Haweswater Aqueduct Resilience Programme - Proposed Marl Hill Section

Volume 6

Proposed Ribble Crossing

Appendix 8.1: Flood Risk Assessment

June 2021

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1. Introduction

1.1 Purpose

1) This Flood Risk Assessment (FRA) has been prepared for the Proposed Ribble Crossing, which forms one of the construction traffic route options for the Proposed Marl Hill Section of the Haweswater Aqueduct Resilience Programme (HARP). The FRA has been carried out in combination with design development through the Environmental Impact Assessment (EIA) process. The FRA informs Chapter 8 (Flood Risk) of the Environmental Statement (ES) and is intended to support the planning application for the Proposed Marl Hill Section.

2) The FRA has been carried out with consideration of the National Planning Policy Framework (NPPF)[1] and the Planning Practice Guidance (PPG)[2]. Complying with planning policy would promote a development that would be appropriate given the level of local flood risks, would be safe during the construction and operational phases of its lifetime, and would not increase flood risk both on site and elsewhere.

3) Due to programme constraints, hydraulic modelling required to support this assessment has not yet been completed. Therefore, this FRA is intended to be an interim assessment that will be updated following completion of the hydraulic modelling which is anticipated by the end of July 2021.

1.2 Proposed Programme of Works Overview

4) The existing 110 km Haweswater Aqueduct takes raw water from the Haweswater Reservoir in the Lake District National Park along a 16 km section of the aqueduct to a Water Treatment Works (WTW) near Kendal. From this WTW the aqueduct conveys treated water to customers in Greater Manchester, Cumbria and Lancashire.

5) The aqueduct comprises six existing tunnel sections replaced with five proposed tunnels (generally 2.6 m internal diameter). The flow of water along the entire length of the aqueduct is achieved by gravity, with no energy-consuming pumps involved in supplying the water from north to south. Out of the total 110 km length of the aqueduct, the Proposed Programme of Works on the single line sections accounts for just under half this distance, about 53 km.

1.3 Development Proposals

6) The crossing would be temporary and would be in place for the duration of the construction of the Proposed Marl Hill Section. Enabling works on the Proposed Ribble Crossing would start in 2023, depending on the outcome and timing of the planning decision, and would be followed by a main construction phase which would last for approximately one year. The Proposed Ribble Crossing would then be operational for approximately seven years until the end of the tunnel construction and reinstatement works. Following completion of the construction works on the Proposed Marl Hill Section, the Proposed Ribble Crossing would be removed and land re-instated to its former use.

7) The Proposed Ribble Crossing would be located approximately 2 km north of Clitheroe town centre and to the south of West Bradford village as indicated on Figure 8.1. Furthermore, the Proposed Ribble Crossing is located to the north-west of the Ribblesdale Cement Works , off Clitheroe Road and West Bradford Road. The National Grid Reference (NGR) for the Proposed Ribble Crossing is SD 74404 43875

8) The Local Planning Authority is Ribble Valley Borough Council and the Local Lead Flood Authority is Lancashire County Council.

9) The Proposed Ribble Crossing would combine the following key elements:

[1] Department for Communities and Local Government (2019) National Planning Policy Framework. [Online] Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2. [Accessed: 09 March 2021].
[2] Department for Communities and Local Governments (2019) Planning Practice Guidance. [Online] Available at: https://www.gov.uk/government/collections/planning-practice-guidance. [Accessed: 09 March 2021].

- Enabling works including the establishment of temporary construction compounds and temporary access roads
- Temporary drainage around the compound locations
- Construction of a temporary three-span bailey bridge across the River Ribble
- Construction of three, temporary single span bridge across the Ordinary Watercourses; Coplow Brook, Greg Sike and an unnamed watercourse referred to as Unnamed Watercourse 2097
- Construction of a temporary tarmac road approximately 7 m wide with associated drainage between a junction with West Bradford Road at to the south of the River Ribble at SD 74517 43833 and another junction with West Bradford Road to the north of the River Ribble at SD 73344 44007.

10) Drawings showing the indicative design of the Proposed Ribble Crossing are presented in Appendix B.

11) The temporary laydown compounds would have an approximate design life of one year and would be reinstated for the operational phase of the Proposed Ribble Crossing. The Proposed Ribble Crossing itself, including the road with the bridge and crossings over Ordinary Watercourses, would have a design life of six years after which it would be decommissioned and the land re-instated to its previous condition. The decommissioning works would require the re-establishment of the compounds that were re-instated following the completion of the construction phase. Following the completion of the decommissioning, the compounds would once again be re-instated to their pre-development condition.

12) The road would be a two-lane carriageway 7.7 m wide and 1450 m in length. The road would be fully removed, and the land reinstated once the tunnel construction works have been completed. During the works the road would be reserved for the use of all construction traffic. Public access to the road would be prohibited through the provision of vehicle barriers at either end of the road.

13) The road would be suitable for heavy duty use and would be surfaced with a tarmac construction based on a stone aggregate foundation.

14) A temporary bridge crossing of the River Ribble would be incorporated in the road. The bridge would be a Bailey bridge type clear span construction supported on columns either side of the river with 72 m in length. The bridge would extend over the adjacent floodplain with additional bridge sections either side of the river bridge. Overall, the bridge would be approximately 140 m in length as shown in the drawings supporting the planning application. Earthwork abutments would be required either side of the bridge.

15) The Proposed Ribble Crossing has been designed to include the following embedded mitigation measures:

- A three-span structure that crosses the floodplain of the River Ribble on slender piers with a flood relief culvert built into the embankment within the left-hand floodplain
- Clear span crossings of Ordinary Watercourses
- Soffit levels for all crossings to be set 600 mm above the 1 % AEP peak flood level
- The road surface constructed at grade across areas of floodplain except for a slight camber
- Drainage systems based on Sustainable Drainage System (SuDS) to manage runoff from construction compounds and roads.

16) With the exception of the bridge, the road would be constructed at grade to follow the existing topography. Cuttings and embankments would be kept to a minimum and would only be made to create a suitable profile for the road.

17) Drainage would be provided to keep the road surface and foundations free from water. A drainage system would be put in place that would attenuate and treat the water prior to discharge into the River Ribble at a rate not exceeding greenfield run off.

18) The route of the road has been selected to keep to the periphery of field boundaries where possible. Gated crossing points would be provided for landowners and tenants to enable access to land that the road crosses.

19) The road crosses several public rights of way (PROWs) including the Ribble Way. The temporary bridge across the River Ribble would cross over the Ribble Way with sufficient clearance to avoid any disruption to access apart from during the bridge construction which may require a temporary diversion. Gated crossing points would be provided to ensure continuity of access for any other affected public rights of way.

20) Temporary laydown areas would be established for the construction and removal of the road, but these would not be present when the road in use.

21) The construction of the road would require removal of topsoil and sub-surface material where required. These materials would be stockpiled adjacent to the road at intervals and they would be re-used to reinstate the land once the road is removed.

2. Scope and Methodology

2.1 Assessing Flood Risk

22) The assessment of flood risk has been undertaken in line with the development of the EIA and the Proposed Ribble Crossing design. A summary of the main HARP FRA methodology aligned with this reports' methodology is presented in the following sections along with key datasets, assumptions and limitations.

2.1.1 Source-pathway-receptor

23) Flood risk is conceptualised using the source-pathway-receptor model. For a flood risk to be present each of the three elements is required:

- A source of flood water such as a river or groundwater body
- A pathway that enables the flow of flood water from a 'source' to a 'receptor'. This could include low lying land within a floodplain or permeable strata that enable groundwater to seep to the surface, or construction activities such a tunnelling
- A receptor such as a person, property or habitat that may be impacted by a flood event.

24) Flood risk is therefore dependent on all elements being present and is assessed in terms of the probability (likelihood) of an event occurring and the consequence of the flood.

2.1.2 Probability

25) The probability of flooding in this report is defined using Annual Exceedance Probability (AEP). This is the preferred approach in comparison to the annual maximum return period (e.g. 1 in 100-year event). This is due to the potential misconception that return periods are associated with a regular occurrence rather than an average recurrence interval. For example, it is sometimes assumed that the 1 in 100-year event flood would occur once every 100-years. However, events with a magnitude of the 1 in 100-year event have a 1 % chance of being exceeded in any one year. Table 1 provides a comparison of AEP to return periods to aid the understanding of flood frequency.

Table 1: Equivalent annual exceedance probabilities and return periods

AEP	10%	3.33%	2%	1.33%	1%	0.1%
Return Period	1 in 10-year	1 in 30-year	1 in 50-year	1 in 75-year	1 in 100-year	1 in 1000-year

2.1.3 Consequence

26) The consequence of flooding is dependent on two factors:

- Exposure – For example, the number of people or properties potentially affected
- Vulnerability – The potential for people or property to be harmed or damaged.

27) Floods impact both individuals and communities, and have social, economic, and environmental consequences. These can be both negative and positive and can include direct and indirect loss.

28) With regards to development and flood risk, vulnerability is largely driven by the type of development proposed or affected.

2.1.4 Impacts

29) The assessment of the flood risk impacts as a result of the Proposed Ribble Crossing and the magnitude of the change in flood risk, considers the potential effects on all elements of flood risk including flood frequency, extent, depth, velocity and combinations of these components.

30) The duration of changes to flooding is also considered when assessing flood risk impacts, where a distinction is made between permanent changes and temporary changes where the effect would cease to be felt after a period. Temporary changes can be long-term or short term in nature.

31) Embedded mitigation measures are also considered when determining potential impacts on flood risk. These measure form part of an optimised design used to reduce the significance of flood risk effects, for example:

- Following the sequential approach to avoid placing assets, features and activities within areas at high flood risk where possible
- Designing the scheme, including construction phase, in accordance with established good practice
- Discharge surface water run-off as high up the drainage hierarchy and implementing Sustainable Drainage Systems (SuDS) where possible, to minimise the impact on the receiving watercourse.

2.1.5 Links to the Environmental Statement

32) The EIA process adopts a slightly different assessment model to flood risk (sensitivity x magnitude of change = significance), where:

- The sensitivity of a feature or resource is typically determined by, among other things, its level of designation or protection (e.g. importance, value or rarity), its susceptibility to or ability to accommodate change. Within the context of this FRA, sensitivity is a function of the likelihood of flooding and the potential consequences (i.e. baseline flood risk)
- The magnitude of change is a measure of the scale or extent of the change in the baseline condition, irrespective of the value of the feature or resource(s) affected (i.e. impact on flood risk)
- The significance of the overall flood risk is a product of the sensitivity of the resource or feature and the magnitude of the impacts.

33) Whilst the flood risk assessment model (probability x consequence = risk) will be used within this FRA, technical evidence provided in this FRA will be used to inform Chapter 8 (Flood Risk) of the Proposed Ribble Crossing ES. Annexe A therefore provides a set of assessment criteria used within the ES to define sensitivity, magnitude of change and significance.

2.2 Scope

2.2.1 Sources of information and data

34) The following readily available sources of development, flood risk information and datasets have been reviewed and assessed for the purpose of this FRA:

- Conceptual designs for the construction and operation of the Proposed Ribble Crossing provided by United Utilities
- Environment Agency Flood Map for Planning[3]
- Environment Agency Risk of Flooding from Surface Water Mapping[4]
- Environment Agency Reservoir Flood Mapping[4]
- British Geological Survey (BGS) mapping[5]
- British Geological Survey (BGS) groundwater flooding susceptibility maps[6]

[3] Environment Agency (2020) Flood Map for Planning. [Online] Available at: https://flood-map-for-planning.service.gov.uk/. [Accessed: January 2021].
[4] Environment Agency (2020) Risk of Flooding from Surface Water Mapping. [Online] Available at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map. [Accessed: January 2021].
[5] British Geological Survey (2020) Geology of Britain viewer (classic). [Online] Available at: https://mapapps.bgs.ac.uk/geologyofbritain/home.html. [Accessed: January 2021].
[6] BGS (2020) BGS Groundwater Flooding Susceptibility Dataset [Accessed: January 2021]

- Ordnance Survey Datasets including 1:25,000 scale mapping
- The Ribble Valley Strategic Flood Risk assessment[7]
- United Utilities asset data
- A web search of historical flood incidents.

2.3 Assessment Area and Sources of flood risk

35) The assessment area of the Proposed Ribble Crossing FRA is focused on the planning application boundary but also extends along the River Ribble approximately 1 km upstream and approximately 500 m downstream of the B6478 road to identify sources of flood risk and the extents of possible scheme impacts.

36) With the Proposed Ribble Crossing located within the floodplain of the River Ribble and with crossings of Ordinary Watercourses required, fluvial flood risk has been identified as the main source of potential flood risk. Environment Agency Mapping has also identified a potential risk from surface water, reservoirs and groundwater.

37) The Proposed Ribble Crossing is approximately 40 km from the River Ribble Estuary at an elevation of more than 50 m AOD. Therefore, no coastal flood risk has been identified and no further assessment is necessary. A review of Ordnance Survey mapping coupled with local site knowledge have not identified any canals in the vicinity of the Proposed Ribble Crossing that could pose a risk of flooding.

38) United Utilities has not identified any areas of sewer flood risk in close proximity to the Proposed Ribble Crossing and no discharges to the public sewer network are proposed. Failure of water mains are a potential source of flooding due to surcharging of man-made drainage systems but are unlikely to impact this type of development. Therefore, no further assessment of sewer and water mains have been undertaken.

39) No data are available on the location of local land drainage assets such as drains, channels and outflow pipes. Where these features are identified on site and affected, they would be replaced if necessary, with assets that have the same performance. Therefore, the risk of flooding, which is most commonly the result of obstructions, poor maintenance and/or blockages, is unlikely to change and no further assessment would be necessary.

40) The lifetime of the Proposed Ribble Crossing would be approximately seven years starting in 2023 as part of the enabling and construction phase of the main HARP. Therefore, the effects of climate change should not be considered in relation to this development.

41) In summary, this FRA would be focus on the following flood sources:

- Fluvial flooding
- Surface water flooding
- Groundwater flooding
- Reservoir flooding.

2.4 Limitations and assumptions

42) The flood risk assessment was undertaken with the following limitations and assumptions:

- The assessment was based on the design details that were available at the time of writing, a qualitative review of national datasets and publicly available data only
- A hydraulic river modelling and quantitative hydrological assessment is being undertaken following this flood risk assessment report. Therefore, the assessment of risk and potential scheme impacts at this stage has been determined based on a conceptual understanding of changes to flooding

[7] Ribble Valley (2010) Level 1 Strategic Flood Risk Assessment. [Online] Available at: https://www.ribblevalley.gov.uk/download/downloads/id/7085/strategic_flood_risk_assessment.pdf. [Accessed: 09 March 2021].

mechanisms. Where there was uncertainty, a precautionary approach has been taken. This assessment will be updated once the results are available

- Consultation with the Lancashire County Council (Lead Local Flood Authority) has been undertaken through virtual workshops
- No Ground Investigation (GI) has yet been undertaken and no BGS historical boreholes are located within or in the vicinity of the study area to provide data on groundwater levels. No springs are annotated on current Ordinance Survey maps within the study area. Therefore, the groundwater assessment is based on BGS mapping only
- Where elements of the Proposed Ribble Crossing design have not been completed, it is assumed that the Proposed Ribble Crossing would be designed using appropriate flood design standards and good practice to help mitigate the flood risks and potential scheme impacts. The Construction Code of Practice (CCoP) has been produced to provide an overview of appropriate flood design principles, standards and good practice to be considered at later stages of the design process.

3. Planning Policy

43) The legislation and planning policies relevant to the Proposed Ribble Crossing are considered in Volume 2, Chapter 5 of the ES.

44) The legislation and planning policies relevant to Water Environment are also considered in Volume 2, Section 7.3 of the ES.

3.1 National Planning Policy

3.1.1 National Planning Policy Framework

45) The National Planning Policy Framework (NPPF)[8] was published by the Ministry of Housing, Communities and Local Government in February 2019. This sets out the government's policies for planning in England. The Planning Practice Guidance[9] is available online to support the policy documented within the NPPF.

46) The principle aim of the NPPF assessment of flood risk is that: "Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere."

47) The NPPF requires an FRA to be produced in the following scenarios:

- All proposals for new development (including minor development and change of use) in Flood Zone 2 and 3
- Proposals in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency) or greater than one hectare in size
- Where land identified in a strategic flood risk assessment as being at increased flood risk in future
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

3.1.2 Assessment of Flood Risk

48) The flood risk from fluvial (Main Rivers) and tidal flooding is assessed through the use of the Environment Agency Flood Map for Planning (rivers and sea). This map defines three flood zones of different flood risk (the third of which is subdivided into two categories), as detailed in Table 1 of the Planning Practice Guidance (PPG):

- Zone 1 "Low probability of flooding" – This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1 % Annual Exceedance Probability (AEP))
- Zone 2 "Medium probability of flooding" – This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1 % – 0.1 % AEP), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5 % – 0.1 % AEP) in any year
- Zone 3a "High probability of flooding" – This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1 % AEP), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5 % AEP) in any year
- Zone 3b "The Functional Floodplain" – A sub-part of Zone 3, this zone comprises land where water has to flow or be stored in times of flood. This zone is not normally included within the national Flood Map for Planning and is calculated where necessary using detailed hydraulic modelling and is typically defined as areas having a 1 in 20 or greater annual probability of flooding (> 5% AEP).

[8] Ministry of Housing, Communities and Local Government (2019). National Planning Policy Framework. [Online] Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2 [Accessed: 09 March 2021].
[9] Ministry of Housing, Communities and Local Government (2019). Planning practice guidance. [Online] Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change [Accessed: 09 March 2021].

49) The NPPF requires that developers consider not just the flood risk to a development but also the impact that a development might have on flood risk elsewhere. As well as Main Rivers and the sea, it is also necessary to consider flood risk from other sources, including surface water, groundwater, Ordinary Watercourses, artificial drainage systems, canals and reservoirs, where relevant.

3.1.3 Sequential Test

50) The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding i.e. to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, sites in Flood Zone 2 should be considered. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered.

51) The Proposed Ribble Crossing would be difficult to locate entirely within Flood Zone 1 as it is required to provide access over the River Ribble to provide linkages between west and east banks and through agricultural land. However, a sequential approach has still been applied, with the Proposed Ribble Crossing located in one of the narrowest areas of the floodplain (Flood Zone 2 and 3 is approximately 125 m wide) and in an area with no property immediately upstream. This embedded mitigation enables flood risk and potential impacts to be limited as far as practicable. It is therefore considered that the Sequential Test has been passed.

3.1.4 Vulnerability Classification

52) Since the Proposed Ribble Crossing would be in Flood Zone 3, it is necessary to take into account the flood risk vulnerability of land uses and if necessary, apply the Exception Test.

53) Table 2 [10] illustrates the flood risk vulnerability categories and flood zone compatibility matrix for England from the NPPF. The Proposed Ribble Crossing forms part of the HARP, which as water transmission infrastructure is considered to be water-compatible development and therefore appropriate within all flood zones providing that it would remain safe and not result in an increase in flood risk elsewhere.

Table 2: Flood Risk Vulnerability and Flood Zone Compatibility.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water-compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	X	Exception Test required	✓	✓
Zone 3b	Exception Test required	X	X	X	✓

[10] Ministry of Housing, Communities and Local Government (2019). Planning practice guidance. Table 3: Flood risk vulnerability and flood zone 'compatibility'. [Online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/575184/Table_3_-_Flood_risk_vulnerability_and_flood_zone__compatibility_.pdf [Accessed: 09 March 2021].

3.1.5 Exception Test

54) The Exception Test, as set out in paragraph 160 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available. For the Exception Test to be passed it should be demonstrated that:

- *"The development would provide wider sustainability benefits to the community that outweigh the flood risk*
- *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."*[11]

55) As outlined in Section 8.1.4, the Proposed Ribble Crossing is categorised as water-compatible development and therefore the Exception Test is not applicable. However, given the sensitivity of the location, this FRA has been carried out to show that the Proposed Ribble Crossing would be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.

3.2 Local Planning Policy

56) NPPF is supplemented at a local level by development and flood risk policies put in place by the local authorities. The main documents which form Ribble Valley Borough Council's local planning policy relating to flood risk management is detailed below.

3.2.1 Ribble Valley Strategic Flood Risk Assessment (SFRA) Level One – May 2010[12]

57) The SFRA forms an integral part of the Ribble Valley Borough Council's flood risk and planning evidence base in terms of identifying locations for development and preparation of flood risk policies. The SFRA assess all types of flood risk across the Ribble catchment by using generalised and detailed model results supplied by the Environment Agency and existing Flood Zone mapping.

58) For the Clitheroe Policy Unit, the preferred policy is to take further action to reduce flood risk in this area. Policy DP9 also encourages new development to include adaptation to climate change. It emphasises the protection of the most versatile agricultural land and the use of SuDS techniques for transport development. Mitigation measures must be incorporated in any development that, exceptionally, must be placed in areas of current or future flood risk.

3.2.2 Lancashire and Blackpool Local Flood Risk Management Strategy – Oct 2013[13]

59) This strategy should be consulted as part of the planning process to ensure that flood risk management issues are adequately considered. Section 6 of the strategy covers spatial planning and SuDS including two Strategic Objectives:

- Development should be managed so that it reduces flood risk
- The use of SuDS should be promoted.

60) SuDS became part of a wider land management considerations for the planning process aimed at reducing surface run off and diffuse pollution. Since the strategy was published in 2013, the Government made amendments to the NPPF to stipulate that decisions on planning applications relating to major

[11] Ministry of Housing, Communities and Local Government (2019). National Planning Policy Framework. [Online] Available at: https://www.gov.uk/guidance/national-planning-policy-framework/14-meeting-the-challenge-of-climate-change-flooding-and-coastal-change#para160 [Accessed: 09 March 2021].
[12] Ribble Valley Strategic Flood Risk Assessment (2010). [Online] Available at: https://www.ribblevalley.gov.uk/download/downloads/id/7085/strategic_flood_risk_assessment.pdf [Accessed: 09 March 2021].
[13] Lancashire County Council and Blackpool Council (2013). Lancashire and Blackpool Local Flood Risk Management Strategy. [Online] Available at: https://www.lancashire.gov.uk/media/900474/lancashire-and-blackpool-local-flood-risk-management-strategy-consultation-draft.pdf [Accessed: 09 March 2021].

developments (ten dwellings, or equivalent non-residential developments) should ensure that SuDS are put in place, unless demonstrated to be inappropriate.

3.2.3 Ribble: Catchment flood management plan – Dec 2009[14]

61) This plan provides an overview of the flood risk across the River Ribble Catchment and recommended ways of managing the flood risk now and over the next 50 to 100 years.

62) The Clitheroe sub-area is located downstream from the Proposed Ribble Crossing, which falls into areas of moderate to high flood risk where we can generally take further action to reduce flood risk. Appropriate highways drainage would need to be implemented to avoid increased flood risk downstream. The policy promotes the application of rigorous planning control for any new development in and around Clitheroe using the principles in Planning Policy Statement 25 and encourage the implementation of SuDS.

[14] Environment Agency (2009). Ribble: Catchment flood management plan. [Online] Available at: https://www.gov.uk/government/publications/ribble-catchment-flood-management-plan [Accessed: 09 March 2021].

4. Assessment of Flood Risk

63) This section of the FRA focuses on both the flood risk to the Proposed Ribble Crossing and potential impacts it would have on flood risk. The assessment includes consideration of temporary construction compound sites, associated features, temporary access tracks and surface water drainage.

4.1 Existing Land Use and Topography

64) The landscape in the vicinity of the Proposed Ribble Crossing consists predominantly of agricultural fields with grassland and farmsteads. There are numerous footpaths throughout the red line boundary of the Proposed Ribble Crossing.

65) Nationally and internationally designated Sites[15] in proximity to the Proposed Ribble Crossing include:

- Forest of Bowland, which is an Area of Outstanding Natural Beauty (AONB) and located adjacent to the other side of West Bradford Road to the north from the Proposed Scheme
- Cross Hill Quarry, which is a Local Nature Reserve (LNR) and located approximately 500 m to the south from the Proposed Ribble Crossing
- Coplow Quarry, which is a Sites of Specific Scientific Interest (SSSI) and located approximately 1 km to the south from the Proposed Ribble Crossing.

66) Light Detection and Ranging (LiDAR) data show the changes in height across the surface within the vicinity of the Proposed Ribble Crossing. Topographically, the high point within the red line boundary is at the northern end of the Proposed Ribble Crossing on the West Bradford Road at the junction with the proposed access road. The land here is nearly 81 m Above Ordnance Datum (AOD) and it falls to the south-east to a level of approximately 60 m AOD at bridge crossing of the Proposed Ribble Crossing. South of the Ribble, land rises up to approximately 63 m AOD at the east end of the Proposed Ribble Crossing and the southern junction with West Bradford Road.

4.2 Hydrology

67) The Main Rivers within the assessment area are the River Ribble, Waddington Brook and West Bradford Brook.

68) The River Ribble is the main hydrological point of interest and source of flooding in the area. The River Ribble flows from northeast to southwest direction. The catchment area[16] for the River Ribble upstream (NGR: SD 74404 43875) of the Proposed Ribble Crossing is approximately 390 km^2. The watershed runs approximately from north to south from Gayle Moor in the Yorkshire Dales National Park to the Proposed Ribble Crossing. The River Ribble catchment has a predominately agricultural land use with small urban areas dispersed throughout the catchment.

69) Approximately 100 m upstream of the Proposed Ribble Crossing, the River Ribble is crossed by an existing bridge which carries the West Bradford Road north towards the village of West Bradford. This historic bridge comprises four masonry arches which are supported by three piers within the river channel.

70) The Ordinary Watercourses within the assessment area from east to west along the River Ribble are Moor Roads Sike, Unnamed Watercourse 2100, Unnamed Watercourse 2099, Unnamed Watercourse 2097, Greg Sike, Coplow Brook, and Unnamed Watercourse 2098. Four of them are present within the Proposed Ribble Crossing planning application boundary. These are identified on Figure 8.2 and are summarised below:

- Coplow Brook would be crossed approximately 200 m downstream of the existing West Bradford Road culvert crossing. The catchment area at the proposed crossing location would be 0.95 km^2

[15] DEFRA Multi-Agency Geographic Information for the Countryside (MAGIC) online mapping tool. [Online] Available at: https://magic.defra.gov.uk/MagicMap.aspx. [Accessed: February 2021].
[16] Flood Estimation Handbook (FEH) Web Service. [Online] Available at: https://fehweb.ceh.ac.uk/. [Accessed: February 2021].

- Greg Sike would be crossed at a point approximately 650 m south of West Bradford Road between Waddington and West Bradford. Its catchment at this point would be approximately 1 km^2. Two culvert crossings to provide field access have been identified upstream of the proposed crossing
- Unnamed Watercourse 2097 would be crossed at a point approximately 650 m south of West Bradford Road. The catchment of this watercourse is approximately 0.1 km^2. A culvert providing field access is located approximately 30 m upstream of the proposed crossing
- Unnamed Watercourse 2099 is located to the south of the River Ribble. It would not be crossed by the Proposed Ribble Crossing and with a catchment area of less than 0.1 km^2 it is likely to be ephemeral.

71) Outside of the planning application boundary, immediately to the north of the Proposed Ribble Crossing, is the confluence of the River Ribble and West Bradford Brook (Main River, NGR: SD 74588 44167) and approximately 40 m further upstream is the confluence of the Moor Roads Sike (Ordinary Watercourse, NGR: SD 74627 44194). West Bradford Brook at this point has a catchment area of approximately 4.59 km^2 and Moor Roads Sike has a catchment area of approximately 1 km^2.

72) Immediately to the south of the planning application boundary of the Proposed Ribble Crossing there is the confluence of the River Ribble and Waddington Brook (Main River, NGR: SD 74012 43438). Waddington Brook at this point has a catchment area of approximately 5.20 km^2.

73) Existing receptors within the assessment area include:

- The local road network (Clitheroe Road, West Bradford Road)
- Approximately ten residential properties within Flood Zone 2 in West Bradford upstream of the Proposed Ribble Crossing
- The Hanson Cement quarry located on the left (southern) bank
- Isolated farm properties and pastoral farmland.

74) A hydrological study is currently being undertaken by Jacobs to support the hydraulic modelling of the watercourses within the assessment area.

4.3 Soils, Geology and Hydrogeology

75) Pending the results of a detailed ground investigation (GI), geological data have been obtained from the British Geological Survey (BGS) online mapping viewer.[17] Hydrogeological information has been obtained from the DEFRA MAGIC online mapping tool.

76) The majority of the area consists of slowly permeable seasonally wet acid loamy and clayey soils, which drains to the stream network. However, the soil of the east side of the River Ribble is freely draining slightly acid but base-rich, which drains to the groundwater.[18]

77) The underlying bedrock geology comprises the Clitheroe Limestone Formation and Hodder Mudstone Formation. This was formed approximately 337 to 347 million years ago in an environment dominated by shallow carbonate seas. The rocks comprising carbonate material (coral, shell fragments), forming beds and locally reefs.

78) The overlying superficial deposits largely comprise Alluvium - Clay, Silt, Sand and Gravel. These rocks were formed up to two million years ago in the Quaternary Period. Glacial deposits are also recorded.

79) There are no GI or historical BGS boreholes within the site of the Proposed Ribble Crossing to confirm the geology or prove otherwise. However, the crossing and the access road linking it to West Bradford Road to the south is expected to directly cross all the superficial lithologies.

80) The Environment Agency's aquifer designation maps indicate that the assessment area is underlain by bedrock designated as a Secondary A aquifer. This classification refers to aquifers with '*permeable layers capable of supporting water supplies at a local level rather than a strategic scale, and in some case*

[17] The British Geological Survey online tool [Online]. Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html.
[18] Cranfield University, Soilscapes mapping tool [Online]. Available at: http://www.landis.org.uk/soilscapes/. [Accessed: February 2021].

forming an important source of base flow to rivers. These are generally aquifers formally classified as minor aquifers."[19]

81) The superficial deposits are designated as Secondary (undifferentiated) aquifers. These are layers assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

82) The groundwater-bearing Glacial Till is designated as a Secondary Undifferentiated aquifer by the Environment Agency and the BGS with each bedrock formation designated as Secondary A aquifers. This means that each of the bedrock aquifers contain permeable layers of rock capable of supporting water supplies at a local scale with Glacial Till having the potential to store and yield limited amounts of groundwater which are potentially important to river baseflow and abstractions at a local scale only.

83) The assessment area falls within a Groundwater Vulnerability Zone classified as Medium at the east bank of the River Ribble, which become Medium-Low and Low for the majority of the assessment area. The whole assessment area lies within soluble rock risk category.

4.4 Fluvial Flood Risk

84) This section of the report includes details of the baseline fluvial flood risk, the potential effects and the likely magnitude of impacts as a result of the proposed scheme.

85) Fluvial flooding refers to flooding from rivers, streams and other inland watercourses. Fluvial flooding is usually caused by prolonged or intense rainfall, generating high rates of runoff which overwhelm the capacity of the channel. When this occurs, excess water spills onto low-lying areas of land adjacent to the channel.

86) Fluvial flood risk can be divided between risk from Main Rivers and risk from Ordinary Watercourses. Main Rivers are usually larger rivers and streams where the Environment Agency carries out maintenance, improvement or construction work to manage flood risk. Ordinary Watercourses are any other watercourses not designated as Main Rivers.

4.4.1 Fluvial flood risk to the Proposed Ribble Crossing

87) During the outline design stage of the Proposed Ribble Crossing, several temporary road routes and bridge locations were considered taking into account a range of design and environmental considerations including flood risk. The location of the proposed temporary haul road and temporary bridge crossing has been confirmed in January 2021, as it is believed to be the best location due to the stable straight channel, the relatively narrow floodplain and its proximity to the existing road network (see Proposed Marl Hill Section Planning Application Drawings belonging to the RVBC-MH-APP-04 series).

Risk from Main Rivers

88) The Environment Agency Flood Map for Planning (FMfP) as illustrated in Figure 8.2 shows the extents of Flood Zone 2 and 3. The Strategic Flood Risk Assessments (SFRA) for Ribble Valley adds that all rural/undeveloped sites within Flood Zone 3 should also be considered as "potential" areas of Functional Floodplain (Flood Zone 3b) as a precautionary approach to development. Therefore, the development envelope of the Proposed Ribble Crossing potentially could be associated with Flood Zone 3b.

89) Table 3 provides a summary of the fluvial flood risk to enabling phase works from Main Rivers. This identifies that significant elements of the enabling works would take place within Flood Zone 3 and would therefore be at risk from fluvial flood events with a probability of greater than 1 % AEP and are considered to be at high risk of flooding. The central laydown area is located in Flood Zone 2 and would be at risk from flood events with a probability of between 1 % and 0.1 % AEP.

[19] Environment Agency – Aquifers. [Online] Available at: http://apps.environment-agency.gov.uk/wiyby/117020.aspx. [Accessed: February 2021].

Table 3: Summary of probability of fluvial flooding from Main Rivers

Enabling phase works	Summary of risk
Left bank laydown area	Half of the area is in Flood Zone 3 including welfare location and generators, topsoil storage is in Flood Zone 1.
Right bank laydown area	Almost the whole area is in Flood Zone 3 including welfare location and generators.
Central laydown area	Approximately a quarter of the area is in Flood Zone 2, welfare location and generators are in Flood Zone 1.
Northern laydown area	The whole area is in Flood Zone 1.
Temporary construction access track to the right bank laydown area	The whole track is in Flood Zone 3.

90) The Environment Agency's Historic Flood Map and Recorded Flood Outlines data sets have been reviewed and no flooding has been recorded at the location of the Proposed Ribble Crossing. A web search has also been undertaken which has not identified any flood events in the location of the Proposed Ribble Crossing. However, given the rural location, it is possible that flood events have not been recorded.

91) Without detailed modelling or reliable evidence of flood history, it is not possible to refine the assessment of the likelihood of flooding beyond that indicated by the Environment Agency Flood maps. The risk to the Proposed Ribble Crossing will be re-assessed following completion of the ongoing hydraulic modelling. A hydraulic modelling report will be submitted to the Local Planning Authority under separate cover from the main planning submission.

92) Although the probability of flooding is high, good practice measures within the CoCP including micro-siting of sensitive equipment to try to avoid the areas of high risk, monitoring and evacuation plans would ensure that the consequences of flooding would be low. Therefore, the overall flood risk to the enabling works is considered to be low.

93) Whilst the design of the bridge has not yet been finalised, the bridge piers would be located within Flood Zone 3 with a high probability of flooding. However, the bridge soffit would be placed above the level of the 1 % AEP flood level + 600 mm freeboard in accordance with the standard design requirements of the Environment Agency. Therefore, the probability of floodwater overtopping the bridge structure would be low.

94) In contrast, sections of the road leading from the bridge would run through the floodplain and be located within Flood Zone 3 but would be constructed at grade. Therefore, the probability of flooding from the River Ribble would be high. The application of good practice detailed with the CCoP including the subscription to flood warnings and a flood response plan to manage the closure of the road and the removal of staff and equipment from the floodplain would ensure that the consequences of flooding would be limited to temporary disruption.

95) In summary, although the likelihood of flooding from Main Rivers is high, the likely consequences are considered to be low and the overall flood risk is also considered to be low. Therefore, no additional mitigation requirements have been identified.

96) There would be a residual risk from events greater than 1 % AEP but given the assumed seven-year design life this is considered to be low.

Risk from Ordinary Watercourses

97) The Proposed Ribble Crossing would involve the crossing of three Ordinary Watercourses (Unnamed Watercourse 2097, Greg Sike, and Coplow Brook). The Ordinary Watercourses individually are not

included in the Environment Agency FMfP although their confluences with the River Ribble are located within Flood Zones 2 and 3. Therefore, the probability of flooding along the whole length of these watercourses has been inferred from the Environment Agency's Risk of Flooding from Surface Water Mapping, which is presented in Figure 8.3.

98) The mapping shows that flooding from these Ordinary Watercourses is generally restricted to narrow floodplains with a generally low probability of flooding (between the 1 % and 0.1 % AEP) although areas of higher flood probability do exist, especially between Coplow Brook and Waddington Brook. Flood depths would be shallow (less than 300 mm) for most cases except along Coplow Brook, where depths of up to 900 mm could be experienced.

99) All the four temporary construction laydown areas including welfare and generator locations would be located within areas with a low probability of flooding from Ordinary Watercourses.

100) Crossings of these watercourses would include use of single span structures and the setting of the soffit level above the 1 % AEP flood level + 600 mm freeboard. Therefore, the probability of the road being flooded from these watercourses is considered to be low. Good practice including a flood response plan would reduce the consequences of any flooding and would ensure that the risk from Ordinary Watercourses is low.

101) There would be a residual risk from events greater than 1 % AEP but given the assumed seven-year design life this is considered to be low.

4.4.2 Impacts on fluvial flood risk from the Proposed Ribble Crossing

102) Embedded mitigation has been incorporated into the design of the Proposed Ribble Crossing to avoid or reduce the magnitude of the following potential fluvial flood risk impacts:

- Temporary loss of storage volume within the River Ribble floodplain
- The temporary restriction of flood flows within the River Ribble floodplain
- The temporary constriction of flood flows within the three Ordinary Watercourses that would be crossed
- Temporary increase in runoff rates entering watercourses due to an increase in hard standing associated with access road and compound sites
- Temporary increase in the risk of blockages
- Temporary discharges of groundwater entering watercourses from excavations activities.

103) Due to the width of the floodplain at the Proposed Ribble Crossing, it would not be practical to cross the River Ribble in a single span and avoid any impacts. However, embedded mitigation measures including the road being constructed at grade and the used of slender bridge piers rather than an embankment would minimise loss of floodplain storage. The volume of storage that would be lost has not been quantified but is likely to be negligible compared to the floodplain within Flood Zone 3 as inferred from the Environment Agency's Flood Map for Planning. Without a detailed analysis of floodplain losses, a precautionary approach has been taken and it is assumed that the loss of floodplain storage would have result in a minor increase in flood depths within farmland across the assessment area due to the bridge piers and embankment in the floodplain. As such mitigation measures should be considered which are detailed in Section 8.8.

104) Structures within the floodplain of the River Ribble including piers and bridge embankments would also act as a barrier to floodplain flow. Embedded mitigation measures including the slender piers and a flood relief culvert would ensure that this effect would be minimised, but it is likely that flood waters would back up behind the structures within the floodplain. Based on a conceptual assessment of flood risk, the potential impacts would be as follows:

- The onset of flooding would not change. The existing West Bradford Road Bridge located 100 m upstream of the proposed Ribble Crossing would have a smaller capacity than the proposed bridge.

Therefore, floodwater is likely to back up behind the existing bridge before overtopping into the downstream floodplain. This mechanism would not be changed by the proposed bridge

- The extent of flooding is predicted to increase, but the magnitude of this change would be negligible. The topography rises relatively steeply on either side of the floodplain and therefore, whilst depths may increase, the effect of this on flood extents would be negligible and no new flood-sensitive land uses are predicted to be exposed to flooding
- The depth of flooding is predicted to increase. Although it is not possible to quantify the increase in flood depth without hydraulic modelling[20] it is predicted that the magnitude of the effect on flood depth within pastoral farmland would be moderate. With the existing Clitheroe Road bridge forming a hydraulic break, it is predicted that the magnitude of the effect on flood depth at Clitheroe Road and upstream of this point would be negligible.

105) Increase in blockage risk is considered to be unlikely because the existing upstream bridge has a smaller capacity and structures within the channel and is therefore more likely to trap large debris carried in upstream flows. The proposed bridge across the Ribble would have a high level so is unlikely to block. Good practice measures including maintenance and monitoring of the bridge by United Utilities would also ensure this impact would be negligible.

106) The proposed access road and the proposed construction compounds are located on existing greenfield sites currently comprising agricultural land. The compaction of soil and the creation of impermeable surfaces associated with the proposed construction compounds have the potential to increase the rate of surface water runoff which could have impacts on or fluvial flood risk within the receiving watercourses. However, the management of surface water runoff using the proposed surface water drainage system (see Section 8.3) would reduce runoff to greenfield rates would ensure that magnitude of any effects on surface water or fluvial flood risk would be negligible.

107) In summary, although the impact on surface water runoff and blockage on fluvial flood risk would be negligible, it is predicted that there are likely to be temporary adverse impacts on fluvial flood risk due to the constriction of flows and the loss of floodplain volume. Therefore, additional mitigation would be required which is detailed in Section 4.8.

108) Embedded mitigation including the road being constructed at grade and clear span crossings of Ordinary Watercourses with the soffit level set 600 mm above the predicted peak 1 % AEP flood level would ensure that flow would not be constricted and that the loss of floodplain storage would be negligible. Existing culvert crossings have been identified upstream of each of the proposed crossings which are likely to already constrict flow. Therefore, the magnitude of the effect on the onset, extent and depth of flooding due to the proposed Ordinary Watercourse crossings would be negligible and no additional mitigation is proposed.

4.5 Surface Water Flood Risk

109) Surface water flooding is defined as water flowing over the ground that has not yet entered a drainage system or watercourse. It usually occurs as a result of an intense period of rainfall, which exceeds the infiltration capacity of the ground or sewer system.

4.5.1 Surface water flood risk to the Proposed Ribble Crossing

110) The Environment Agency's Risk of Flooding from Surface Water mapping indicates that the probability of surface water flooding across the red line boundary is generally very low (less than 0.1% AEP). However, localised areas of risk along surface water flowpaths or areas or ponding have been identified as shown on Figure 8.4. These areas include:

- At the eastern end of the Proposed Ribble Crossing, the junction of West Bradford Road to the south of the Ribble would be at risk of flooding to a depth of less than 300 mm during the 1 % AEP rainfall event

[20] A hydraulic modelling report will be submitted to the Local Planning Authority under separate cover from the main planning submission.

- The construction compound on the right (north) bank of the River Ribble at the eastern end of the planning application boundary would be at risk of flooding to a depth of less than 300 mm during the 1 % AEP flood event
- A section of road approximately 5 m long immediately east of the central laydown area would flood to a depth of less than 300 mm during the 0.1 % AEP flood event
- A surface water flowpath up to 900 mm deep would form during the 3.33 % AEP flood event immediately to the south of the proposed crossing of Coplow Brook.

111) Embedded mitigation in the form of drainage around construction compounds and along the road would ensure that shallow surface water flooding is managed safely and would ensure that the risk of flooding to the Proposed Ribble Crossing would be low.

112) Good practice detailed with the CCoP would be applied during the design of the track and compounds to ensure that additional drainage features such as cross drains are included to reduce the risk of flooding along the road. In the event of an extreme rainfall event and localised surface water flooding, a flood response plan would be in place to manage the safety of staff and equipment on site.

113) In summary, although localised areas of moderate to high surface water flood risk have been identified, embedded mitigation measures and good practice would ensure that the risk to the Ribble Crossing from surface water would be low.

4.5.2 Impacts on surface water flood risk from the Proposed Ribble Crossing

114) Land within the assessment area currently comprises agricultural land. The development of the temporary haul route and associated features are likely to increase the area of impermeable surfaces due to the road surface, which is proposed to be of tarmac construction based on a stone aggregate foundation. Therefore, it would increase the rate of surface water runoff. Uncontrolled, any increase in runoff could increase the risk of surface water flooding downstream through the surface water catchment or to the discharge location.

115) In line with NPPF, surface water management strategies would be developed for the Proposed Ribble Crossing assessment area with the focus on the temporary access road and bridge.

116) The proposed drainage strategy would include:

- The placement of stockpiles of materials outside of areas of surface water flood risk
- A system serving the compounds that captures runoff and drain to attenuation lagoons prior to discharge to the River Ribble.

117) The impacts on surface water runoff associated with the compounds and laydown areas during construction phase would not be experienced in the operational phase of the Proposed Ribble Crossing as they would be restored back to agricultural land.

118) The establishment of temporary compounds and laydown areas to enable the decommissioning would have the potential to result in increase in surface water runoff as during construction phase. Mitigation would be the same as during construction with temporary drainage managing runoff to ensure that the impact on flood risk would be negligible.

119) The proposed surface water drainage would manage any potential increase in surface water runoff rates as a result of the Proposed Ribble Crossing and as a result, the impact on surface water flood risk would be negligible.

4.6 Groundwater Flood Risk

120) Groundwater flood risk refers to either a rise in the water table or lowering of the ground level leading to an increased likelihood of flooding at the ground surface. The magnitude of the change in groundwater levels relative to the ground surface and spatial extent affected is considered for this assessment of groundwater flood risk impacts.

4.6.1 Groundwater flood sources

121) Groundwater is stored in both superficial aquifers, typically of Glacial Till, and underlying bedrock aquifers which is discussed in Volume 6 Chapter 7.

122) The aquifer units present are described in Section 8.3 and include Alluvium and underlying bedrock comprising Clitheroe Limestone Formation and Hodder Mudstone Formation.

123) No springs are annotated on current Ordinance Survey maps within the assessment area. However, it is considered likely that shallow groundwater flow follows the topography towards the River Ribble.

4.6.2 Groundwater flood risk to the Proposed Ribble Crossing

124) The temporary access route across the River Ribble is immediately adjacent to the River Ribble itself and minor tributaries. As groundwater is likely to be in continuity with river levels, emergence of groundwater is likely to be indistinguishable from fluvial flooding which is assessed in Section 8.4.

125) Below ground elements of the construction and enabling works such as foundations would be designed in accordance with good practice following a ground investigation to ensure that they would be designed with regard to local groundwater conditions. This would ensure that the risk from groundwater flooding would be low.

4.6.3 Impacts on groundwater flood risk from the Proposed Ribble Crossing

126) Earthworks associated with the construction of laydown areas, topsoil storage, welfare and generator locations, attenuation ponds as part of the drainage system have the potential to encounter groundwater. These works have therefore the potential to allow groundwater to flood excavation areas and reach the surface.

127) Excavations, relating mainly to construction of bridge foundations, would have the potential to result in localised disturbance of groundwater flow and the potential release of artesian pressures. However, the localised scale of the works combined with good practice design following a GI would reduce the magnitude of any impacts on groundwater flooding to negligible levels.

4.7 Reservoir Flood Risk

128) Flooding could also occur due to the collapse and/or failure of man-made water retaining features such as hydro-dams, water supply reservoirs, canals, flood defences structures, underground conduits, and water treatment tanks or pumping stations. No canals or flood defences have been identified within the vicinity of the Proposed Ribble Crossing and therefore, the assessment of flooding from artificial infrastructure is focussed on reservoirs.

129) Reservoir failure can be a particularly dangerous form of flooding as it results in the sudden release of large volumes of water that can flow rapidly. This can result in deep and widespread flooding, potentially resulting in significant damage. The likelihood of reservoir flooding occurring is however extremely low even with all large reservoirs (over 25,000 m^3) managed in accordance with the Reservoirs Act 1975.

4.7.1 Reservoir flood sources

130) There is one covered reservoir located approximately 2 km upstream of the northern extent of Proposed Ribble Crossing, called West Bradford Reservoir.

131) The Environment Agency's online reservoir flood mapping (Figure 8.5) illustrates the maximum flood extents from reservoir failure along the Proposed Ribble Crossing.

4.7.2 Reservoir flood risk to the Proposed Ribble Crossing

132) Environment Agency reservoir flood mapping indicates that the Proposed Ribble Crossing would be located within the maximum extent of potential reservoir flooding. Therefore, failure of this reservoir would pose a risk to the access road and the temporary bridge across the River Ribble and the construction works associated with these scheme elements. Maximum flood depths of more than 2 m

and maximum flow velocities of more than 2 m/s are predicted along the River Ribble in the event of a reservoir failure.

133) Failure of any reservoir would be however highly unlikely during the enabling and construction phase of the Proposed Ribble Crossing. Good practice mitigation in the form a flood response plan which included subscription to flood warnings and an evacuation plan is outlined in the CCoP. This would also ensure that the consequences of a reservoir flood to the Proposed Ribble Crossing would be low. Therefore, the overall risk is low, and no additional mitigation is needed.

4.7.3 Impacts on reservoir flood risk from the Proposed Ribble Crossing

134) The Proposed Ribble Crossing would be located downstream and remote from West Bradford Reservoir. Therefore, no mechanism has been identified by which the Proposed Ribble Crossing would increase the likelihood of reservoir failure.

135) The proposed temporary bridge across the River Ribble would act as a barrier to flood flow in the unlikely event of a reservoir failure and would have the potential to increase flood levels upstream of the structure through the floodplain. However, any impact in the vicinity of the bridge would be confined by the topography of the area and no new receptors would be likely to be affected. Increases in flood depth would have a negligible impact on overall flood risk.

136) The impact of the enabling and construction phase activities of the Proposed Ribble Crossing on reservoir flooding would therefore be negligible.

4.8 Mitigation

137) Embedded mitigation and good practice measures would ensure that most potential impacts on flood risk would be negligible. However, this conceptual assessment of risk has identified that the Proposed Ribble Crossings would have the potential to have adverse impacts on fluvial flood risk within the River Ribble.

138) The first stage to mitigating these impacts will be to undertake hydraulic modelling to confirm the baseline flood risk. This will inform the optimisation of the design to reduce the impacts on flood risk. If, following design optimisation impacts on flood risk remain, additional mitigation options would be assessed. These would include the investigation of conveyance improvements and/or floodplain storage; and agreements with landowners to compensate them for temporary adverse impacts.

139) The results of the hydraulic modelling along with details of any further mitigation will be presented in a supplemental report to be submitted under separate cover.

140) To manage the risk of flooding to workers during the construction of the bridge a flood plan would be developed as part of the Construction Code of Practice. The contractor would subscribe to the Environment Agency's Flood Warning service for the Upper River Ribble, Hodder Flood Alert Area and/or River Ribble at Low Moor, Clitheroe Flood Warning Rapid Response Area downstream[21]. Water levels and weather forecasts would also be monitored. Proactive measures would be implemented if required, including removing workers and equipment from the floodplain prior to a flood event occurring. This plan should be supplemented by flood frequency and level information taken from the detailed hydraulic modelling undertaken prior to construction commencing. During construction of the bridge, these measures would manage the risk of fluvial flooding to an acceptable low level, with consequences likely to be limited to short-term (hours to days) construction programme delays.

[21] Environment Agency (2021). Sign up for flood warnings. [Online] Available from: https://www.fws.environment-agency.gov.uk/app/olr/towncitydetails?method=selectedTownCity&selectedTownCity=CLITHEROE [Accessed: March 2021].

5. Summary and Conclusions

5.1 Summary

141) This FRA has been prepared to support the planning application for the Proposed Ribble Crossing, which includes temporary features to provide road access to construction traffic associated with the Haweswater Aqueduct Resilience Programme (HARP). The Proposed Ribble Crossing would be located approximately 2 km north of Clitheroe town centre and to the south of West Bradford.

142) The FRA focuses on the following key high risk or high impact activities or features associated with the enabling, construction and decommission of the Proposed Ribble Crossing:

- Temporary laydown sites, associated features, temporary construction access track and surface water drainage associated with the enabling and construction phases of the Proposed Ribble Crossing
- Management of groundwater intercepted during excavation works
- A temporary access road and bridge crossing over the River Ribble
- Temporary access road crossings of three Ordinary Watercourses.

143) The proposed Ribble Crossing would be primarily located within Flood Zone 1; however, the bridge over the River Ribble and parts of the access road would be located in Flood Zone 3 and 2, which is unavoidable. A sequential approach has been applied, with the Proposed Ribble Crossing located in one of the narrowest areas of the floodplain (Flood Zone 2 and 3 is approximately 125 m wide) and in an area with no property immediately upstream, so that flood risk and potential impacts are limited as far as reasonably possible through the placement of the proposed scheme. It is therefore considered that the Sequential Test has been passed.

144) As the Proposed Ribble Crossing is proposed in support of the Proposed Marl Hill Section it is considered to be water-compatible development, which the NPPF considers to be appropriate across all flood zones. Due to the form and location of the Proposed Ribble Crossing in this high flood risk area, this FRA has been undertaken to demonstrate that the development would be safe from flooding and not increase flood risk elsewhere.

145) The assessment of flood risk is largely based on a qualitative assessment of national flood risk datasets provided by several Risk Management Authorities including the Environment Agency, Lancashire County Council and United Utilities.

146) Table 4 provides a summary of the assessment of flood risk. This assessment has considered the embedded mitigation contained (e.g. flood design standards) within the design process and good practice that would be applied during the construction and operational phases of the proposed Ribble Crossing. Where additional mitigation over and above that embedded into the design or covered by good practice, this has been identified.

Table 4: Flood risk assessment summary

Flood Assessment	Fluvial	Surface Water	Groundwater	Reservoir
Flood Risks	High	Low	Low	Low
Flood Risk Impacts	Moderate	Negligible	Negligible	Negligible
Additional Mitigation	Yes	No	No	No

147) The Proposed Ribble Crossing has been identified as being at high risk of fluvial flooding from the River Ribble and the Ordinary Watercourses. Whilst the soffit of the River Ribble bridge and access road bridges over the Ordinary Watercourses would be designed above the 1% AEP peak flood level plus 600 mm to reduce flood risks and flood risk impacts, the access roads leading to the bridges would run through the floodplain at grade and would therefore be at risk of flooding.

148) Since no hydraulic model of the River Ribble was available at the time of drafting this FRA, the assessment has been based on a conceptual understanding gained from Environment Agency Flood Maps. The actual onset of fluvial flooding to the access roads and potential fluvial flood risk impacts as a result of all features in the floodplain is difficult to define without such detailed hydraulic models. A precautionary approach has therefore been taken and it is considered likely that adverse impacts would occur. It is considered that these adverse impacts would be limited to minor temporary increases in flood depth over agricultural land located within existing areas of floodplain. Additionally, the risk of fluvial flooding of the access roads would be managed through good practice such as the development of flood response plans. Given the level of risk and potential impacts, however, additional mitigation could therefore be required.

149) Risks from all other identified sources are generally low, except for localised areas with a high probability of surface water flooding. Surface water drainage associated with the compound sites and the road, together with the application of good practice, would ensure that the risk posed to these features and the temporary impacts of the development would be low.

5.2 Conclusions

150) This FRA has been undertaken in line with the NPPF and local development and flood risk policy and guidance. Where reasonably practicable, steps have been taken to manage flood risks and limit potential flood risk impacts from all sources through the alignment of the Proposed Ribble Crossing and through embedded mitigation.

151) Given the flood risk evidence available, a precautionary approach has been adopted and a potential risk of fluvial flood risk to the scheme and a potential impact of fluvial flood risk elsewhere have been identified. Whilst the magnitude of the impact is considered unlikely to be greater than moderate and limited to areas of existing floodplain, it has been recommended that a hydraulic modelling study is undertaken to accurately quantify these impacts, with the results used to inform the detailed design process and the development of any additional mitigation if required. Due to the area of land enclosed within the planning application boundary, it is considered that if additional mitigation is required, then it could be accommodated within the planning application boundary and would not require additional development works outside the application boundary. The results of the hydraulic modelling and the detailed design process will be presented in due course under separate cover.

Annexe A: EIA Assessment Criteria

A.1 Baseline Sensitivity

The baseline sensitivity for flood sources considers the:

- Probability (likelihood) of flooding from the flood source considered e.g. Main Rivers, Ordinary Watercourses, groundwater etc. (the primary receptor) using probability values used by the Environment Agency on flood zone data; and
- Consequences of flooding as indicated by the vulnerability of receptors at risk (property, infrastructure, agricultural land etc.) using vulnerability classifications within NPPF.

Baseline sensitivity criteria are shown in Table A-1.

Table A-1: Baseline sensitivity criteria

Sensitivity Importance	Criteria
Low	▪ Fluvial - Land having a less than 0.1% AEP of river flooding (Flood Zone 1) ▪ Surface water - Land having between 1% and 0.1% AEP of flooding from surface water ▪ Groundwater - areas with limited potential for groundwater flooding to occur ▪ Artificial infrastructure - Areas at risk of flooding from failures of water infrastructure or ▪ Land use that is defined within the NPPF as water compatible.
Medium	▪ Fluvial- Land having between 1% and 0.1% AEP of river flooding (Flood Zone 2) ▪ Surface water - Land having between a 1% and 3.3% AEP of flooding from surface water ▪ Groundwater - Areas with potential for groundwater flooding to receptors situated below ground level ▪ Land use including productive farmland or unclassified roads.
High	▪ Fluvial - Land having a greater than 1% AEP of river flooding (Flood Zone 3) ▪ Surface water - Land having a greater than 3.3% AEP of flooding from surface water ▪ Groundwater - Areas with potential for groundwater flooding to occur at surface level or ▪ Land uses classified as Less Vulnerable within the NPPF or local transport networks and infrastructure.
Very High	▪ Fluvial – Land where water has to flow or be stored in times of flood, referred to as Functional Floodplain (Flood Zone 3b) ▪ Land uses classified as Essential Infrastructure; More Vulnerable; or Highly Vulnerable; or where the increase in flood risk would result in a risk to life (i.e. a flood hazard that is dangerous for all).

A.2 Magnitude of Change Criteria

The magnitude of change is a measure of the scale or extent of the change in the baseline condition, irrespective of the value of the resource(s) affected. However, flood risk can be influenced by several factors, including:

- Potential changes associated with the source of flooding linked to a change (or combination in changes) in run-off/higher discharge, flood storage volume, conveyance, flood frequency, depth/extent, velocity and/or peak flow.

- Temporal changes to flooding such as permanent or temporary changes such as those that would be limited in duration to the construction period and those that would remain for the full duration of the operational life of the scheme.
- "Embedded" mitigation measures that form part of an optimised design used to manage the likely significant flood risk effects.

The magnitude of change has been determined based on the factors listed above, the data available for flood sources and the criteria set within Table A-2. The term "Magnitude" of effects has been used to describe the severity of impacts within both the FRA and the Environmental Statement.

The overall baseline sensitivity was determined by the availability of data to determine probability for all flood sources and the potential for multiple receptors to be at risk. Where there was uncertainty regarding whether a receptor would be at risk, a precautionary approach was taken.

Table A-2: Magnitude of change criteria

Magnitude	Criteria
Major	A large adverse or beneficial change in flood depth, flood extent, velocity, or peak flow, that may have an impact some distance upstream or downstream. Potential to significantly change flood frequency. Potential change in risk to life. A large adverse or beneficial change in groundwater levels and flows which would affect groundwater flooding susceptibility over catchment scale.
Moderate	A moderate adverse or beneficial change in flood depth, flood extent or peak flow that may have limited impact some distance upstream or downstream. Potential for some change in flood frequency. Minor changes in floodplain flow pathways that increase velocity or extent of flooding but does not lead to new areas being inundated or new flow pathways forming. A moderate adverse or beneficial change in groundwater levels and flows which would affect groundwater flooding susceptibility over catchment scale or a large adverse or beneficial change in groundwater levels and flows which would affect groundwater flooding susceptibility over local scale.
Minor	A small or very localised adverse or beneficial change in flood depth, extent or peak flow with no perceptible impact upstream or downstream or in the floodplain. Small changes in flood frequency. A small adverse or beneficial change in groundwater levels and flows which would affect groundwater flooding susceptibility over catchment scale or a moderate adverse or beneficial change in groundwater levels and flows which would affect groundwater flooding susceptibility over local scale.
Negligible	Very limited potential for change. No change in flood frequency.

A.3 Significance of Impacts

The Significance of the overall flood risk is a product of the likelihood (sensitivity/value) and the magnitude of the impacts. Should the overall significance of flood risk be classified as Moderate, Large or Very Large, then additional mitigation would be required. Any effects that cannot be mitigated would be recorded as residual effects.

The overall risk of flooding during the construction and operational phases is a product of the likelihood of occurrence and the severity of impact as indicated in Table A-3.

Table A-3: Significance of flood risk Impacts

		Magnitude of Impact			
		Negligible	**Minor**	**Moderate**	**Major**
Baseline Flood Risk	**Low**	Neutral	Neutral	Slight	Moderate/Large
	Medium	Neutral	Slight	Moderate	Large
	High	Neutral	Slight/Moderate	Moderate/Large	Large/Very Large
	Very High	Neutral	Moderate/Large	Large/Very Large	Very Large

Annexe B: Figures

Figure 8.1 – Proposed Ribble Crossing Location

Figure 8.2 – The Flood Map for Planning

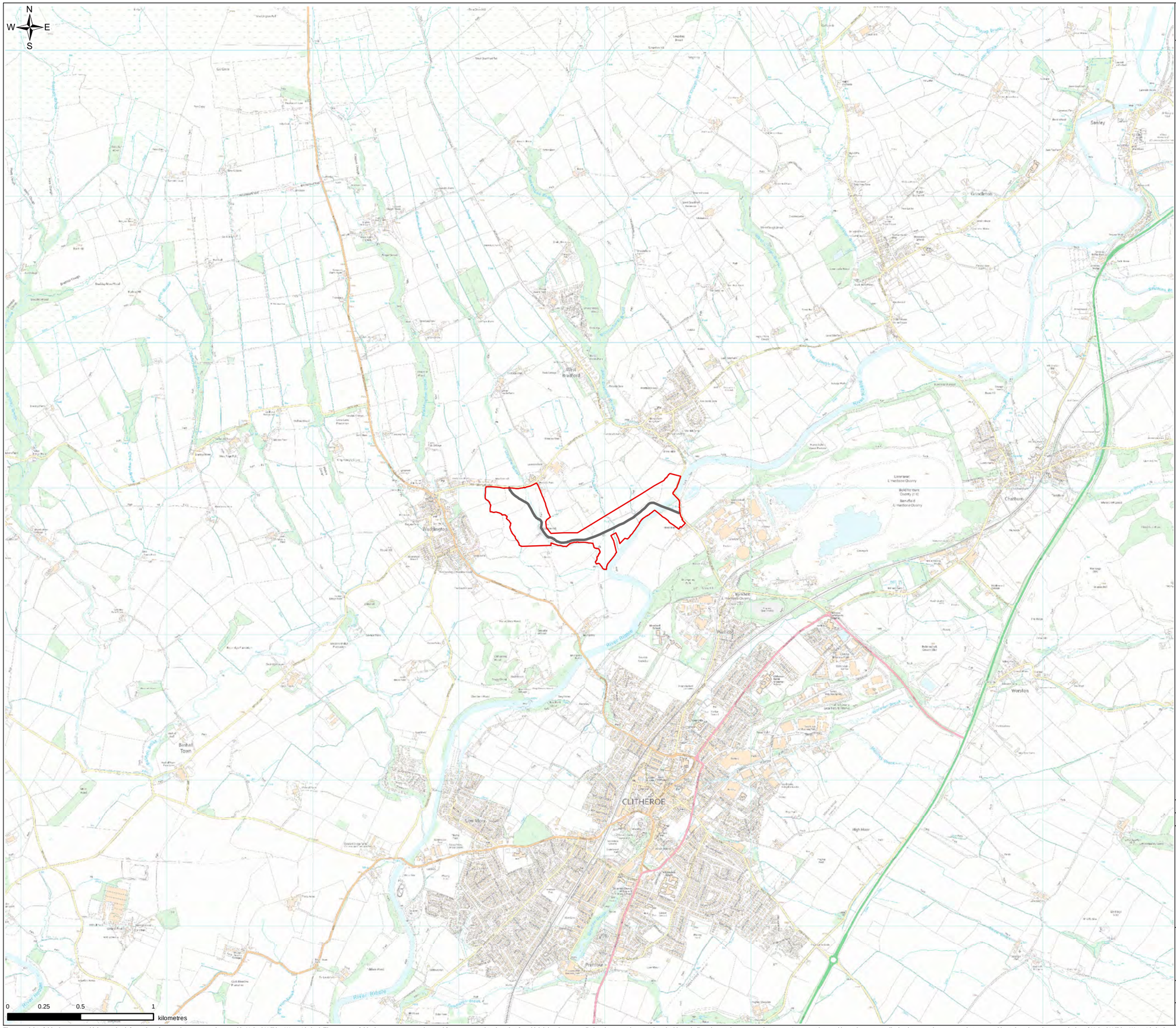
Figure 8.3 – The Risk of Flooding from Surface Water Map

Figure 8.4 – Risk of flooding from Reservoirs Map

Drawing 0061155-01-UU-TR4-XX-DR-C-20009 – Ribble Crossing Route 1 – Construction Compounds and Topsoil Storage

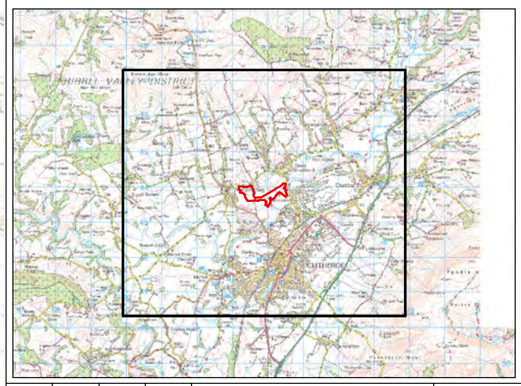
Drawing 80061155-01-JAC-TR4-XX-M3-C-00007 – Haweswater Aqueduct Resilience Programme TR4 Access Road Sections

FIGURE 1



Legend

- Planning Application Boundary
- Indicative Route Alignment



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SITE LOCATION
PROPOSED RIBBLE CROSSING
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SCALE	SHEET SIZE
1:25,000	A3
DRAWING NUMBER	REVISION
RVBC-MH-RC-FIG-01	0

FIGURE 2

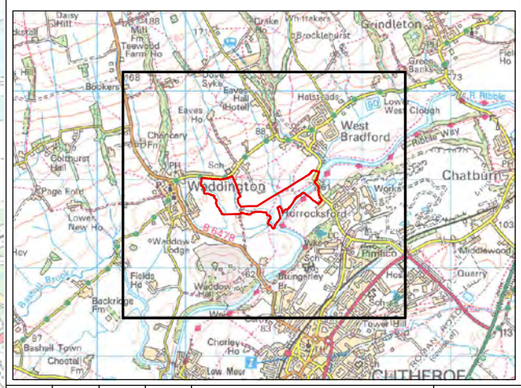
West Bradford Brook

River Ribble

Waddington Brook

Legend

- Planning Application Boundary
- Indicative Route Alignment
- Main Rivers
- Flood Zone 2
- Flood Zone 3



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FLOOD MAP FOR PLANNING
PROPOSED RIBBLE CROSSING
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SCALE	SHEET SIZE
1:10,000	A3
DRAWING NUMBER	REVISION
RVBC-MH-RC-FIG-02	0

0 0.25 0.5 1 kilometres

FIGURE 3

Greg Sike

West Bradford Brook

Coplow Brook

Unnamed Watercourse 2097

River Ribble

Waddington Brook

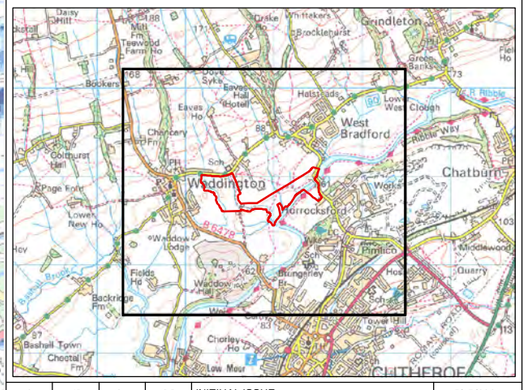
0 0.25 0.5 1 kilometres

Legend

- Planning Application Boundary
- Indicative Route Alignment
- Watercourses

Risk of Flooding from Surface Water

- Surface Water Flood Extent 3.33% AEP
- Surface Water Flood Extent 1% AEP
- Surface Water Flood Extent 0.1% AEP



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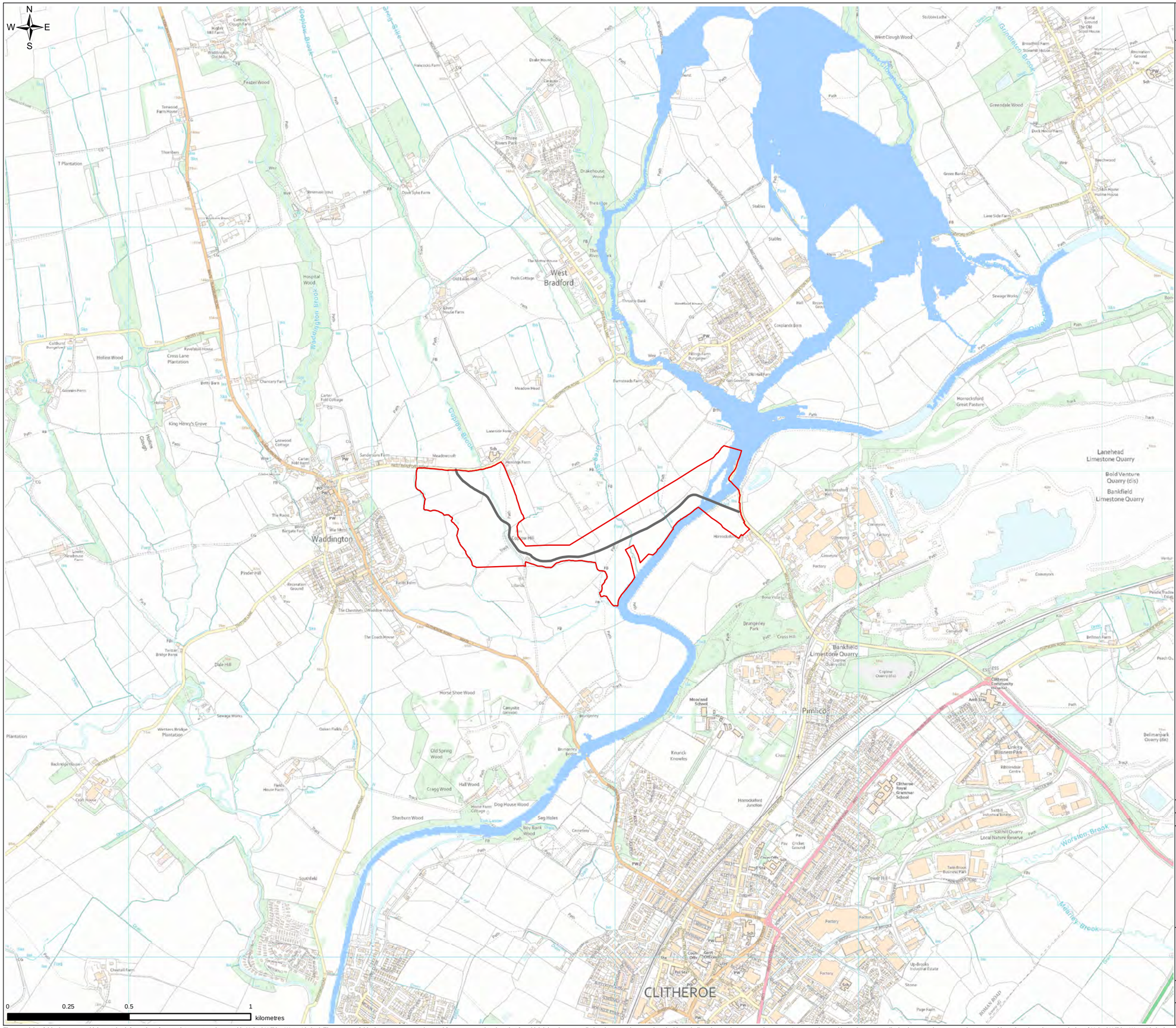
RISK OF FLOODING FROM SURFACE WATER
PROPOSED RIBBLE CROSSING
PAGE 1 OF 1

SCALE	SHEET SIZE
1:10,000	A3
DRAWING NUMBER	REVISION
RVBC-MH-RC-FIG-03	0

FIGURE 4

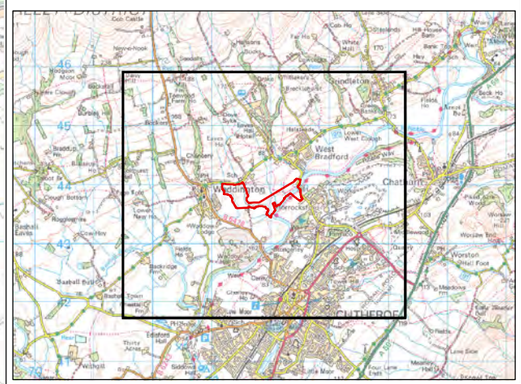


Legend

- Planning Application Boundary
- Indicative Route Alignment

Risk of Flooding from Reservoirs

- Maximum Extent of Flooding



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RESERVOIR FLOOD EXTENT
PROPOSED RIBBLE CROSSING
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SCALE	SHEET SIZE
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DRAWING NUMBER	REVISION
RVBC-MH-RC-FIG-04	0