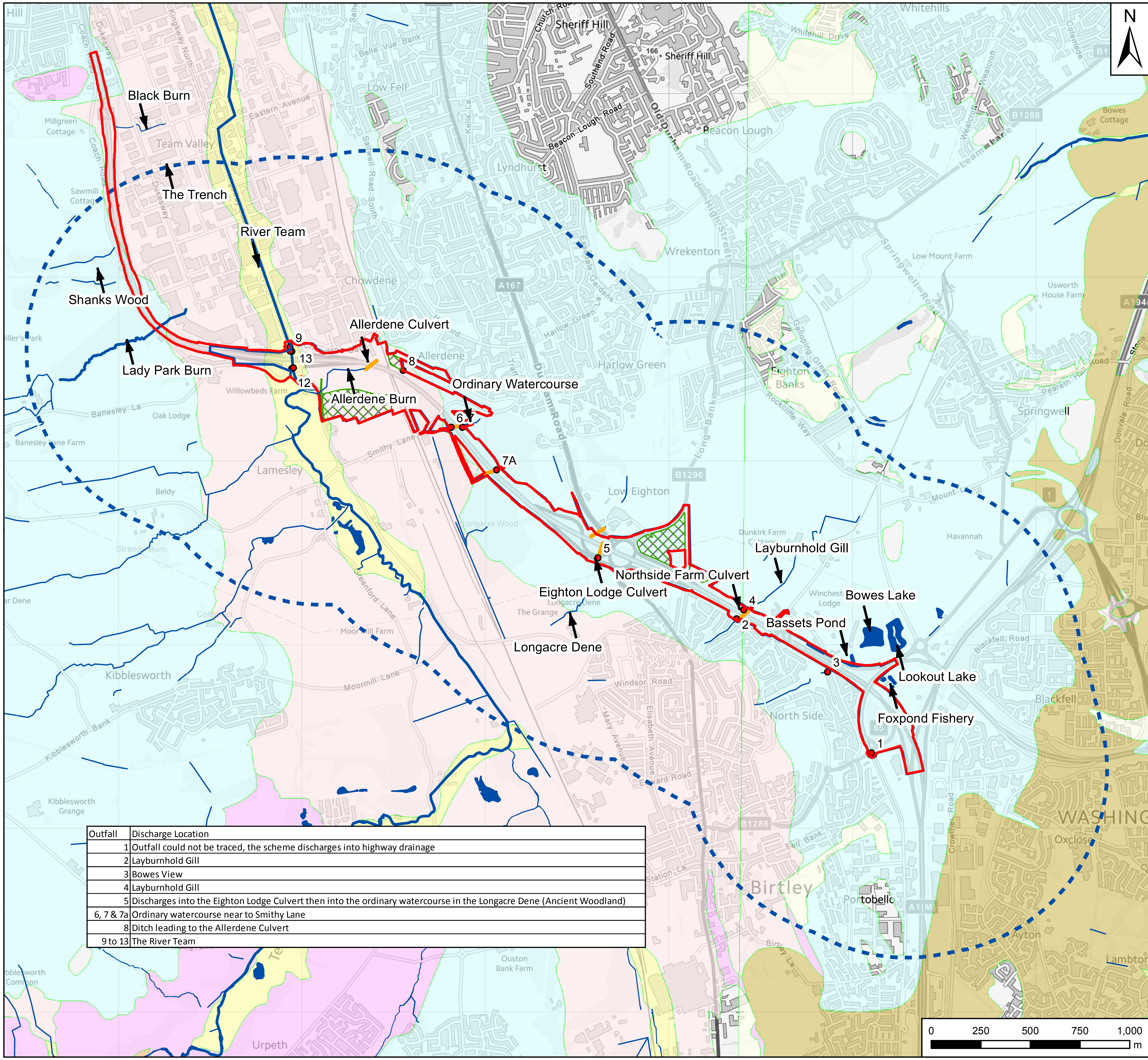
User Name: UKGDH001 Date Saved: 31/07/2019 15:57:13



Outfall	Discharge Location
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2	Layburnhold Gill
3	Bowes View
4	Layburnhold Gill
5	Discharges into the Eighton Lodge Culvert then into the ordinary watercourse in the Longacre Dene (Ancient Woodland)
6, 7 & 7a	Ordinary watercourse near to Smithy Lane
8	Ditch leading to the Allerdene Culvert
9 to 13	The River Team

Key

- Scheme Footprint
- Study Area
- Study Area 1km Buffer
- Proposed Construction Compounds
- Outfalls
- Culverts
- Watercourses

Superficial Deposits Designations

- Glaciolacustrine Deposits, Devensian - Clay And Silt
- Alluvium - Clay, Silt, Sand And Gravel
- Till, Devensian - Diamicton
- Glaciofluvial Deposits, Devensian - Sand And Gravel
- Pelaw Clay Member - Clay

Rev	Date	Description	By	Chk'd	App'd
P05	31/07/19	Fourth Issue	GH	SS	AS
P04	24/04/19	Third Issue	EHC	SS	AS
P03	28/02/19	Second Issue	EHC	SS	AS
P02	12/12/18	First Issue	EHC	SS	AS
P01	29/11/18	First Issue	EHC	SS	AS

Suitability: Suitable for Information — Status: S2

PINS Reference Number: TR010031

Client: highways england

Project Title: A1 Birtley to Coal House Scheme

Drawing Title: Figure F Superficial Deposits Designations Regulation 5 (2) (a)

Scale	Drawn	Checked	Approved	Authorised
1:20,000	EHC	SS	AS	NJA
Original Size A3	Date 29/11/18	Date 04/12/18	Date 06/12/18	Date 12/12/18

Drawing Number: HE PIN HE551462 — Originator WSP — Volume — Revision P05

B2CH — Section | Type | ID | Direction | Type | Role | Number — PW Stage Code

Document Path: \\uk.wsgroup.com\central data\Projects\700419xx\70041947 - A1BCH PCF Stage 3 and 4\02 WIP\WA Water and Flood Risk\02 Drawing\ArcGIS\Figure F - Superficial Deposits Designations.mxd

User Name: UKGDH001 Date Saved: 31/07/2019 15:57:59

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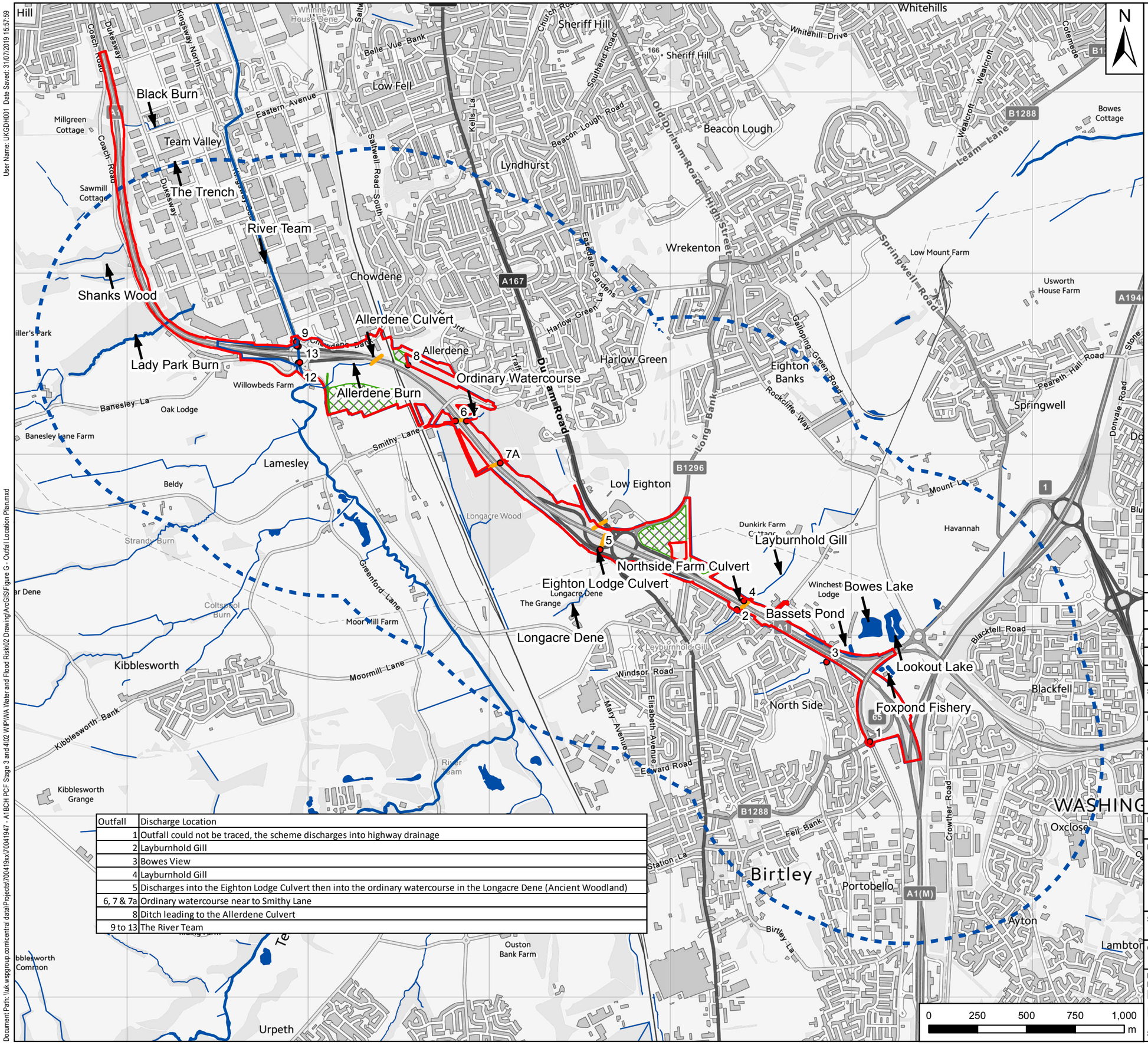

Outfall	Discharge Location
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9 to 13	The River Team

Rev	Date	Description	By	Chk'd	App'd
P05	31/07/19	Fourth Issue	GH	SS	AS
P04	24/04/19	Third Issue	EHC	SS	AS
P03	28/02/19	Second Issue	EHC	SS	AS
P02	12/12/18	First Issue	EHC	SS	AS
P01	29/11/18	First Issue	EHC	SS	AS

Suitability: Suitable for Information

Status: S2

PINS Reference Number: TR010031

Client: highways england

Project Title: A1 Birtley to Coal House Scheme

Drawing Title: Figure G Outfall Location Plan
Regulation 5 (2) (a)

Scale	Drawn	Checked	Approved	Authorised
1:20,000	EHC	SS	AS	NJA
Original Size	Date	Date	Date	Date
A3	29/11/18	04/12/18	06/12/18	12/12/18

Drawing Number
HE PIN
HE551462
B2CH

Originator: WSP

Volume:

Revision: P05

PW Stage Code:

Section | Type | ID | Direction | Type | Role | Number

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