# Haweswater Aqueduct Resilience Programme - Proposed Bowland Section

## Volume 6

## Proposed Ribble Crossing

## Chapter 7: Water Environment

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Jacobs

# Haweswater Aqueduct Resilience Programme - Proposed Bowland Section

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# 7. Water Environment

## 7.1 Introduction

1) This chapter presents an assessment of the likely significant effects of the Proposed Ribble Crossing on the Water Environment.

2) Water Environment includes the sub-disciplines fluvial geomorphology, surface water quality, and groundwater. Flood risk is covered separately in Chapter 8: Flood Risk. A Water Environment Regulations (WER) assessment (formerly referred to as a Water Framework Directive (WFD) assessment) can be found in Appendix 7.1. The scope of each sub-discipline is as follows:

- Fluvial geomorphology – the forms and functions associated with watercourses and their interaction with the surrounding terrestrial environment including sediment transport, erosion, and deposition
- Surface water quality – the quality of surface waters and impacts arising from potential pollution
- Groundwater – the water contained within the pore spaces of rocks and soils, including quantity and quality and its availability as a water resource.

3) The assessment area, nature, value and sensitivity of the existing baseline environment are introduced and explained in support of an assessment of the likely significant of the Proposed Ribble Crossing on the Water Environment. Mitigation measures have been proposed to avoid, reduce or offset any likely significant effects. Embedded mitigation measures are explained in Chapter 3: Design Evolution and Development Description, while additional mitigation measures are outlined in Section 7.7.

## 7.2 Scoping and consultations

### Scoping

4) A Water Environment chapter was included within the Proposed Bowland Section EIA Scoping Report which was submitted to the relevant planning authorities for comment in October 2019, followed by a Scoping Addendum in February 2021 due to design changes and refinements. Scoping report responses were provided by each of the local authorities and these have been reviewed and October 2019 Scoping Report Responses incorporated into the assessment. Scoping comments and responses are outlined in Volume 4: Appendix 4.1. The Scoping Addendum did not result in any change to the assessment methodologies or criteria outlined in the Scoping Report.

5) A summary of the matters scoped in/out of assessment in this chapter are detailed in Table 7.1

### Consultation

6) During this assessment, consultation has taken place with relevant statutory and non-statutory consultees, stakeholders and third parties, through both correspondence and face-to-face meetings. This has been summarised in Volume 4: Appendix 4.1

**Table 7.1: Summary of Matters Scoped In / Out of the Assessment**

| Discipline | Potential Effect | Scoped in/out | Justification |
|---|---|---|---|
| Fluvial Geomorphology | Watercourse crossing by temporary haul route. | In for all watercourses. | Potential for significant impact on all watercourses crossed. |
| | Watercourse receiving discharge from the Proposed Ribble Crossing. | In for watercourses of Medium sensitivity or greater.<br><br>Out for Low sensitivity watercourses. | Discharge volumes are likely to be of low volume and would only potentially impact watercourses where sensitive geomorphological features and processes have been identified. |
| | Watercourses within 250 m of site compounds or temporary haul route, but not directly interacting with the Proposed Ribble Crossing. | In for watercourses of Very High or High sensitivity.<br><br>Out for Medium and Low sensitivity watercourses. | Would only potentially impact watercourses where sensitive geomorphological features and processes have been identified. |
| Surface Water Quality | Decrease in water quality related to sediment laden runoff chemical pollution and bed and/or bank disturbance from the Proposed Ribble Crossing. | In for all watercourses that could interact with enabling, construction, operation and decommissioning activities (River Ribble, Greg Sike, Coplow Brook, Unnamed Watercourse 2097 and Unnamed Watercourse 2099). | A case-by-case basis for each watercourse has been made to determine potential impacts. |
| | Degradation of surface water dependent habitats due to sediment laden runoff and/or chemical pollution. | Out | Although identified within the assessment area, all surface water dependent habitats occur up gradient or out with the drainage catchments associated with the Proposed Ribble Crossing. |
| | Deterioration of surface water abstractions due to sediment laden runoff and/or chemical pollution. | Out | Although identified within the assessment area, all identified surface water abstractions occur up slope or outwith the drainage catchments associated with the Proposed Ribble Crossing. |

| Discipline | Potential Effect | Scoped in/out | Justification |
|---|---|---|---|
| Groundwater | Groundwater contamination through mobilisation of suspended solids. | In | Potential for significant impact on bedrock and superficial aquifers and associated receptors. |
| | Shallow groundwater flow disturbance resulting from earthworks and compaction-related effects. | In | |
| | Groundwater contamination through accidental leaks and spills and road runoff. | In | |
| | Construction of the temporary bridge structure, including piling of bridge foundations. | In | |

## 7.3 Key Legislation and Guidance

7) Key legislation and guidance relating to the assessment of the Water Environment are detailed in Volume 2 Chapter 7.

## 7.4 Assessment Methodology and Criteria

8) The assessment methodology and criteria used for the assessment of the Proposed Ribble Crossing is the same as that set out in the Proposed Bowland Section ES.

**Assumptions and limitations**

- No information on Private Water Supplies (PWSs) has been obtained to date and therefore potential impacts on PWSs have not been assessed
- No site-specific ground investigation (GI) data or historical British Geological Survey (BGS) log information for the assessment area were available at the time of writing.
- Details on the design have not yet been finalised to confirm the excavation depths. At this stage, it has been assumed that earthworks would be no deeper than 1 m. This is considered to be a reasonable assumption taking account of the limited requirement to alter levels for construction of the haul route
- Potential effects from each activity consider embedded mitigation as detailed in Chapter 3 (Design Evolution and Development Description), and the Construction Code of Practice (CCoP) (Volume 4 Appendix 3.2)
- No in-channel working would be required, except to facilitate the installation of outfalls associated with drainage.

## 7.5 Baseline Conditions

9) This section details the Water Environment baseline for the assessment area and identifies receptors where there is potential for significant effects to arise. The Proposed Ribble Crossing extends across the River Ribble and surrounding flood plain. The assessment area generally extended up to 500 m from the planning application boundary, as shown in Figure 7.1.

10) Baseline data were collated from a variety of sources in compiling this assessment, including:

- Desk based information sources
- Fluvial geomorphology site walkover surveys.

### 7.5.2 Desk Based Sources

11) The assessment was undertaken with reference to the same desk-based sources of information detailed in Volume 2 Chapter 7: Water Environment.

### 7.5.3 Site Walkover Surveys

12) A fluvial geomorphology site walkover was undertaken on 12 February 2021. The site walkover included all watercourses that potentially could be impacted by the Proposed Ribble Crossing. Fluvial geomorphological features and processes were identified and recorded using handheld mappers and photography. The extent of each survey was based on watercourse sensitivity determined during the desk-based assessment as follows:

- 500 m reach for Very High and High sensitivity watercourses
- 250 m reach for Medium sensitivity watercourses
- Single, spot check for Low sensitivity watercourses.

13) The data from the site walkover were used to validate assumptions made during desk-based analysis, particularly the sensitivity of watercourses, and identify geomorphological features and processes not readily identifiable from desk-based sources.

### 7.5.4 Fluvial Geomorphology

14) Appendix 7.2 contains a summary of the current fluvial geomorphology baseline of watercourses which could interact with the Proposed Ribble Crossing. Watercourse locations can be found in Figure 7.2.

15) A summary of the watercourses scoped into the assessment, the corresponding sensitivity, and the project interaction has been provided in Table 7.3.

16) There is one Very High, one High, one Medium, and one Low sensitivity watercourse carried forward for further assessment for the Proposed Ribble Crossing for fluvial geomorphology.

**Table 7.3: Fluvial Geomorphology Watercourses and Sensitivities**

| Sensitivity | Watercourse Name | Description | Project Interaction |
|---|---|---|---|
| Very High | River Ribble (W2325) | A naturally straight channel within the assessment area, with large meanders and sinuosity outside the assessment area. A range of geomorphological processes and features are present. Exposed bedrock forming a step in the channel profile, a vegetated mid-channel bar, lateral, point, and medial bars, and a total of 150 m of bank erosion on both banks were all observed. Modifications noted within the study reach include a road bridge with piers in the river and bank reinforcement on both banks. Due to the range of features and minimal modifications a High sensitivity has been assigned. | Temporary haul route crossing, within 10 m of two construction laydown areas. Receiving discharge from temporary roads, through four outfalls. |
| High | Greg Sike (W2321) | A sinuous channel with a range of geomorphological processes and features. Steps, riffles, lateral bars, woody debris, and bank erosion were all observed. Modifications noted within the study reach include a culvert and some evidence of straightening. The range of features and limited modifications give this watercourse a High sensitivity. | Temporary haul route crossing. |
| Medium | Coplow Brook (W2349) | A sinuous channel with straightened and over-widened section and a range of geomorphological processes and features. A lateral bar, step-pool sequences, riffles, and bank erosion were all observed. Modifications noted within the study reach include 10 m of bank reinforcement, two bridges, two culverts, manmade debris, and an embankment. Poaching was also observed. Although there is evidence of recovery to a natural equilibrium, due to the extent of modifications a Medium sensitivity has been assigned. | Temporary haul route crossing, within 5 m of temporary road as several locations, within 10 m of two construction laydown areas. |
| Low | Unnamed Watercourse 2097 (W2348) | A straightened channel with limited geomorphological processes and features. 10 m of bank erosion was observed. Modifications noted within the study reach include two culverts, and evidence of the channel having been realigned and straightened. Due to the lack of features and extent of modifications a Low sensitivity has been assigned. | Temporary haul route crossing. |

### 7.5.5 Surface Water Quality

17) One WER classified surface water body, named the Ribble – Downstream Stock Beck has been identified within the 500 m assessment area which is likely to interact with the Proposed Ribble Crossing. A summary of the baseline WER data (Environment Agency, 2021[1]) is outlined in Table 7.4 and detailed on Figure 7.3. The WER data provides an indication of water quality status as the overall status comprises of physico-chemical quality and chemical water quality elements. For further details on the catchment to which the Proposed Ribble Crossing interacts refer to Appendix 7.3. These have been briefly summarised below.

**Table 7.4: Baseline description of WER classification information of waterbody associated with the Proposed Ribble Crossing**

| Element | Ribble – Downstream Stock Beck |
|---|---|
| Water body ID | GB112071065612 |
| Catchment size | 50.2 $km^2$ |
| Hydromorphological designation | Not designated artificial or heavily modified |
| Current overall status | Moderate |
| Ecological status | Moderate |
| Physico-chemical quality elements | Moderate |
| Biological quality elements | Good |
| Chemical status | Fail |

18) The Ribble - Downstream Stock Beck herein referred to as 'the River Ribble', is designated an Environment Agency Main River which holds an overall Moderate classification under WER, based on 2019 data. The watercourse has an overall Moderate status for ecological and physico-chemical parameters in addition to a Good status for biological quality elements.

19) Land use within the River Ribble catchment is approximately 80 % rural, with the remaining 20 % made up of largely urban areas. Non-rural areas include the towns of Clitheroe, Sawley, Great Mitton and the outskirts of Whalley. Towns and smaller settlements within the catchment are linked by a major road network including the A59. The rural areas within the catchment consist of isolated residential holdings, farmsteads, fields and areas of wooded plantations interlinked by minor B roads. There are no designated Sites of Special Scientific Interest (SSSI), Special Protection Areas (SPA) or Special Areas of Conservation (SAC) within the assessment area. The Cross Hill Quarry Local Nature Reserve (LNR) is within the assessment area, although is not in hydrological connectivity with the Proposed Ribble Crossing. Further details of the LNR are provided in Appendix 7.3.

20) One surface water abstraction has been identified within the assessment area associated with the Proposed Ribble Crossing. The identified surface water abstraction is located upstream of the Proposed Ribble Crossing and is not in hydrological connectivity with the Proposed Ribble Crossing. Further details on the abstraction are provided in Appendix 7.3.

21) Aside from the WER water body, there are a further four unnamed watercourses which could potentially interact with the Proposed Ribble Crossing that are located within the River Ribble catchment. These unnamed watercourses are either tributaries of the River Ribble or are other water features, such as drainage channels or ditches. The watercourses, project interaction and sensitivity are presented in Table 7.5.

[1] Environment Agency (2021) *Catchment Data Explorer.* [Online] Available from: https://environment.data.gov.uk/catchment-planning/ [accessed February 2021]

**Table 7.5: Surface Water Quality Watercourses and Sensitivities**

| Sensitivity | Watercourse Name | Project Interaction |
|---|---|---|
| Medium | River Ribble (W2325) | Temporary haul route crossing, within 10 m of two construction laydown areas. Four construction drainage discharge locations. |
| Medium | Greg Sike (W2321) | Temporary haul route crossing. |
| Medium | Coplow Brook (W2349) | Temporary haul route crossing, within 5 m of temporary road as several locations and within 10 m of two construction laydown areas, including topsoil storage locations. |
| Low | Unnamed Watercourse 2097 (W2348) | Temporary haul route crossing. |
| Low | Unnamed Watercourse 2099 (W2352) | Within construction laydown area. |

### 7.5.6 Groundwater

22) Clitheroe Limestone Formation and Hodder Mudstone Formation bedrock underlies the whole assessment area. Overlying this is glacial till which is assumed to underlie all other superficial deposits in the assessment area. There are no ground investigations or historical British Geological Society (BGS) boreholes within the site of the Proposed Ribble Crossing to confirm the geology. However, the crossing and the temporary haul route linking it to West Bradford Road to the south is expected to directly cross all the superficial deposits described in Table 7.6 as shown in Figure 7.4.

23) There are no nearby GI or BGS historical boreholes located within or in the vicinity of the assessment area to provide data on groundwater levels. No springs are annotated on current Ordnance Survey maps within the assessment area. However, shallow groundwater flow is likely to follow the topography and be towards the River Ribble.

24) Groundwater vulnerability across the proposed crossing is categorised as Low, with one area in the northeast corner being categorised as Medium. The assessment area is classed as a soluble rock risk.

25) The Proposed Ribble Crossing is not located within a Groundwater Source Protection Zone (SPZ). There is one licensed groundwater abstraction within 1 km of the Proposed Ribble Crossing at Bankfield Quarry, beyond the assessment area.

26) Based on ecological surveys undertaken and reported in Chapter 9: Ecology, no Groundwater Dependent Terrestrial Ecosystems (GWDTEs) have been identified within the assessment area.

**Table 7.6: Hydrogeological units identified in the assessment area**

| Sensitivity | Hydrogeological Unit | Description | Aquifer Designation | Hydrogeology | Project Interaction |
|---|---|---|---|---|---|
| **Bedrock** | | | | | |
| High | Clitheroe Limestone Formation and Hodder Mudstone Formation (Undifferentiated) - Mudstone | Packstones, wackestones and subordinate grainstones and mudstones with reef limestones. | Secondary A | Moderately productive aquifer.<br>Argillaceous strata dominate, acting as aquitards or aquicludes, isolating the occasional sandstone horizons which act as separate aquifers. This is where most of the groundwater storage/ movement occurs as both intergranular and fracture flow. Faulting has split the once continuous sandstone horizons into discrete blocks, to which no direct recharge can occur. | Crossed by the Proposed River Ribble Crossing |
| **Superficial Deposits** | | | | | |
| High | Alluvium | Typically, soft to firm, consolidated compressible silty clay, that can contain layers of silt, sand, peat, basal gravel, and a desiccated surface zone. | Secondary A | Typically, intergranular flow with varying permeability. Where sand/gravel layers are thick and continuous, groundwater yields would be high, making local groundwater abstraction possible, although dominance of clay in this unit may limit its potential as an aquifer. | Crossed by the Proposed River Ribble Crossing |
| Medium | Till (diamicton) | Variable lithology, typically sandy, silty clay, with pebbles, but can contain gravel-rich, or laminated sand layers. | Secondary Undifferentiated | Typically, mixed flow with varying permeability. Usually acts as an aquitard or aquiclude but can locally comprise productive sand and gravel horizons, which may yield limited amounts of groundwater, although groundwater abstraction is unlikely. | |
| Medium | Hummocky (mounds) glacial deposits | Diverse and complex glacial deposits that have characteristic hummocky topographic form. Composed of rock debris, clayey till and poorly- to well-stratified sand and gravel | Secondary Undifferentiated | Similar hydrogeological characteristics to till. | |
| Low | Glaciolacustrine | Sands, silts, and clays of deltaic origin, shoreface sand and gravel and lake bottom varved, fine-grained (fine sand, silt and clay) sediments. | Unproductive | Similar hydrogeological characteristics to till. | |

### 7.5.7 Summary of Sensitivity

27) The features and the assigned sensitivities for the Water Environment have been summarised in Table 7.7.

**Table 7.7: Summary of Sensitivity**

| Feature Name | Sensitivity | Description |
|---|---|---|
| **Fluvial Geomorphology** | | |
| River Ribble (W2325) | Very High | A naturally straight channel with a range of geomorphological processes and features. Limited modifications. |
| Greg Sike (W2321) | High | A sinuous channel with a range of geomorphological processes and features. Limited modifications. |
| Coplow Brook (W2349) | Medium | A sinuous channel with a range of geomorphological processes and features. Extensive modifications. |
| Unnamed Watercourse 2097 (W2348) | Low | A straightened channel with limited geomorphological processes and features. Some modifications. |
| **Surface Water Quality** | | |
| River Ribble (W2325) | Medium | The River Ribble holds Moderate status for overall, ecological and physico-chemical quality elements. The watercourse holds Good status for biological quality elements. |
| Greg Sike (W2321)<br>Coplow Brook (W2349) | Medium | Hydrologically connected and/or a mainstem tributary of the River Ribble. |
| Unnamed Watercourse 2097 (W2348)<br>Unnamed Watercourse 2099 (W2352) | Low | Assessed to be modified (straightened) drainage channel. |
| Groundwater | | |
| Clitheroe Limestone Formation and Hodder Mudstone Formation (Undifferentiated) | High | Argillaceous strata dominate, acting as aquitards or aquicludes, isolating the occasional sandstone horizons which act as separate aquifers. |
| Alluvium | High | Typically, soft to firm, consolidated compressible silty clay, that can contain layers of silt, sand, peat, basal gravel, and a desiccated surface zone. |
| Till (diamicton) | Medium | Variable lithology, typically sandy, silty clay, with pebbles, but cam contain gravel-rich, or laminated sand layers. |
| Hummocky (moundy) glacial deposits | Medium | Diverse and complex glacial deposits that have characteristic moundy topographic form. Composed of rock debris, clayey till and poorly- to well-stratified sand and gravel. |
| Glaciolacustrine | Low | Sands, silts and clays of deltaic origin, shoreface sand and gravel and lake bottom varved, fine-grained (fine sand, silt and clay) sediments. |

## 7.6 Assessment of likely significant effects

28) The following section describes the effects of the Proposed Ribble Crossing on the Water Environment during the enabling, construction, operational and decommissioning phases.

### 7.6.2 Enabling Works Phase

29) The following provides an overview of the potential effects on the water environment as a result of the enabling works phase.

**Fluvial Geomorphology**

30) The enabling phase of the Proposed Ribble Crossing would include vegetation clearance along the proposed temporary haul route which could interact with the watercourses identified in the fluvial geomorphology baseline. It is not anticipated that the minimal level of preparatory work required to establish compound laydown areas would be sufficient to have a significant effect on fluvial geomorphological receptors.

31) Without any specific mitigation (i.e. non-embedded mitigation), vegetation clearance would have the potential to cause the loss of riparian vegetation, the effects of which are described in more detail below.

Loss of riparian vegetation

32) Clearance of riparian vegetation would be required on the River Ribble for the proposed temporary haul route and bridge. The riparian vegetation at the proposed crossing location included continuous trees on the left bank. The watercourse was seen to be laterally adjusting and removal of the vegetation could exacerbate the rate of adjustment. Therefore, the impact would likely be Minor, resulting in a Moderate significance of effect.

33) Clearance of riparian vegetation would be required on Unnamed Watercourse 2097 for the proposed temporary haul route. The riparian vegetation at the proposed crossing location included continuous trees. Erosion was seen on the watercourse, which could be exacerbated by removal of the vegetation. Therefore, the impact would likely be Moderate, resulting in a Slight significance of effect.

34) Clearance of riparian vegetation would be required on Greg Sike for the proposed temporary haul route. The riparian vegetation at the proposed crossing location consisted of short grass and the channel was considered to be stable. Therefore, the impact would likely be Negligible resulting in a Neutral significance of effect.

35) Clearance of riparian vegetation could be required on Coplow Brook for the proposed temporary haul route. The vegetation clearance would be required for a crossing and at several locations where the temporary haul route would be adjacent to the watercourse. The riparian vegetation consisted of short grass and trees. Whilst the channel was seen to be incising at some locations, there was little evidence of lateral migration/significant bank erosion. Therefore, loss of riparian vegetation is unlikely to lead to bank erosion/destabilisation. Any impact would likely be Minor resulting in a Slight significance of effect.

**Surface Water Quality**

36) During the enabling phase of the Proposed Ribble Crossing, the following activities have been identified which could interact with the watercourses identified in the surface water quality baseline:

- Preparatory works for the site compounds which would involve site clearance works, including vegetation stripping
- Minor earthworks to level the ground within the footprint of compound laydown areas. This would include topsoil stripping and storage
- Construction of a bridge launch platform on the southern bank of the River Ribble
- Discharge of site drainage to the River Ribble and Coplow Brook.

37) Without any specific mitigation (i.e. non-embedded mitigation), these activities for the enabling works would have the potential to cause the following effects on water quality which are described in more detail below:

- Sediment laden runoff
- Chemical pollution.

Sediment laden runoff

38) Sediment laden runoff impacts which could lead to degradation in surface water quality would most likely be associated with activities of topsoil stripping and storage, vegetation clearance, and earthworks required to prepare the compound laydown areas as well as construction of the bridge launch platform.

39) Increases in impermeable areas associated with the compaction of the ground surface and placement of granular material for the formation of hardstanding associated with the site compounds increases the potential for runoff containing high concentrations of suspended solids to nearby water features, potentially affecting pH and high turbidity and other potential impacts to water chemistry.

40) As outlined in the CCoP, mitigation would be in place with regards to fine sediment controls throughout the enabling phase, including topsoil storage areas to be located as far away as practicable from watercourses.

41) Preparatory earthworks are required for the formation of the compound laydown areas, including vegetation stripping and topsoil storage. Exposed soil surfaces, as well as increased impermeable areas could result in sediment laden runoff reaching the Coplow Brook. Site discharges with high sediment content could also affect the water quality of the Coplow Brook. The magnitude of impact for sediment laden runoff would be Minor for Coplow Brook, which would result in a Slight significance of effect of sediment laden runoff.

42) The magnitude of impact of sediment laden runoff is reported as Minor for Unnamed Watercourse 2099, due to the proximity of the watercourse to preparatory earthworks required for the compound laydown area and the bridge launch platform on the south bank of the River Ribble. Unnamed Watercourse 2099 is a modified drainage channel of low sensitivity and likely has a low dilution capacity. This results in a Neutral significance of effect for sediment laden runoff on Unnamed Watercourse 2099.

43) There would likely be a requirement for vegetation stripping and minor earthworks during the enabling phase near the River Ribble in preparation of the launch platform from the southern bank. This would also be required for the creation of the site compounds on the north and south banks of the River Ribble. Due to the proximity of the works there would be the potential for sediment laden runoff to enter the watercourse directly. Furthermore, construction drainage would be discharged to the River Ribble from the hardstanding areas. The River Ribble is a mainstem watercourse and as such it is anticipated to have a high dilution capacity which, combined with construction drainage and mitigations outlined in the CCoP, would minimise the impact of sediment laden runoff on the River Ribble. Therefore, the magnitude of impact would be reported as Minor. This results in a Slight significance of effect for the River Ribble.

Chemical pollution

44) During the enabling phase, several potential pollutants would be present, including oils, fuels, chemicals, waste and wastewater. Most of these potential pollutants would be stored within the compound laydown areas. In addition, there would be the potential for pollution from spillages along the access and egress routes from the surrounding road network. This could impact on surface water quality should the pollutant reach the receiving watercourses.

45) The magnitude of impact of any chemical pollution incident on surface water quality would depend on the type of pollutant, volume and concentration of the spill/leak as well as conditions on site at the time, specifically related to how effectively the water environment would be able to buffer (dilute) the incident. Where current and antecedent conditions on site have been wet and receiving watercourses have a high

discharge volume, their dilution capacity would be high and the magnitude of incident would be reduced and alternatively, lower discharges could increase the magnitude of relatively small volume spills.

46) Due to the proximity of the preparatory earthworks required for the formation of the compound laydown areas, including the use of plant and machinery within these areas, the magnitude of impact for chemical pollution would be reported as Minor for Coplow Brook. This results in a Slight significance of effect of chemical pollution.

47) Due to the proximity of Unnamed Watercourse 2099 to the compound laydown area, and the likely limited dilution capacity of this modified drainage channel of low sensitivity, the magnitude of impact of chemical pollution is reported as Minor. This results in a Neutral significance of effect for chemical pollution on Unnamed Watercourse 2099.

48) There is the requirement for material storage, and plant to be working near the River Ribble. This has the potential for accidental spillages of potentially polluting substances from plant and materials to enter the River Ribble directly. Mitigations outlined in the CCoP with regards to chemical storage and usage is likely to minimise the impact of any chemical pollution incident. Therefore, the magnitude of impact is reported as Negligible. This results in a Neutral significance of effect for the River Ribble.

**Groundwater**

49) During the enabling phase of the Proposed Ribble Crossing, the main activities that could impact those groundwater bodies identified in the baseline include construction of temporary access, laydown and working areas and associated earthworks.

50) Without any specific mitigation (i.e. non-embedded mitigation), these activities for the enabling works would have the potential to cause the following impacts, which are described in more detail below:

- Shallow groundwater flow disturbance resulting from earthworks and compaction-related effects
- Groundwater contamination through mobilisation of suspended solids
- Groundwater contamination through accidental leaks and spills.

<u>Groundwater flow disturbance</u>

51) Because of the shallowness of the proposed earthworks, it is unlikely that groundwater would be intercepted. As a result, negligible dewatering effects are expected, and this aspect will not be subject to further assessment.

52) As identified above, groundwater flow disturbance could occur due to compaction-related construction activities and earthworks that do not require dewatering, i.e. minor re-profiling at laydown areas and compounds, temporary bridge access track construction, and formation of bridge construction working areas and the crane platform. At the scale of the superficial aquifers, this would result in a potential magnitude of impact of Negligible, resulting in a Neutral significance of effect. No groundwater flow disturbance is expected on bedrock aquifers.

<u>Groundwater contamination</u>

53) Ground disturbance due to these activities could also impact on groundwater quality due to mobilisation of suspended solids. Implementation of the embedded mitigation measures (see Chapter 3) and measures referred to in the CCoP (see Volume 4 Appendix 3.2) would significantly reduce the likelihood of suspended solids causing a deterioration in groundwater quality at the site. However, due to the filtering effect of the unsaturated zone and aquifer materials present within the assessment area, suspended solids are not expected to migrate to any significant extent. Due to this, and the mitigation measures referred to in the CCoP, impacts to the underlying aquifers would be Minor, resulting in a Slight or Neutral significance of effect, depending on the sensitivity of the aquifer units.

54) Accidental spills and leaks of fuels and chemicals during the enabling phase would have the potential to introduce contaminants into groundwater. The embedded mitigation measures contained within the CCoP would significantly reduce the likelihood of an incident occurring. However, if a spill or leak did

occur, this would lead to a Minor impact on the superficial deposits lying directly in the path of the access track, resulting in a Slight or Neutral significance of effect depending on the sensitivity of the aquifer unit.

55) Measures in the CCoP relating to soil storage would prevent the mobilisation of any contamination and suspended solids. As a result, any impact on groundwater quality within the superficial deposits is assessed as Negligible, resulting in in a Neutral significance of effect.

**Summary of Effects**

56) A summary of the enabling works phase effects is shown in Table 7.8.

**Table 7.8: Summary of Enabling Works Effects**

| Environmental / Community Asset | Value / Sensitivity | Effect | Duration | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| **Fluvial Geomorphology** | | | | | |
| River Ribble (W2325) | Very High | Loss of riparian vegetation | Long term | Minor | Moderate |
| Greg Sike (W2321) | High | Loss of riparian vegetation | Long term | Negligible | Neutral |
| Coplow Brook (W2349) | Medium | Loss of riparian vegetation | Long term | Minor | Slight |
| Unnamed Watercourse 2097 (W2348) | Low | Loss of riparian vegetation | Long term | Moderate | Slight |
| **Surface Water Quality** | | | | | |
| River Ribble (2325) | Medium | Sediment Laden Runoff | Temporary | Minor | Slight |
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| Coplow Brook (W2349) | Medium | Sediment Laden Runoff | Temporary | Minor | Slight |
| | | Chemical Pollution | Temporary | Minor | Slight |
| Unnamed Watercourse 2099 (W2352) | Low | Sediment Laden Runoff | Temporary | Minor | Neutral |
| | | Chemical Pollution | Temporary | Minor | Neutral |
| **Groundwater** | | | | | |
| Clitheroe Limestone Formation and Hodder Mudstone Formation (Undifferentiated) | High | Flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Negligible | Neutral |
| Alluvium | High | Flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |

| Environmental / Community Asset | Value / Sensitivity | Effect | Duration | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| Till (diamicton) | Medium | Flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |
| Hummocky (mounds) glacial deposits | Medium | Flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |
| Glaciolacustrine | Low | Flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Neutral |

### 7.6.4 Construction Phase

57) The following provides an overview of the potential effects on the water environment as a result of the construction phase.

**Fluvial Geomorphology**

58) The construction phase of the Proposed Ribble Crossing would include the following activities which could interact with the watercourses identified in the fluvial geomorphology baseline:

- Topsoil stripping, storage and earthworks related to construction activities
- Construction of temporary bridges
- Construction of temporary outfalls
- Discharge of drainage from the temporary haul route and compounds.

59) Without any specific mitigation (i.e. non-embedded mitigation), these activities would have the potential to cause the following impacts which are described in more detail below:

- Increased fine sediment input
- Changes to flow regime
- Disturbance to bed and banks.

Increased fine sediment input

60) During the construction of the temporary haul route fine sediment could be mobilised and reach the River Ribble, via surface water run-off. This watercourse has morphological features which could be affected by fine sediment associated with the works (i.e. smothering). Specifically, a medial bar immediately adjacent to the proposed crossing location could be affected. However, given the ability of the River Ribble to effectively transport sediment through this reach, it is unlikely that smothering would occur, with any fine sediment entering the watercourse likely to be efficiently transported downstream and dispersed. Therefore, the impact would likely be Minor, with a Moderate significance of effect.

61) Unnamed Watercourse 2097 would be crossed by the temporary haul route. There were few geomorphological features on the watercourse, and the bed material consisted predominantly of silt. Therefore, an increase in the supply of fine sediment during construction would likely have a Negligible impact, with a Neutral significance of effect.

62) Greg Sike would be crossed by the temporary haul route. The geomorphological features on this watercourse included steps, riffles, and lateral bars, which would be sensitive to increased fine sediment input and siltation (i.e. smothering). Therefore, an increase in the supply of fine sediment during construction of the crossing works would likely have a Moderate impact on Greg Sike, with a Moderate significance of effect.

63) Coplow Brook would be crossed by the temporary haul route. In addition, the temporary haul route would pass within 10 m of the watercourse at several locations. This watercourse exhibited several morphological features which could be affected by fine sediment (i.e. smothering). Given the potential for multiple impact pathways between the temporary haul route and the watercourse during construction, the impact would likely be Moderate, with a Moderate significance of effect.

64) Surplus material is proposed to be stored within approximately 15 m of Coplow Brook and 130 m of the River Ribble, representing a potential source of fine sediment which could be mobilised to the watercourses. However, providing suitable control measures are in place, such as use of effective construction drainage measures, the impact on both watercourses would likely be Negligible, with a Neutral significance of effect.

Changes to flow regime

65) Drainage from the temporary haul route would be discharged into the River Ribble through four temporary outfalls and into Coplow Brook through one temporary outfall. This could change the local flow regime and potentially cause highly localised erosion of the bed along both watercourses. The bank opposite the outfall on Coplow Brook (which already shows evidence of erosion occurring) would be at risk from further erosion. Several morphological features were observed on these watercourses which could be disturbed. However, the proposed discharge from the temporary haul route matches the existing greenfield runoff rate. The only change from the existing situation would be the concentration of the discharge to the outfall location, however, the proposed volumes of water being discharged are unlikely to change local fluvial processes or features. Therefore, there would likely be a Negligible impact on the watercourses with a Neutral significance of effect.

Disturbance to bed and banks

66) The construction of four outfalls and the temporary bridge could disturb bed and bank features and cause compaction of bed substrate on the River Ribble. Geomorphological features included a step, a pool, a vegetated mid-channel bar, and lateral, point, and medial bars. All these features are in-channel and situated away from the banks, lessening the potential to impact these features. However, the proposed outfall locations would lead to a loss of natural bank resulting in a Minor impact on the River Ribble, with a Moderate significance of effect.

67) Activities associated with the construction of the temporary bridge across the River Ribble (e.g. construction of piling platform, piling activities and movement of plant within the floodplain) has the potential to cause disturbance to the banks of the River Ribble. Whilst piling would occur approximately 10 m from the bank tops, it is possible the construction easement may encroach on the bank tops, promoting disturbance and potentially destabilising the bank. This would likely have a Minor impact, with a Moderate significance of effect.

68) Outfall construction could disturb bed and bank features and cause compaction of bed substrate on Coplow Brook. At the location of the proposed outfall there were few notable geomorphological features. Therefore, there would likely be a Minor impact on Coplow Brook, with a Slight significance of effect.

69) Construction of temporary bridges would also be required to facilitate the crossing of Greg Syke, Coplow Brook and Unnamed Watercourse 2097. The bridges would require no in-channel construction activities or modification of bank tops (except for vegetation clearance conducted during the enabling phase). Consequently, impacts would likely be Minor, with either a Slight significance of effect for Greg Syke and Coplow Brook and Neutral significance of effect for Unnamed Watercourse 2097.

**Surface Water Quality**

70) During the construction phase of the Proposed Ribble Crossing some of the activities that could have an adverse impact on surface water quality identified in the enabling works phase could continue to be applicable during the construction phase. These are:

- Topsoil stripping and earthworks related to all site construction activities and storage of soils on site
- Release of polluting substances (oils, fuels, chemicals and cement) from plant and machinery
- The discharge of construction drainage to surface water features.

71) Other activities which are more exclusively linked to the construction phase include:

- Construction of temporary haul routes and temporary bridge crossings on minor watercourses within the working area
- Construction of piled foundations required to support the Proposed Ribble Crossing
- Construction of concrete abutments to support the Proposed Ribble Crossing
- Construction of drainage and associated formalised drainage outfalls to surface water features.

72) Without any specific mitigation (i.e. non-embedded mitigation), these activities during the construction works would have the potential to cause the following effects on surface water quality, which are described in more detail below:

- Sediment laden runoff
- Chemical pollution
- Bed and bank disturbance.

Sediment Laden Runoff

73) Sediment laden runoff impacts which could lead to degradations in surface water quality would most likely be associated with activities of topsoil stripping and storage, vegetation clearance, and earthworks required to prepare the temporary haul route, as well as from the eventual temporary haul route surface. Without appropriate surface water management measures, sediment laden runoff may impact on nearby water features due to high sediment concentrations, leading to alterations in pH and turbidity and other potential impacts to water chemistry.

74) As outlined in the enabling works phase, soil storage areas would be sited within an acceptable distance from any watercourses as defined in the CCoP to ensure impacts from sediment laden runoff are minimised.

75) The proposed temporary haul route, as shown in Figure 7.3, indicates that the route is within 10 m of Coplow Brook at multiple locations. The compound laydown area in the north as well as the smaller laydown area to the south are also near to the Coplow Brook. Sediment laden runoff entering this watercourse from these activities may lead to short-term degradations in water quality as indicated above, but with mitigation in CCoP these should be reduced. The magnitude of impact of sediment laden runoff during the construction phase is reported as Minor for Coplow Brook, resulting in a Slight significance of effect.

76) Due to the smaller extents impacted from the proposed temporary haul route (which runs perpendicular to the watercourses in this location), focussed on the crossing locations, the magnitude of impact of sediment laden runoff during the construction period to Greg Sike and Unnamed Watercourse 2097 would be Negligible. This would result in a Neutral significance of effect for Greg Sike and Unnamed Watercourse 2097.

77) Unnamed Watercourse 2099 is in close proximity to the southern compound laydown area and bridge launch location. With construction drainage, mitigations detailed in the CCoP and the likely limited dilution capacity of this low sensitivity modified drainage channel, the magnitude of impact of sediment laden runoff is reported as Minor. This would result in a Neutral significance of effect for sediment laden runoff on Unnamed Watercourse 2099.

78) The construction of the Proposed Ribble Crossing would require working within the floodplain to construct a piling platform and bridge foundations. Abutments would be set back and located out of the channel. The temporary haul route would also be formed within 50 m of the watercourse at certain locations along its route. There would be discharges of treated construction runoff at designated outfalls to the River Ribble. With the consideration of construction drainage treatment as well as the mitigations in the CCoP, combined with dilution capacity of the River Ribble, the effects of sediment laden runoff would be reduced. Therefore, the magnitude of impact of sediment laden run off for the River Ribble is reported as Minor, resulting in a Slight significance of effect.

Chemical Pollution

79) During the construction phase, the activities outlined above, would also be applicable for chemical pollution. As discussed in the enabling phase, several potential pollutants would be present and used for the activities described. Most of these potential pollutants would be stored within the compound laydown areas. There is also a risk present from accidental release from plant and machinery used to create the access haul route and the watercourse crossings. In addition, there would be the potential for

pollution to occur by potential spillages along the access and egress routes from the surrounding road network. This could impact on surface water quality should pollutants reach the receiving watercourses.

80) As described previously, the magnitude of any chemical pollution incident on surface water quality would depend on the volume of the spill/leak as well as conditions on site at the time and the buffering capacity of the watercourse.

81) Due to the proximity of the compound laydown areas, the proposed temporary haul route and watercourse crossing, where plant and machinery would be regularly operating, the magnitude of impact of chemical pollution is reported as Minor for Coplow Brook. This would result in a Slight significance of effect for chemical pollution in relation to Coplow Brook.

82) Due to the smaller extents impacted from the proposed access haul route (which runs perpendicular to the watercourses in this location), focussed on the crossing locations, the magnitude of impact from chemical pollution during the construction period to Greg Sike and Unnamed Watercourse 2097 would be Negligible. This would result in a Neutral significance of effect for Greg Sike and Unnamed Watercourse 2097.

83) Due to the proximity of Unnamed Watercourse 2099 to the southern compound laydown area and bridge launch location, and the likely limited dilution capacity of this low sensitivity modified drainage channel, the magnitude of impact of chemical pollution is reported as Minor. This would result in a Neutral significance of effect for chemical pollution on Unnamed Watercourse 2099.

84) The River Ribble would be crossed by a bridge structure which would be erected during the construction phase. The activities outlined in the sediment laden runoff section are also applicable to chemical pollution during the construction phase. The magnitude of impact from chemical pollution to the River Ribble would be Negligible. This would result in a Neutral significance of effect.

Bed and Bank Disturbance

85) During the construction phase there would be a requirement for the installation of temporary clear span bailey bridges on three minor watercourses within the assessment area to facilitate the temporary haul route. The activities associated with the construction of the temporary bridge crossings including working within the vicinity of the watercourse and the tracking of plant, which have the potential to generate impacts relating to bank disturbance. There would also be a requirement for the construction of temporary drainage outfalls on Coplow Brook and the River Ribble. These activities may lead to disturbances to the bed and banks of watercourses which may lead to short-term increases in turbidity, change in pH value and increase suspended solids leading to changes in surface water quality should disturbed bank material enter the watercourse. There would also be a requirement for a temporary bridge crossing on the River Ribble.

86) Clear span temporary bailey bridges would be installed on Coplow Brook and Greg Sike and therefore the need for working in these watercourses to construct the crossings is removed. However, there would still be a requirement for in-channel working on Coplow Brook to construct a drainage outfall headwall. Therefore, the magnitude of impact of bed and bank disturbance on Coplow Brook is Minor. This would result in a Slight significance of effect for Coplow Brook.

87) Due to the requirement of a bailey bridge on Greg Sike, but no requirement for in-channel working, the magnitude of impact from bank disturbance is reported as Negligible. This would result in a Neutral significance of effect for Greg Sike.

88) A further bailey bridge is required to be installed across Unnamed Watercourse 2097 to facilitate the access haul route. As there would be no requirement for in-channel working, the magnitude of impact from bank disturbance is Negligible. This would result in a Neutral significance of effect for Unnamed Watercourse 2097.

89) The temporary bridge crossing over the River Ribble would be clear span and constructed on raised bridge piers and associated abutments (formed in the channel floodplain). The bridge piers or deck would not be in direct contact with the bed or banks of the watercourse once constructed. Therefore, impacts to bank disturbance would be minimised. Construction of the piling platform, the operation of

piling itself and the movement and tracking of plant within the floodplain has the potential to cause disturbance to the banks of the River Ribble. Additionally, the construction of four temporary drainage outfalls would be required along the banks of the River Ribble. Therefore, the magnitude of impact reported for bank and bed disturbance on the River Ribble is Minor. This would result in a Slight significance of effect.

**Groundwater**

90) During the construction phase of the Proposed Ribble Crossing, the main activities that have been identified as having the potential to impact groundwater bodies identified in the groundwater baseline include:

- Construction of temporary haul route (including topsoil stripping and earthworks)
- Topsoil storage mound formation
- Construction of bridges for smaller watercourse crossings
- Construction of the temporary bridge structure, including piling of bridge foundations
- Shallow groundwater flow disturbance resulting from earthworks and compaction-related effects
- Groundwater contamination through mobilisation of suspended solids
- Groundwater contamination through accidental leaks and spills.

91) As assessed in the enabling phase, groundwater flow disturbance could occur due to compaction-related to construction activities, but this would be expected to have Negligible impact, resulting in Neutral significance of effect.

92) As assessed in the enabling phase, the temporary haul route construction, topsoil mound formation and other earthworks could trigger groundwater quality issues due to mobilisation of suspended solids and / or accidental spills and leaks of fuels. With embedded mitigation measures (see Chapter 3) and measures identified in the CCoP (see Appendix 3.2) in place, potential impacts would be the same as during the enabling phase (Minor magnitude), resulting in Slight or Neutral potential significance of impact depending on the sensitivity of the aquifer units.

93) Piling has the potential to create new vertical pathways for any surface contamination to migrate into superficial and bedrock aquifers. Without any specific prevention measures this could have a Moderate impact on both the alluvium aquifer and the bedrock, resulting in in a Moderate potential significance of effect on both aquifers.

**Summary of Effects**

94) The summary of construction effects for fluvial geomorphology, surface water quality and groundwater are shown in Table 7.9.

**Table 7.9: Summary of Construction Phase Effects**

| Environmental / Community Asset | Value / Sensitivity | Effect | Nature of Effect | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| **Fluvial Geomorphology** | | | | | |
| River Ribble (W2325) | Very High | Increased fine sediment input | Temporary | Minor | Moderate |
| | | Changes to flow regime | Temporary | Negligible | Neutral |
| | | Disturbance to bed and banks (outfalls) | Temporary | Minor | Moderate |
| | | Disturbance to bed and banks (bridge crossing) | Temporary | Minor | Moderate |
| Greg Sike (W2321) | High | Increased fine sediment input | Temporary | Moderate | Moderate |
| | | Disturbance to bed and banks | Temporary | Minor | Slight |
| | | Changes to flow regime | Temporary | Negligible | Neutral |
| Coplow Brook (W2349) | Medium | Increased fine sediment input | Temporary | Moderate | Moderate |
| | | Changes to flow regime | Temporary | Negligible | Neutral |
| | | Disturbance to bed and banks | Temporary | Minor | Slight |
| Unnamed Watercourse 2097 (W2348) | Low | Increased fine sediment input | Temporary | Negligible | Neutral |
| | | Disturbance to bed and banks | Temporary | Minor | Neutral |

| Environmental / Community Asset | Value / Sensitivity | Effect | Nature of Effect | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| | | Changes to flow regime | Temporary | Negligible | Neutral |
| **Surface Water Quality** | | | | | |
| River Ribble (W2325) | Medium | Sediment Laden Runoff | Temporary | Minor | Slight |
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| | | Bed and Bank Disturbance | Temporary | Minor | Neutral |
| Greg Sike (W2321) | Medium | Sediment Laden Runoff | Temporary | Negligible | Neutral |
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| | | Bank Disturbance | Temporary | Negligible | Neutral |
| Coplow Brook (W2349) | Medium | Sediment Laden Runoff | Temporary | Minor | Slight |
| | | Chemical Pollution | Temporary | Minor | Slight |
| | | Bed and Bank Disturbance | Temporary | Minor | Slight |
| Unnamed Watercourse 2097 (W2348) | Low | Sediment Laden Runoff | Temporary | Negligible | Neutral |
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| | | Bank Disturbance | Temporary | Negligible | Neutral |
| Unnamed Watercourse 2099 (W2352) | Low | Sediment Laden Runoff | Temporary | Minor | Neutral |
| | | Chemical Pollution | Temporary | Minor | Neutral |
| **Groundwater** | | | | | |
| | High | Flow disturbance | Temporary | Negligible | Neutral |

| Environmental / Community Asset | Value / Sensitivity | Effect | Nature of Effect | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| Clitheroe Limestone Formation and Hodder Mudstone Formation (Undifferentiated) | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Negligible | Neutral |
| | | Creation of vertical pathway for surface contamination to migrate as a result of piling | Permanent | Moderate | Moderate |
| Alluvium | High | Flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |
| | | Creation of vertical pathway for surface contamination to migrate as a result of piling | Permanent | Moderate | Moderate |
| Till (diamicton) | Medium | Flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |
| Hummocky (mounds) glacial deposits | Medium | Flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |
| Glaciolacustrine | Low | Flow disturbance | Temporary | Negligible | Neutral |

| Environmental / Community Asset | Value / Sensitivity | Effect | Nature of Effect | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Neutral |

### 7.6.5 Operational Phase

95) The following provides an overview of the potential effects on the water environment for the operational phase.

**Fluvial Geomorphology**

96) The operational phase of the Proposed Ribble Crossing would include the following activities which could interact with the watercourses identified in the fluvial geomorphology baseline:

- Use of temporary haul route
- Discharge of surface water run-off.

97) Without any specific mitigation (i.e. non-embedded mitigation), these activities would have the potential to cause the following which are described in more detail below:

- Increased fine sediment input
- Changes to flow regime.

Increased fine sediment input

98) While the proposed temporary haul route would be in use, fine sediment could be mobilised and washed into the River Ribble, Greg Sike and Coplow Brook. These watercourses exhibited a range of geomorphological features and processes which could be impacted by increased volumes of fine sediment (smothering). However, the volumes of mobilised sediment are likely to be low and would likely be intercepted and deposited in the drainage swales which run adjacent to the haul route. Therefore, the impact would likely be Minor, with a Slight significance of effect for Greg Sike and Coplow Brook. Given the ability of the River Ribble to effectively transport sediment through this reach it is unlikely that smothering would occur, with any fine sediment entering the watercourse likely to be efficiently transported and dispersed downstream. Therefore, any impacts would be Negligible resulting in a Neutral significance of effect for the River Ribble

99) While the proposed temporary haul route would be in use, fine sediment could be mobilised and reach Unnamed Watercourse 2097. The impact would likely be Negligible resulting in a Neutral significance of effect, as assessed and identified during the enabling works phase (Section 7.6.1).

Changes to flow regime

100) Impacts associated with changes in flow regime would be similar in nature to the ones identified and assessed during the construction phase (Section 7.6.2), i.e. Negligible resulting in a Neutral significance of effect.

**Surface Water Quality**

101) The operational phase of the Proposed Ribble Crossing would include the following activities which could have the potential to interact with the watercourses identified in the surface water quality baseline:

- Use of temporary haul route and compound laydown areas
- Use of temporary bridges
- Soil storage within compound laydown areas
- Release of polluting substances (oils, fuels, and chemicals)
- Continued discharge of site drainage.

102) The potential impacts to surface water quality associated with these activities remain of a similar nature to those detailed in the enabling and construction phases. The significance of effect from sediment laden runoff, chemical pollution and bank disturbance are Slight or Neutral for each of the identified watercourses.

**Groundwater**

103) During the operational phase of the Proposed Ribble Crossing, the main activities that have been identified as having the potential to impact groundwater bodies identified in the groundwater baseline include:

- Potential compaction within shallow aquifers beneath the temporary haul route during use of the haul route to facilitate construction access
- Contamination derived from haul route runoff and accidental leaks and spills
- Long term groundwater disturbance associated with piling.

104) The potential impacts associated with compaction flow disturbance and groundwater quality impacts remain of similar nature to the ones identified during enabling and construction phases, and the significance of impacts remain the same i.e. Slight or Neutral.

105) Long term disturbance of groundwater flows associated with piles is expected to be very localised and negligible at the scale of the aquifers. This would result in a Neutral significance of impact.

**Summary of Effects**

106) The summary of commissioning phase effects for fluvial geomorphology, surface water quality and groundwater are shown in Table 7.10.

**Table 7.10: Summary of Operational Phase Effects**

| Environmental / Community Asset | Value / Sensitivity | Effect | Nature of Effect | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| **Fluvial Geomorphology** | | | | | |
| River Ribble (W2325) | Very High | Increased fine sediment input | Temporary | Minor | Moderate |
| | | Changes to flow regime | Temporary | Negligible | Neutral |
| Greg Sike (W2321) | High | Increased fine sediment input | Temporary | Moderate | Slight |
| | | Changes to flow regime | Temporary | Negligible | Neutral |
| Coplow Brook (W2349) | Medium | Increased fine sediment input | Temporary | Moderate | Slight |
| | | Changes to flow regime | Temporary | Negligible | Neutral |
| Unnamed Watercourse 2097 (W2348) | Low | Increased fine sediment input | Temporary | Negligible | Neutral |
| | | Changes to flow regime | Temporary | Negligible | Neutral |
| **Surface Water Quality** | | | | | |
| River Ribble (W2325) | Medium | Sediment Laden Runoff | Temporary | Minor | Slight |
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| | | Bank Disturbance | Temporary | Negligible | Neutral |
| Greg Sike (W2321) | Medium | Sediment Laden Runoff | Temporary | Negligible | Neutral |

| Environmental / Community Asset | Value / Sensitivity | Effect | Nature of Effect | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| | | Bank Disturbance | Temporary | Negligible | Neutral |
| Coplow Brook (W2349) | Medium | Sediment Laden Runoff | Temporary | Minor | Slight |
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| | | Bank Disturbance | Temporary | Negligible | Neutral |
| Unnamed Watercourse 2097 (W2348) | Low | Sediment Laden Runoff | Temporary | Negligible | Neutral |
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| | | Bank Disturbance | Temporary | Negligible | Neutral |
| Unnamed Watercourse 2099 (W2352) | Low | Sediment Laden Runoff | Temporary | Negligible | Neutral |
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| **Groundwater** | | | | | |
| Clitheroe Limestone Formation and Hodder Mudstone Formation (Undifferentiated) | High | Compaction flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Negligible | Neutral |
| | | Long term groundwater flow disturbance due to piling | Permanent | Negligible | Neutral |

| Environmental / Community Asset | Value / Sensitivity | Effect | Nature of Effect | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| Alluvium | High | Compaction flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |
| | | Long term groundwater flow disturbance due to piling | Permanent | Negligible | Neutral |
| Till (diamicton) | Medium | Compaction flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |
| Hummocky (mounds glacial deposits | Medium | Compaction flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |
| Glaciolacustrine | Low | Compaction flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Neutral |

### 7.6.6 Decommissioning Phase

107) The following provides an overview of the potential effects on the water environment due to the decommissioning phase.

**Fluvial Geomorphology**

108) The decommissioning phase of the Proposed Ribble Crossing would include the following activities which could interact with the watercourses identified in the fluvial geomorphology baseline:

- Replacement of removed soil and removal of soil storage
- Removal of temporary bridges
- Removal of temporary outfalls
- Removal of temporary haul routes.

109) Without any specific mitigation (i.e. non-embedded mitigation), these activities would have the potential to cause the following which are described in more detail below:

- Increased fine sediment input
- Disturbance to bed and banks.

Increased fine sediment input

110) During the removal of the temporary haul route and associated structures, fine sediment could be mobilised and reach the River Ribble, through surface water run-off. This watercourse exhibited extensive morphological features which could be impacted (i.e. smothered) by fine sediment associated with the works. Specifically, a medial bar immediately adjacent to the proposed crossing location. The impact would likely be Minor, resulting in a Moderate significance of effect.

111) There were few geomorphological features on Unnamed Watercourse 2097. Therefore, an increase in the supply of fine sediment during the removal of the temporary haul route and associated structures would likely have a Negligible impact, resulting in a Neutral significance of effect.

112) The geomorphological features on Greg Sike included steps, riffles, and lateral bars, which would be sensitive to increased fine sediment input and siltation (i.e. smothering). Therefore, an increase in the supply of fine sediment during the removal of the temporary haul route and associated structures would likely have a Moderate impact on Greg Sike, resulting in a Moderate significance of effect.

113) Coplow Brook exhibited several morphological features which could be affected by fine sediment (i.e. smothered), during the removal of the temporary haul route and associated structures. The impact would likely be Moderate, resulting in a Moderate significance of effect.

114) Surplus material stockpiles within 15 m of Coplow Brook and 130 m of the River Ribble, would be used in the reinstatement works. This represents a potential source of fine sediment which could be delivered to the watercourses. This would likely have a Minor impact, resulting in a Slight significance of effect of for Coplow Brook and Moderate significance of effect for the River Ribble.

Disturbance to bed and banks

115) Removal of four outfalls could disturb bed and bank features and cause compaction of bed substrate on the River Ribble. Geomorphological features included a step, a vegetated mid-channel bar, and lateral, point, and medial bars. All these features are in the channel and are away from the banks, lessening the impact. Whilst four outfalls would need to be removed, the impacts associated with removal of the structures would likely be Minor resulting in a Moderate significance of effect.

116) Outfall removal could disturb bed and bank features and cause compaction of bed substrate on Coplow Brook. At the location of the proposed outfall, geomorphological features were limited, therefore there would likely be a Minor impact on Coplow Brook, resulting in a Slight significance of effect.

117) The removal of the bridge structures on Greg Sike, Coplow Brook and Unnamed Watercourse 2097 after being in place for a prolonged period of time may lead to a disturbance of the bank which may adjust following the removal of the structure. This could result in bank failure which would likely have a Moderate impact on the watercourses affected, resulting in either a Moderate (for Greg Sike and Coplow Brook) or Slight (Unnamed Watercourse 2097) significance of effect.

**Surface Water Quality**

118) During the decommissioning phase of the Proposed Ribble Crossing, the following activities have been identified as having the potential to impact on watercourses identified in the surface water quality baseline:

- Removal of temporary watercourse crossings
- Reinstatement of temporary haul route and compounds laydown areas
- Release of polluting substances (oils, fuels, chemicals and cement) from plant and machinery during reinstatement
- Removal of temporary drainage outfalls to surface water features.

119) Without any specific mitigation (i.e. non-embedded mitigation), these activities for the decommissioning works would have the potential to cause the following effects on water quality which are described in more detail below:

- Sediment laden runoff
- Chemical pollution
- Bank disturbance.

<u>Sediment Laden Runoff</u>

120) The activities outlined above have the potential to generate sediment laden runoff which would potentially impact the watercourses identified in the surface water quality baseline. It is assumed that reinstatement would be phased, and that drainage features would be the last features to be reinstated. Reinstated areas can take time before vegetation establishes and these exposed or unconsolidated surfaces may be a source of sediment laden runoff. Should runoff enter watercourses this can lead to decreases in water quality arising from changes in pH value, sediment loading and high turbidity and other potential impacts to water chemistry.

121) Due to proximity of reinstatement works at multiple locations to the Coplow Brook, the magnitude of impact of sediment laden runoff during the decommissioning phase would be Minor, resulting in a Slight significance of effect.

122) Due to the smaller extents impacted by the reinstatement of the access haul route, and the removal of the bridge crossings, the magnitude of impact of sediment laden runoff during the decommissioning phase for Greg Sike and Unnamed Watercourse 2097 would be Negligible. This would result in a Neutral significance of effect for Greg Sike and Unnamed Watercourse 2097.

123) Due to the proximity of Unnamed Watercourse 2099 to the south compound laydown area, which would be reinstated, and the temporary bridge location which would be removed, the magnitude of impact of sediment laden runoff is reported as Minor. This would result in a Neutral significance of effect.

124) The removal of the bridge crossing on the River Ribble would require working within the floodplain to remove the bridge and reinstate the surrounding area, including the access haul route and compound laydown areas on the north and south banks. These activities could impact on surface water quality, with the reinstated surfaces remaining a potential source of sediment generation for some period until the establishment of vegetation. Therefore, the magnitude of sediment laden runoff for the River Ribble is reported as Minor. This would result in a Slight significance of effect.

Chemical Pollution

125) During the decommissioning phase, the activities outlined above in relation to the generation of sediment laden runoff, would also be applicable for chemical pollution.

126) Due to proximity of reinstatement works at multiple locations to the Coplow Brook, the magnitude of impact of chemical pollution during the decommissioning phase is reported as Minor. This would result in a Slight significance of effect.

127) Due to the smaller reaches impacted by the reinstatement of the proposed temporary haul route and the distance from site compounds/construction laydown areas the magnitude of impact of chemical pollution during the decommissioning phase for Greg Sike and Unnamed Watercourse 2097 is reported as Negligible. This would result in a Neutral significance of effect for Greg Sike and Unnamed Watercourse 2097.

128) Due to the proximity of Unnamed Watercourse 2099 (W2352) to the southern compound/laydown area and bridge location where plant and machinery would be regularly working, and the likely limited dilution capacity of this low sensitivity modified drainage channel, the magnitude of impact of chemical pollution is reported as Minor. This would result in a Neutral significance of effect for chemical pollution on Unnamed Watercourse 2099.

129) As outlined in sediment laden runoff, several activities would be required to decommission the Proposed Ribble Crossing and reinstate the surrounding area. These activities would be undertaken within the floodplain of the River Ribble and have the potential to generate chemical pollution through accidental spillages and leakages from plant and materials. The magnitude of impact of chemical pollution for the River Ribble would be Negligible. This would result in a Neutral significance of effect.

Bank Disturbance

130) During the decommissioning phase the temporary bridges would be removed. The removal of the temporary bridges could cause a short-term impact on surface water quality following the release of and disturbance to the banks of the channel. This would increase turbidity and suspended solids leading to a decrease in water quality.

131) There would be the requirement to remove the temporary drainage outfalls and headwalls on Coplow Brook and the River Ribble. This has the potential to disturb bank material through the tracking of plant and the physical removal of the headwalls. Should disturbed bank material enter the watercourse it could lead to temporary increases in pH value, suspended solids and turbidity and other impacts to water quality.

132) The magnitude of impact of bank disturbance related to the removal of the bailey bridge and outfall headwall Coplow Brook is reported as Minor. This would result in a Slight significance of effect for Coplow Brook.

133) Similar impacts to those outlined above for Coplow Brook exist for Greg Sike and Unnamed Watercourse 2097 with regards to the removal of the temporary bailey bridges. However, there would not be a requirement for in-channel working to remove drainage outfalls on Greg Sike or Unnamed Watercourse 2097. The magnitude of impact of bank disturbance related to the removal of the temporary bailey bridge for Greg Sike and Unnamed Watercourse 2097 is reported as Negligible. This would result in a Neutral significance of effect.

134) Activities associated with the removal of the temporary bridge crossing over the River Ribble are outlined in the sediment laden runoff section. Some of these activities including the removal of bridge piers and abutments, as well as the drainage outfalls have the potential to disturb the banks of the watercourse. For similar reasons to those outlined for sediment laden runoff, the magnitude of impact of bank disturbance for the River Ribble is reported as Minor. This would result in a Slight significance of effect.

**Groundwater**

135) The decommissioning phase would involve removing the infrastructure and restoring the land to baseline conditions. The soil removed during the enabling and construction phase would be reinstated,

and the removal of infrastructure would relieve some of the compaction of the ground, allowing groundwater flows to resume natural flow paths. Therefore, no long-term compaction flow disturbance impacts would be expected. Potential groundwater quality impacts during decommissioning works would be similar to those identified during the operational phase i.e. Negligible, resulting in a Neutral significance of effect.

136) As assessed in the enabling phase, the temporary haul route construction, topsoil mound formation and other earthworks could trigger groundwater quality issues as a result of mobilisation of suspended solids and / or accidental spills and leaks of fuels. With embedded mitigation measures (see Chapter 3) and measures from the CCoP (see Appendix 3.2) in place, potential impacts would be the same as during the enabling phase (Minor magnitude) and result in Slight or Neutral potential significance of impact, depending on the sensitivity of the aquifer units.

137) The piles for the bridge are expected to remain in situ when decommissioning the site, therefore the potential impacts identified during the operational phase would be permanent i.e. moderate magnitude of impact with Moderate significance of effect.

**Summary of Effects**

138) The summary of decommissioning effects for fluvial geomorphology, surface water quality and groundwater are shown in are shown in Table 7.11.

**Table 7.11: Summary of Decommissioning Phase Effects**

| Environmental / Community Asset | Value / Sensitivity | Effect | Nature of Effect | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| **Fluvial Geomorphology** | | | | | |
| River Ribble (W2325) | Very High | Increased fine sediment input | Temporary | Minor | Moderate |
| | | Disturbance to bed and banks | Temporary | Minor | Moderate |
| Greg Sike (W2321) | High | Increased fine sediment input | Temporary | Moderate | Moderate |
| | | Disturbance to bed and banks | Temporary | Moderate | Moderate |
| Coplow Brook (W2349) | Medium | Increased fine sediment input | Temporary | Moderate | Moderate |
| | | Disturbance to bed and banks (outfall) | Temporary | Minor | Slight |
| | | Disturbance to bed and banks (bridge) | Temporary | Moderate | Moderate |
| Unnamed Watercourse 2097 (W2348) | Low | Increased fine sediment input | Temporary | Negligible | Neutral |
| | | Disturbance to bed and banks | Temporary | Moderate | Slight |
| **Surface Water Quality** | | | | | |
| River Ribble (W2325) | Medium | Sediment Laden Runoff | Temporary | Negligible | Neutral |
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| | | Bank Disturbance | Temporary | Minor | Slight |
| Greg Sike (W2321) | Medium | Sediment Laden Runoff | Temporary | Negligible | Neutral |
| | | Chemical Pollution | Temporary | Negligible | Neutral |
| | | Bank Disturbance | Temporary | Negligible | Neutral |
| Coplow Brook (W2349) | Medium | Sediment Laden Runoff | Temporary | Minor | Slight |
| | | Chemical Pollution | Temporary | Minor | Slight |
| | | Bed and Bank Disturbance | Temporary | Minor | Slight |
| | Low | Sediment Laden Runoff | Temporary | Negligible | Neutral |

| Environmental / Community Asset | Value / Sensitivity | Effect | Nature of Effect | Magnitude | Significance of Effect (Pre-Mitigation) |
|---|---|---|---|---|---|
| Unnamed Watercourse 2097 (W2348) | | Chemical Pollution | Temporary | Negligible | Neutral |
| | | Bank Disturbance | Temporary | Minor | Neutral |
| Unnamed Watercourse 2099 (W2352) | Low | Sediment Laden Runoff | Temporary | Minor | Neutral |
| | | Chemical Pollution | Temporary | Minor | Neutral |
| **Groundwater** | | | | | |
| Clitheroe Limestone Formation and Hodder Mudstone Formation (Undifferentiated) | High | Compaction flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Negligible | Neutral |
| | | Long term groundwater flow disturbance due to piling | Permanent | Negligible | Neutral |
| Alluvium | High | Compaction flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |
| | | Long term groundwater flow disturbance due to piling | Permanent | Negligible | Neutral |
| Till (diamicton) | Medium | Compaction flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |
| Glaciolacustrine | Low | Compaction flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Neutral |
| Hummocky (mounds) glacial deposits | Medium | Compaction flow disturbance | Temporary | Negligible | Neutral |
| | | Accidental spills/ leaks and mobilisation of suspended solids | Temporary | Minor | Slight |

## 7.7 Mitigation and Residual Effects

139) Mitigation is most effective if considered as an integral part of the Proposed Ribble Crossing design to avoid, reduce or offset any adverse effects on the Water Environment or wider environment – this is embedded mitigation. Good practice mitigation, and following relevant guidelines and legislation, is addressed in the CCoP. Essential mitigation measures, beyond embedded mitigation and the CCoP, are detailed in the following sections and summarised in Table 7.12.

**Fluvial Geomorphology**

140) To mitigate the impact on fluvial geomorphology from the Proposed Ribble Crossing the following essential mitigation would be required:

- Where necessary reinstate natural bed features to counteract smothering of features by fine sediment during the enabling, construction and decommissioning phases on the River Ribble, Coplow Brook and Greg Sike (**Mitigation Item WE-RC1**)
- Use a biodegradable geotextile on the banks to allow for vegetation re-establishment along the upper and mid-banks and to aid bank re-stabilisation during reinstatement on the River Ribble, Coplow Brook and Greg Sike (**Mitigation Item WE-RC2**)
- Ensure riparian vegetation re-establishment is prioritised during reinstatement works on the River Ribble, Coplow Brook and Greg Sike to minimise the risk of bank destabilisation (**Mitigation Item WE- RC3**)
- Reinstatement work to be supervised by a geomorphologist or Environmental Clerk of Works with experience of channel restoration. This would be of particular importance where bridge crossings would be removed which could result in bank destabilisation on Coplow Brook and Greg Sike, and where sediment augmentation is necessary (**Mitigation Item WE-RC4**).

**Surface Water Quality**

141) The surface water quality impact assessment did not identify any significant effects for any of the watercourses identified within the surface water quality baseline. Therefore, no additional mitigation would be required to further reduce impacts identified in the surface water quality assessment.

**Groundwater**

142) To mitigate the impact on bedrock and alluvial aquifers a piling risk assessment would be carried out to assess these potential impacts and identify mitigation measures (if required) during detailed design of the Proposed Ribble Crossing (**Mitigation Item WE-RC5**).

**Table 7.12: Summary of Mitigation and Residual Effects**

| Environmental / Community Asset | Mitigation | Magnitude (With Mitigation) | Residual Effect and Significance |
|---|---|---|---|
| **Fluvial Geomorphology** | | | |
| River Ribble<br>Greg Sike<br>Coplow Brook | ▪ Reinstate the natural bed where necessary (**WE-RC 1**)<br>▪ Stabilise the bank using geotextiles during reinstatement (**WE- RC2**)<br>▪ Prioritise riparian planting during reinstatement (**WE-RC3**)<br>▪ Employ a geomorphologist/ Environmental Clerk of Works during reinstatement (**WE-RC4**). | Negligible | Neutral |
| **Surface Water Quality** | | | |
| No measures required | | | |
| **Groundwater** | | | |
| Bedrock and alluvium aquifers | ▪ Piling risk assessment to identify specific risks and mitigation measures (**WE-RC5**). | Negligible | Neutral |

## 7.8 Cumulative Effects

143) The following section provides an overview of the potential cumulative effects from different proposed developments and land allocations, in combination with the Proposed Ribble Crossing (i.e. inter-project cumulative assessment). Data on proposed third party developments and land allocations contained in development plan documents were obtained from various sources, including local planning authority websites, online searches, and consultations with planning officers. Proposed development data were then reviewed with a view to identifying schemes or land allocations whose nature, scale and scope could potentially give rise to significant environmental effects when considered in combination with the likely effects arising from the Proposed Ribble Crossing.

144) Intra-project cumulative impacts, i.e. two or more types of impact acting in combination on a given environmental receptor, property or community resource, are considered in Chapter 14: Communities and Health.

145) The over-arching cumulative effects of the Proposed Programme of Works i.e. the five proposed replacement tunnel sections in combination, are considered in Volume 2 Chapter 19: Cumulative Effects. In addition, Volume 2 Chapter 19 examines the cumulative effects associated with the outcomes from Volume 2 (delivery and operation of the main construction compounds, tunnel, and construction traffic routes), Volume 5 (proposed off-site highways works and satellite compounds), and Volume 6 (Proposed Ribble Crossing).

146) Based on professional judgement, it was concluded that there are no proposed third party developments or land allocations in local development plan documents which could potentially give rise to likely significant cumulative effects on any watercourses or hydrogeology. No cumulative assessment was therefore undertaken for Water Environment in the context of the Ribble Crossing.

## 7.9 Conclusion

147) This report has considered the potential water environment impacts associated with the enabling, construction, operation and decommissioning works along the route of the Proposed Ribble Crossing. This has included an assessment of the impacts on fluvial geomorphology, surface water quality and groundwater.

148) The assessment has shown that some impacts can be lessened through embedded mitigation detailed in Chapter 3 (Design Evolution and Development Description) and the Construction Code of Practice (Volume 4 Appendix 3.2). Other impacts require specific mitigation.

149) For fluvial geomorphology, mitigation would be required for the impact of the temporary haul route and temporary bridge crossings on the River Ribble, Greg Sike and Coplow Book. Mitigation measures required include reinstatement of natural bed features (as necessary), stabilise the bank during reinstatement using geotextiles and prioritising re-planting of riparian vegetation. No residual effects would be anticipated.

150) For surface water quality no significant effects of Moderate or above has been identified for any of the watercourses.. If implemented as described, mitigations outlined within the CCoP would be sufficient in controlling the potential impacts to surface water quality arising from the Proposed Ribble Crossing.

151) For groundwater, mitigation would be required to address potential impact to bedrock and alluvium aquifers created as a result of piling. A piling risk assessment would be carried out prior to work commencing to identify specific risks and mitigation measures. No other significant potential impacts to groundwater receptors have been identified.

152) Proposed developments within 5 km of the Proposed Ribble Crossing have been identified. Cumulative effects have been assessed in terms of the additional and combined effects. None of the developments identified are likely to cause a cumulative effect on fluvial geomorphology, surface water quality, or groundwater.

## 7.10 Glossary and Key Terms

153) Key phrases and terms used within this technical chapter relating to Water Environment are defined within Volume 4 Appendix 1.2: Glossary and Key Terms.